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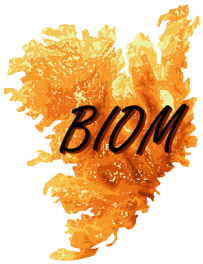

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Session 1: Importance of historical data for assessing dynamic trends of vegetation and landscape

Will the human footprint ever disappear? Importance of historical data for assessing dynamic trends of vegetation in dry Mediterranean grasslands

Thierry Dutoit

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Former human land-uses are important factors determining dynamic trends of vegetation in Europe. Nevertheless, more information are still needed about the very long-term (several centuries to several millennia) influence of these impacts especially in dry Mediterranean grasslands submitted to important changes in land-uses in the 20th century and the present climate change influences. In the most species-rich French Mediterranean dry grassland (La Crau, Southern France), archaeological and historical surveys have revealed a dense network of ancient sheep stables dating from the Roman to Modern period times but also, during the documentary investigations, the existence of ancient botanical surveys dating from the second half of the 20th century. By analysing soil chemistry, soil wood charcoals, vegetation composition and revisiting old phytosociological surveys, we show a pertaining signature of location and exploitation of the Roman, ancient and modern enclosures on present day ecosystem features but also changes in the floristic composition of the whole steppe linking more to recent changes of pastoral practices. These results show that vegetation changes still continue two millennia after human impacts, and that even the small scale pastoral activities of sheep concentrations in enclosures during the Roman times have still sensible impacts on present day herbaceous plant communities composition and species-richness. Then, these results questions the relevance of global plant succession models and for application purposes, long term human legacies must be take into account in conservation and restoration plans of semi natural grasslands.

Talk Sessions

Session 1: Importance of historical data for assessing dynamic trends of vegetation and landscape

Four decades of change in coastal dune vegetation: ecological guilds and emerging drivers along the central Adriatic coast

Maria Carla de Francesco, Maria Laura Carranza, Micaela Del Valle Rasino, Marco Varricchione & Angela Stanisci

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Long-term vegetation plot datasets, including historical records and repeated surveys, are essential tools for detecting and understanding spatial and temporal changes in plant community diversity, structure and functioning (1, 2). We built and compiled AdriaVeg Database (EU-IT-024) available in GIVD (3) which contains 1,000 published and unpublished georeferenced vegetation plots collected between 1985 and 2025 along the Italian sandy coast of Abruzzo, Molise and North Apulia, including both single and re-surveyed plots (4). From AdriaVeg DB, we selected 212 plots and defined two periods series: T1 (1985-2005; n=106) and T2 (2006-2025; n=106), equally distributed across three coastal dune vegetation zones: shifting dunes (EU habitats 1210, 2110, 2120; EUNIS habitats N12, N14), transition dunes (EU habitats 2130*, 2230; EUNIS habitat N16), and fixed dunes (EU habitats 2250*, 2260, 2270*, 9340; EUNIS habitats N1B, N1G, T21).

Species were classified into 4 ecological guilds: (1) typical species (diagnostic of the EU habitats analyzed - shifting, transition, fixed), typical species of other EU habitats, ruderal and (4) non-native species. In addition, Ecological Indicator Values for Europe - EIVEs (5) and Disturbance Indicator Values - DIVs (6) were also assigned to each species.

For each dune zone, we compared species cover and richness within each ecological guild between T1 and T2, and calculated species turnover and beta diversity. Random Forest models were then applied to identify main drivers of temporal change.

From T1 to T2, the cover and richness of typical species significantly increased in the shifting and fixed dune habitats, while the transition dunes remained largely stable in terms of typical species richness and cover. In contrast, the fixed dunes showed a significant decline in the typical species richness, even if the typical species cover increased, accompanied by high species turnover.

Driver analysis implemented with Random Forest showed changes in the three dune zones: a) shifting dunes were associated with the increase in typical species of other habitats and a slightly increase in moisture and disturbance frequency indicators; b) no significant drivers emerged in transition dunes; c) in fixed dunes, the indicators of soil disturbance and disturbance frequency decreased.

Overall this study highlights the value of long-term vegetation databases for disentangling the drivers of ecosystem dynamics and provides insights of emerging drivers trajectories across coastal dune habitats.

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*Recovering historical vegetation plots: digitisation of Yurii Kleopov's century-old relevés from the south-western Donets Ridge, Ukraine

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Yurii D. Kleopov (1902-1943) was a prominent figure in 20th-century Ukrainian geobotany and floristics. He is regarded as a pioneer in the study of the origin and development of floristic complexes, and his most important work concerned forest and steppe vegetation in Eastern Europe. In the Soviet period, however, his name was suppressed for decades, and his works could not be freely cited or used in scientific literature. Only since the 1990s has his legacy gradually returned to the history of botany through the efforts of Ukrainian botanists. One of his most important regional studies, the 160-page monograph "Vegetation of the southwestern part of Donets Ridge" (1933), described the vegetation of the Donets Region (former Stalino District) in Eastern Ukraine. We digitised and georeferenced more than 250 vegetation plots from Kleopov's monograph and made them available for contemporary vegetation science. The workflow included AI-assisted transcription of relevés, followed by manual verification of digitised data, harmonisation of historical taxon names, standardisation of abundance and phenological records, and georeferencing based on historical toponyms and archival cartographic sources. We also assigned EUNIS habitat types and vegetation classes to most plots. The resulting dataset was prepared for inclusion in the Ukrainian National Phytosociological Database, publication as an open-access GBIF-dataset, and further reuse in vegetation analysis. Yurii Kleopov's records combine complete relevés with precise species identification, cover estimates, phenological information, and detailed notes on soil, relief, and geomorphological context. These features created a historical dataset of outstanding value, which covers a broad range of habitat types, including various grasslands (179 relevés), forests (38), scrubs (7), and wetlands (32). The Donets Ridge remains poorly represented in modern vegetation-plot databases, and much of the region has been inaccessible for field surveys since 2014 due to Russia's military aggression against Ukraine. Recovery of these historical data is therefore especially important for documenting past vegetation patterns, supporting national and pan-European studies, and enabling future analyses of long-term vegetation change. Our project also contributes to restoring the visibility of a scientist whose work was long suppressed and makes an important part of Ukrainian botanical heritage accessible for contemporary research.

*Do divergent landscape changes shape grassland plant species richness across the Czech-Austrian border?

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Changes in grassland plant species richness are often driven by changes in land use/cover (1). However, we should be aware that land use/cover gives us different information than landscape structure. While land use/cover data provide information about the landscape macrostructure/composition (i.e. how many different land use/cover types are in the landscape), landscape structure data provide information about microstructure/configuration (i.e. how patchy the landscape is, irrespective of land use/cover types). European landscapes, especially in Central Europe, experienced simplification of their structure over past decades. This pattern is especially pronounced in the Czech Republic (CZ) compared to Austria (AT), as seen from aerial photos. These differences are staggering considering that both countries shared common past until 1918 and are a result of different political regimes and connected policies (2). We therefore investigated the extent of these differences in landscape structure between both countries and their impact on plant species richness in the grasslands. We selected 30 sites along the Czech-Austrian border, establishing 1.5 km buffers around a historically sampled grassland plots provided by the EVA database. These plots were then resurveyed during the 2024-2025 season. Landscape structure data were derived from aerial photographs (both historical from the 1950s and present from the 2024 covering the CZ) and cadastral maps from the 19th century covering AT, using a combination of (semi)automatic classification and manual vectorization. Preliminary results indicate that while species richness significantly decreased at Austrian sites, no significant trend was observed at Czech sites. Nevertheless, landscape structure changed significantly in both countries between the mid-19th/20th century and present; number of patches in selected buffers decreased, while the average patch area increased. Crucially, we found a significant negative relationship between current species richness and the increase of average patch area over time. We conclude that landscape homogenization—manifested as increasing patch size—is associated with a decline in plant species richness.

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Descended from the mountains, following large changes in forestry methods in the 19th and 20th century- the *Epilobio-Digitalietum* in the Netherlands

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The *Epilobio-Digitalietum* Schwickerath 1944 (*Carici piluliferae-Epilobion angustifolii*, *Epilobietea angustifoliae*) was described from the Hohe Venn in the High Ardennes in Belgium (1) and confirmed afterwards from mountain ranges in (Sub)Atlantic Europe. In literature, its limitation to the colline and montane zone is widely recognised. It was not included in the Dutch National Vegetation Classification (2), although it was suggested that the association might occur in the southeastern part of the Province Limburg bordering the Eifel and Ardennes. Only very few historical relevés of this association are known from the Netherlands though. Up the 1970's, the only character species of the *Epilobio-Digitalietum*, *Digitalis purpurea*, was very rare in the Netherlands, mostly confined to a more or less narrow zone along the border with Germany. From 1970 onwards, *Digitalis* increased widely throughout the Netherlands, including the Veluwe, the sand area in the central part of the country which mainly consists of glacial deposits from the Saalien Glaciation. This raises the question whether the *Epilobio-Digitalietum* also occurs in this lowland region, and, if so, what might explain this altitudinal shift of the association. To answer this question, we studied the *Digitalis* vegetation of woodland clearings, disturbed roadsides, and grass and heath sod dump sites. Phytosociological analysis of the relevés showed that the vegetation with *Digitalis purpurea* at the Veluwe for a large part can be assigned to the *Epilobio-Digitalietum*. Thus, the association is not, or better: no longer, constricted to the colline and montane zone, but established in the Northwest-European lowlands as well. Abduction leads to the conclusion that neither climate change nor nitrogen deposition can be considered as an explanation for this shift in the altitudinal preference of the association. The spread of *Digitalis purpurea* and the *Epilobio-Digitalietum* can, however, be attributed to large changes in the landscape after the introduction of coniferous forests in the so-called '*Hochwald*' forestry system. At the beginning of the 20th century, most of the Veluwe landscape consisted of heathlands of the *Genisto-Callunetum*, but after the heath farming system collapsed, large areas were planted with *Pinus sylvestris*. In addition, the fallow heaths proved easy to be invaded with Pine seedlings. This created the conditions for the establishment of *Digitalis* and the spread of the *Epilobio-Digitalietum* from the collinear-montane zone to the lowlands, since *Digitalis purpurea* occurs optimally at litter of coniferous trees. Its increase can be attributed to the expansion of high forests and the large areas of conifers planted ... and felled in this system. Severe browsing by red deer on the Veluwe is the cause for the prolonged life of the *Epilobio-Digitalietum*, resulting in grassy and mossy stages.

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Using historical vegetation plot surveys, cadastral maps and satellite imagery to assess long-term vegetation trajectories: insights from wet grasslands in western France

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In the context of global change and increasing anthropogenic pressures, long-term vegetation monitoring is essential for effective conservation and management. Several resurvey projects targeting historical vegetation plots are currently underway to address this need (1). In parallel, advances in historical data digitization and artificial intelligence open new avenues for analyzing historical datasets, including 19th-century cadastral maps (2) or archive satellite imagery (3), that can improve knowledge on vegetation dynamics. This study aims to assess the contribution of historical datasets to describe long-term vegetation trajectories. A case study is currently conducted in the countryside hedgerows landscape of the eastern Brittany (western France), a region subject to significant agricultural intensification and urban expansion. The multisource dataset comprises: (i) 91 vegetation plots collected in 1988 in wet grasslands (4); (ii) an optical Landsat satellite time series (30 m spatial resolution) spanning the period 1984-2025; and (iii) digitized Napoleonic cadastral maps, produced between 1810 and 1845 at a scale of 1:2,500, depicting land-use types across the study area. The methodological framework combines a floristic resurvey of the old phytosociological plots with a landscape-scale analysis of land-use trajectories derived from the Napoleonic cadastre and the Landsat time series. First results show vegetation evolutions between 1988 and 2026 in a context of land use changes such as afforestation, urbanization, or agricultural decline or intensification (Fig. 1).

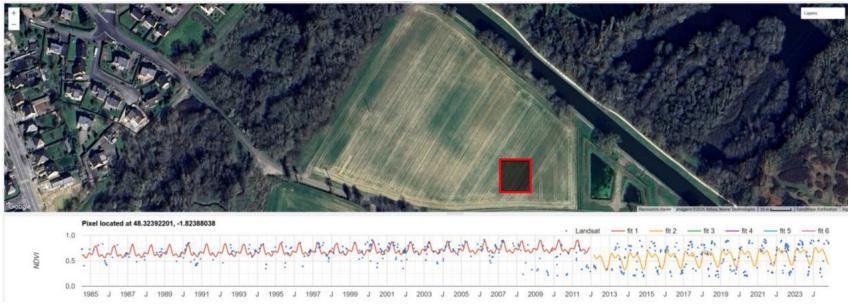

Figure 1. Example of a normalized difference vegetation index (NDVI) time series for a pixel (red rectangle) derived from the Landsat archive (1985-2024) and located on a wet grassland phytosociological plots collected in 1988. Blue dots indicate available Landsat observations for the pixel. A colour change in the curve indicates a conversion of wet grasslands to agricultural land in 2012.

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The Santa Rita Experimental Range: 124 Years of Desert Grassland Dynamics in Southwestern North America

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Established in 1902, the University of Arizona's 20,000-ha Santa Rita Experimental Range (SRER) is the longest continuously operating rangeland research site in the United States and one of the most thoroughly documented sites of vegetation change in the world. Its extensive long-term records of vegetation, precipitation, and livestock use, along with one of the world's largest and most accessible repeat-photography archives, have made the SRER an important site for research on the restoration, protection, and management of desert grasslands in the arid southwestern North America.

This remarkable record exists partly because key methods for measuring vegetation change, such as the line-intercept transect method (1), were developed at the SRER and applied widely and consistently. It also reflects more than 120 years of experiments and systematic observations conducted across elevation, precipitation, and soil gradients, as well as in grazed and ungrazed conditions. This collection provides the temporal and spatial scales for interpreting landscape and vegetation dynamics.

Specifically, the data include 119 photo stations (1902-present), 131 long-term transects (1953-present), 96 transects inside and outside livestock exclosures (2011-present), 24 rain stations (1922-present), and monthly livestock numbers for 35 pastures (1916-present). Together, they span annual, decadal, and centennial time scales across the SRER. These observations have revealed general trends, but their wide spatial distribution, from 900 to 1500 m in elevation and across 18 major soil types, has highlighted exceptions to those trends across environmental gradients and provided insight into the drivers of vegetation dynamics (2).

The most conspicuous long-term change is the steady expansion of the large shrub mesquite since 1902, when livestock dispersed seeds and the cessation of fire allowed it to establish in the grasslands. However, repeat photographs show that mesquite and other woody species were already common in the early 1900s but were largely confined to washes, where fire was less common. Interannual and interdecadal fluctuations in grass cover associated with dry and wet years confirm the role of precipitation in grass dynamics but also demonstrate the resilience of native grasses despite mesquite encroachment and the increasing dominance of the non-native Lehmann lovegrass since the 1970s (3). Similarly, repeated eruptions and declines of cacti and small shrubs exemplify patterns that are primarily driven by precipitation and plant longevity. However, these dynamics vary by elevation and soil type.

The SRER offers vast opportunities for future research, built on more than a century of observation and experimentation and supported by approximately 1,000 scientific publications and partnerships with national agencies such as the National Ecological Observatory Network and the US Department of Agriculture Agricultural Research Service. These opportunities rely on continued access to the long-term datasets and their regular updates (https://santarita.arizona.edu).

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What has happened to the understorey of thermophilous Pannonian oak woods over the past 70 years?

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Communities of subcontinental Pontic-pannonian oak forests on loess sediments of *Aceri tatarici-Quercion* Zólyomi 1957 were already documented in the 1950s by relevés in the Hungarian and Slovak part of the Pannonian region. Opened forest-steppe stands described as *Quercetum pubescenti-roboris* (Zólyomi 1957) Michalko et Džatko 1965 were species-rich, dominated by light demanding subxerophilous species, mainly grasses as *Poa nemoralis*, *Dactylis polygama*, *Brachypodium pinnatum* or *Festuca rupicola*. Closed forests of more mesic communities were classified as *Convallario-Quercetum roboris* Soó (1958) 1971 (1, 2). Both associations are currently extremely rare, and their diagnostic species are disappearing in the Pannonian lowlands. Degradation of original species composition was detected in resurveys of permanent and semipermanent plots located both in managed stands and unmanaged reserves. To verify whether the situation is similar also in the best-preserved sites and in the places not covered by permanent plots, we attempted to repeat sampling in one of the two most representative sites in the Slovak part of Pannonia. We subjectively selected plots in the best-developed patches of herb layer within the same area of the Dubník National Nature Reserve (165 ha) in 2023-5 where preferential sampling was realised in 1957-8 (1) and 2007-8. Significant change of species composition and diversity decrease was found already in 2007 and this trend continued in the latest decades. Mean species richness decreased from 43 to 19 and species pool of the reserve from 135 to 79 taxa. Original relevés from 1950s were clearly separated from the recent ones in the NMDS ordination space and formed a separate cluster in the modified Twinspan classification. We can conclude that species-rich forest-steppe communities of the *Quercetum pubescenti-roboris* no longer exist in the reserve area. They partly changed to more mesic communities and closed stands of the *Convallario-Quercetum roboris* which was considered as climax community (3), however, with limited species composition and richness. Other parts evolved into novel species-poor communities dominated by *Melica uniflora* or *Vinca minor* in the herb layer and *Acer campestre*, which filled the gaps between oaks in the tree layer and thus contributed to a decline in the number of light-demanding forest-steppe species. Preferential sampling in the locality considered as one of the best-preserved confirmed negative trends reported from permanent-plot resurveys. Vegetation of open oak forests and forest-steppes disappeared within several decades following the cessation of historical management, primarily due to the absence of large grazers that could have maintained such communities even before human land use began in the early millennia of the Holocene.

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Time-series on Central European grassland vegetation to study the impacts of country-level landscape dynamics on biodiversity

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Central European grasslands harbor high species diversity and are influenced by local management and land-use histories. These habitats often face shifts from regional management tradition to either abandonment or intensification of land use, which cause a decline in the quality and biodiversity of these habitats (1-2). In most countries of eastern Europe, these ecosystems were severely impacted by collectivization policies in the second half of the 20th century, which led initially similar landscapes to follow divergent trajectories, reshaping grassland cover size and structure (3). These land use changes turned border regions into a natural experiment for studying the impacts of landscape structure and management on grassland plant communities. Here, we provide 401 historical vegetation plots paired with their recent resurveys along the border region between Austria and the Czech Republic. The dataset spans 95 years (from 1930 to 2025), with the first surveys conducted between 1930-2020 (4) and resurveys conducted between 2024-2025. This timespan captures divergent grassland developments of initially similar landscapes, which were caused by socio-economic changes in the 20th century, leading to a land use change gradient ranging from a small habitat patchwork in the south to large, collectivized fields in the north. Our dataset also spans a longitudinal environmental gradient, running from wet uplands in the west to dry lowlands in the east. The resurvey design was structured to balance representations across both countries and to capture the broad longitudinal topoclimatic gradient of the region. The resulting vegetation-plot time series allows us to quantify biodiversity and community change, while testing for the effects of landscape dynamics. Our results show a higher present day species richness as well as lower evenness in the Czech and Slovak Republic in comparison to Austria. Moreover, plots in the Czech and Slovak Republic have higher numbers of gained species and are more often reported to be under conservation or abandoned with respect to the plots located in Austria. Our work aims to contribute to further research on Central European Grasslands and is a valuable addition to understand human-driven biodiversity changes. In summary, this dataset gives valuable insights into the development of initially similar grassland communities impacted by divergent country level landscape dynamics in Central Europe, which deepens our understanding of plant diversity change over the last century.

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Integrating vegetation survey data from diverse nationwide monitoring programmes in Germany - a worklog

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Despite recent efforts to establish new programmes such as ecosystem monitoring and integrating some of the existing programmes across a set ov over 1700 common sampling areas measuring 1km² each, a comprehensive biodiversity monitoring is still lacking in Germany. However, a data gap remains when it comes to analysing changes in biodiversity over the last decades, which has only partially been filled by collecting species occurrence or time series data from a wide range of sources. The heterogeneity of the data often requires extensive harmonisation before analysis. Another untapped source are therefore monitoring programmes on the status of landscapes and nature, (e.g. those according to the Fauna-Flora-Habitat Directive and the Water Framework Directive), which collect species data as part of their evaluation process, but only report the aggregated evaluation results.

Using plants as an example of an organismic group, we researched the vegetation data recorded in nine nationwide monitoring programmes in Germany. Our overall aim was to test the data's potential for analysing national biodiversity trends. To this end, we asked: 1) How accessible is the data?, 2) Which survey methods are used? and 3) What kind of biodiversity analysis is supported by this data?

The monitoring programmes that we investigated had a wide range of primary aims, such as evaluating the quality of water bodies or habitats (WFD, FFH), evaluating long-term changes in soil quality (BDF) or monitoring the effects of substance deposition in forest ecosystems (Level II). The only inclusion cri-terion was that a the programme was executed throughout Germany using a standardised methodology. Here, we present our experience of the process, which involved gathering relevant information from the relevant authorities, requesting data samples - sometimes from each federal state separately - and con-ducting exploratory analysis of the data. Two programmes do not record vegetation data at all, or only record aggregated indicators. Three programmes use closed taxon checklists with relatively small (or even changing) taxon sets. Three programmes conduct full vegetation surveys on permanent plots. Some programmes have completed only one or two full monitoring cycles and are therefore not yet use-ful for trend or change analysis.

For the vegetation data samples three different strategies are being tested:

1) Time series analysis, in cases where a complete harmonised dataset with good spatial coverage al-ready exists (e.g. WFD for rivers and Level II for forests); 2) Integrating the data into a larger, special-interest data collection, to broaden the spatial and taxonomic coverage (e.g. BDF and HNV for arable fields); 3) Engaging with data holders, to encourage them to make their data available in a broader con-text, in cases without previous harmonisation efforts and low spatial coverage. We mainly report on our efforts with the first two strategies.

Long-term processes, direct and indirect drivers behind changes of Natura 2000 grassland habitats

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Traditional management practices are essential for maintaining the biodiversity of many semi-natural grassland habitats. Abandonment of these practices is leading to shrub encroachment and a decline in biodiversity in many European regions. For this reason, understanding the social processes behind transforming traditional management practices and the subsequent habitat changes is currently a major focus of ecological research. We aimed to identify ecologically relevant indirect drivers (economic, demographic, institutional, cultural, and technological) impacting Natura 2000 grassland habitats since the mid-20th century in two neighbouring Central European post-communist countries, Hungary and Romania. Ecological memory on 21 semi-natural grassland localities was collected through 60 oral history interviews from knowledgeable locals. The studied localities were covered by semi-natural grasslands listed in the Habitats Directive, Annex I: 1.) Semi-natural dry grasslands (6210); 2.) Alluvial meadows of river valleys (6440); and 3.) Pannonic salt steppes and salt marshes (1530*). We asked about three time periods (before: 1950-1961, during: 1962-1989, and after socialist collective farming: 1990-2007). We identified 211 mentions of indirect drivers and categorised them into five main indirect driver categories. Economic drivers were the most often mentioned indirect driver categories for alluvial and saline habitats. Demographic drivers, such as ageing, labour shortage, and rural-urban migration, were highly intertwined and most pronounced for dry semi-natural grasslands. We found that the impacts of ecologically relevant social processes beginning in the 1960s-1970s became visible only decades later, reflected by delayed changes in grassland management and vegetation (e.g. shrub encroachment, spread of weeds and invasive species). Migration to cities was amplified by changing lifestyles and values, leading to a decrease in the village labour force and a consequent ageing of inhabitants, ultimately resulting in a major decline in livestock numbers and in traditional management practices. We argue that the decline of grassland management in the 1990s and 2000s was driven by long-term social processes that began in the 1960s. We argue, that appropriate subsidy schemes and governance models are essential to support surviving traditional farming practices, integrate biodiversity conservation with cultural heritage, and sustain innovative rural communities transitioning within Europe's marginalised agricultural landscapes. This research was supported by the NKFIH K 146526 "From long-term trajectories to short-term transitions: country-level analysis and modeling of grassland and wetland habitat changes" project.

Open vegetation data: an example of the Czech Vegetation Database

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Historical vegetation-plot data are a key source of information for assessing vegetation change. However, their full use is still hindered by limited accessibility in many European regions. To increase the visibility of these data, we launched the website EVA-MAP.eu, which displays the locations of historical vegetation plots and their metadata across Europe. Nevertheless, open publication of complete information from vegetation plots, including full species lists and cover-abundance data, would further enhance the study of vegetation change. Therefore, we developed a national pilot project in which the entire Czech Vegetation Database was published online, following the FAIR (Findable, Accessible, Interoperable, Reusable) principles of open science. The data were simultaneously published on a dedicated website (czechveg.github.io), in the Zenodo repository of scientific data (doi.org/10.5281/zenodo.18289905), and in the GBIF database (Global Biodiversity Information Facility, https://doi.org/10.15468/94bfqd). The published version of the database contains 117,739 vegetation plots sampled from 1922 to 2025. These plots contain 2,510,340 occurrence records of vascular plants. We also prepared a more representative, geographically and environmentally stratified subset of 61,282 plots with unified nomenclature, which can be used directly for analyses. A detailed description of the metadata is also provided. During the project, we prepared R code for data conversion between Turboveg and R, data handling and analysis, linking vegetation-plot data with plant trait data and indicator values, database stratification and resampling, and data export to GBIF. We aim to inspire custodians of other European vegetation-plot databases to follow our example and FAIRify their data. Therefore, we also published all the code we developed on the project website, along with data processing tutorials, and we offer courses and support in converting vegetation-plot data to open access.

Talk Sessions

Session 2: Vegetation dynamics knowledge for optimizing biodiversity management and restoration strategies

Beyond Peacetime Standards: Evaluating Warfare Impacts on Bern Convention Resolution 4 Habitats in Ukraine

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Military actions exert an exceptionally profound impact on wildlife. As weaponry advances, new and previously undocumented impacts emerge. These factors affect various types of ecosystems to differing degrees. Several attempts have been made to classify the direct and indirect impacts of warfare on natural ecosystems and landscapes, e.g. (1) (2). However, a unified and standardized classification of such impacts does not currently exist. Consequently, we utilized the standardized List of Pressures and Threats used for reporting under Article 17 of the Habitats Directive (3) for this purpose. From this list, we selected only those pressures that can be directly or indirectly linked to military activities. We further analyzed the impact of these factors on the habitat types listed in Resolution 4 of the Bern Convention that are reported from Ukraine (4). To assess the magnitude of these impacts, a 3-point scale was applied, ranging from 1 (weak) to 3 (strong). The cumulative scores were then calculated for each pressure and each habitat type. Our analysis identified 24 distinct military-related pressures. The highest number of these belonged to the groups PE: Development and operation of transport systems (6 impacts) and PK: Mixed source pollution (5 impacts). The most significant impacts on ecosystems were identified as PK06: Non-chemical mixed source pollution (total score: 207) and PE08: Land, water, and air transport activities generating noise, light, and other forms of pollution (total score: 146). Of the 115 habitat types listed in Resolution 4 of the Bern Convention, 112 have been affected by the war in some extent, representing over 97% of the total. Complex habitats (group X) showed the highest average scores, followed by forests (group G) and grasslands (group E). The highest cumulative scores were recorded for G3.4G Pinus sylvestris forest on chalk in the steppe zone (27 points), followed by E1.9 Open non-Mediterranean dry acid and neutral grassland, including inland dune grassland, G1.7 Thermophilous deciduous woodland, and G3.4232 Sarmatic steppe Pinus sylvestris forests (24 points each). The results demonstrate that the current standardized classification of pressures and threats, developed for peacetime, fails to account for the full spectrum of warfare-related impacts (e.g., landmines or the disruption of migration routes by defensive engineering structures) and thus requires comprehensive revision and expansion. The adequacy or insufficiency of these classifications should be evaluated through pilot assessment projects within protected areas directly affected by military actions.

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Long-term assessment of vegetation and soil moisture changes after drainage blocking in two raised bogs of Western Latvia

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Many mire restoration projects include pre- and post-restoration monitoring of vegetation and groundwater levels. However, post-restoration datasets often cover only two to three years, limiting the assessment of long-term restoration outcomes. We re-surveyed permanent vegetation monitoring plots in two drainage-impacted raised bogs 18 years after ditch blocking using peat dams. To enable comparison, vegetation plots in two additional drainage-impacted raised bogs from the same region, where no restoration measures had been implemented, were also re-surveyed. In addition, we assessed changes in surface moisture across all four raised bogs using moisture and wetness indices (NDMI and NDWI) obtained from time-series of Landsat satellite images. Preliminary results indicate that nearly 20 years after ditch blocking, vegetation responses to hydrological stabilization differ among sites. The degree of drainage impact, vegetation structure and composition before restoration, post-restoration groundwater levels, and climatic conditions—particularly precipitation-are among the most likely factors explaining the observed differences in vegetation trajectories. We also detected shifts in bog vegetation in the central parts of the raised bogs, outside the areas directly affected by hydrological stabilization, as well as in the two non-restored bogs. In these areas, we observed an increase in the cover of lichens and Calluna vulgaris, accompanied by a decrease in bare peat or mud-bottom areas. Notably, the expansion of Rhynchospora alba was recorded in three of the four raised bogs. We will present preliminary results and discuss the most likely drivers of the observed vegetation and soil moisture changes.

Dynamic habitat connectivity modelling: Insights from riparian ecosystems in Slovakia

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Connected habitats are crucial for biodiversity, ecosystem functioning, and climate resilience. Corridors and stepping-stone habitats enable species to shift their ranges as climates change and link current habitats to future suitable ones. To describe how species can disperse in a landscape, landscape ecology employs a combination of patch, fragmentation, and connectivity metrics, often derived from land-cover maps. Vegetation communities or habitats are typically viewed as "patches" of varying quality; however, the spread of habitats is a much more complicated and slow process driven by natural succession. Rivers serve as corridors for the majority of riparian species and communities, which are among the most threatened habitats in Europe. Describing their potential connectivity or isolation is crucial for conservation efforts, including the prevention of invasive species spread.

Relevancy maps for six riparian habitats (91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*; 91F0 Riparian mixed forests of *Quercus robur*, *Ulmus laevis*, and *Ulmus minor*, along with *Fraxinus excelsior* or *Fraxinus angustifolia*; 6440 Alluvial meadows of river valleys of the *Cnidion dubii*; 3270 Rivers with muddy banks featuring *Chenopodion rubri* and *Bidention* vegetation; 3230 Alpine rivers and their ligneous vegetation with *Myricaria germanica*; and 3240 Alpine rivers and their ligneous vegetation with *Salix elaeagnos*) in Slovakia were created using Sentinel-2 satellite data and the Natural Numerical Network (1) method implemented in NaturaSat software (2). The river network of Slovakia, a DTM model, prevailing wind direction, and obstacles that hinder dispersal-such as built-up areas or intensive agricultural land-were combined into an initial raster representing a vector field of varying speeds for potential habitat spread. In this raster environment, an evolving curve approach was applied to the habitat polygons previously computed by the Natural Numerical Network. The fastest intersections of the evolved curves were marked as corridors, resulting in a map of corridors for all studied habitats.

To test the effectiveness of the identified corridors, recent georeferenced phytosociological relevés of the studied habitats from the Slovak vegetation database (3) were selected. The lengths of the corridors between relevés were computed, and differences in species composition were compared with the distance along the corridor.

The habitat corridor computation tool has been integrated into NaturaSat software, enabling rapid corridor detection between any chosen habitat patches in the landscape and providing a new resource for effective conservation planning.

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Abandoned lime kilns influence environmental heterogeneity and plant diversity in karst landscapes

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Karst landscapes are topographically complex areas that cover about 15% of the Earth's land surface. Their most dominant landforms are the bowl- or funnel-shaped topographic depressions called dolines. Due to the high environmental heterogeneity within dolines, they exhibit a distinct microclimate that is decoupled from the regional climate. Consequently, dolines may act as potential microrefugia for several climate change-sensitive plant species under ongoing global warming. Their ability to buffer against regional climatic changes increases the likelihood of species persistence by providing climatic stability during regional environmental changes; however, it might be affected by anthropogenic disturbances. In addition, little is known about the effects of anthropogenic disturbances on biodiversity in dolines. The Bükk Plateau in Hungary is characterized by a high number of dolines, many of which are covered by grasslands. In the past, lime kilns were established in the bottoms of several dolines, which remained in use until their abandonment in the second half of the 20th century. Traditionally, a large part of the kiln was built into the ground, with the excavated soil and rocks deposited beside the kilns as a relatively large mound, while some parts of the doline bottoms were left undisturbed. In our study, we addressed the following research question: how do abandoned lime kilns influence the plant species composition, the values and combinations of functional traits, and the functional diversity in the different doline microhabitats (abandoned kiln, mound and undisturbed bottom) and the surrounding plateau? We found that each microhabitat harbored compositionally different plant assemblages. The functional composition exhibited similar trends, with the only exception that the samples of the plateau did not differ from the samples of the mounds. In addition, the functional diversity expressed by MPD (mean pairwise distance) was lowest in the abandoned kilns and undisturbed bottoms. Based on our results, we can conclude that lime burning in doline bottoms led to the creation of two novel microhabitats within dolines, which differed significantly from the undisturbed doline bottoms in both taxonomic and functional composition. Consequently, former anthropogenic disturbances, such as lime burning, in doline bottoms can influence the plant species composition and functional diversity, and thus the capacity of doline microrefugia to support biodiversity. Therefore, the effects of such disturbances should be considered when planning and applying conservation strategies.

Alien flora of Ukraine: an updated national checklist

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Alien plant invasions are among the most important drivers of human-induced global environmental change. The rapid intensification of globalization, increasing mobility of goods and people, and large-scale transformation of natural landscapes have substantially accelerated the spread of alien plant species across regions. As a result, alien plants increasingly contribute to profound transformations of native ecosystems, including shifts in floristic composition and changes in vegetation structure. Nearly 35 years have passed since the publication of the first catalogue of alien species of Ukraine (1), which summarized information on 646 species considered alien to the national flora. Since then, numerous floristic, ecological and vegetation studies have considerably expanded our knowledge of the diversity, distribution and ecological behaviour of alien plants within the country. In the present study we introduce the second updated national checklist of alien plant species of Ukraine, compiled on the basis of our own field investigations, a comprehensive analysis of published literature, examination of herbarium collections, observations derived from open databases, and personal communications with local experts. For each taxon, the checklist provides information on taxonomic position, geographic origin, residence time, pathways of introduction, the date of the first record in Ukraine (for neophytes) and invasion status. The updated checklist includes 1206 alien species, representing approximately 20% of the total vascular flora of Ukraine. We identified 166 species as archaeophytes, 1017 as neophytes, while 23 taxa exhibit a dual residence-time status. The alien flora of Ukraine is dominated by casual species (756 taxa), with 309 species fully naturalized, 134 showing a dual naturalization status. The considerable geographical extent of Ukraine, stretching across several biogeographical and bioclimatic zones, creates challenges in determining the alien status of certain species at the national scale. This is particularly evident in the pronounced biogeographical and climatic differences between continental Ukraine and the Crimean Peninsula. Consequently, some species that are native to continental regions may be considered alien within the flora of Crimea, and vice versa. Similar complications arise due to the presence of major natural barriers, such as mountain systems (e.g. the Ukrainian Carpathians) and large river valleys (e.g. the Dnipro River). As a result, several species may exhibit different statuses in different parts of Ukraine, being regarded as alien in some regions while remaining native in others. To account for these regional differences, in addition to the main checklist we provide a supplementary list of species that display contrasting native and alien statuses across different regions of the country. This approach allows a more accurate representation of spatial patterns of plant distribution and reflects the transitional biogeographical position of Ukraine.

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European Database of Alien Plants: Towards a Harmonised Resource for Plant Invasion Research

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Although alien plants have been studied for decades, available data remain scattered and often inconsistent in taxonomy, classification schemes, and completeness. To overcome these limitations, we established the European Database of Alien Plants (EuDAP), a harmonised and comprehensive dataset designed to support the study of plant invasions across Europe. EuDAP compiles information on three key dimensions of alien plant status: (1) residence time (archaeophytes vs. neophytes), (2) invasion stage (casual, naturalised or invasive), and (3) geographic origin, primarily following the TDWG continental framework with additional biome-level refinements. Countries represent the basic spatial units of the database, while selected islands and regions are treated separately. Compared with previous datasets, EuDAP explicitly considers geographical context and the distribution of species in neighbouring countries when assigning invasion status. In parallel, patterns in native floras were analysed to identify potential gaps and biases in the available data. The database integrates information from more than 150 sources, including national checklists, scientific publications and major international resources such as Euro+Med PlantBase, GloNAF and Plants Of the World Online. Furthermore, nearly 50 regional experts critically evaluated the taxon-region records (acknowledged in our presentation). EuDAP will be regularly updated and made openly available through the FloraVeg.EU platform. Here, we introduce the structure and content of EuDAP and compare it with other major alien plant databases. We present spatial patterns in both absolute and relative (in relation to native floras) numbers of alien species, identify hot- and coldspots, and examine differences among alien plant categories together with the main drivers shaping these patterns. We expect EuDAP to provide an important resource for research in plant biogeography and invasion ecology, while also supporting biodiversity conservation and ecological restoration initiatives.

The story of hemiparasitic plants, declining keystone component of the European vegetation

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Parasitic plants are often regarded as just botanical curiosities. However, they represent a specialised functional group with a unique trophic strategy in the plant realm. Among them, hemiparasitic plants, which combine autotrophy and heterotrophy, are most abundant in vegetation and have been recognised for their effects on ecosystems and communities. Hemiparasites suppress the growth of their hosts and impact on the competitive balance in the community. Thus, they decrease the dominance in plant communities, including also preventing or even reversing encroachment by competitive grasses and shrubs. Recent research has demonstrated their ability to strongly suppress some noxious invasive plants. Beyond direct parasitism, they accelerate nutrient cycling through litter effects and create gaps in communities, thereby facilitating seedling establishment. Nutrient availability and cycling may be further supported by a special, partly mutualistic interaction between hemiparasites and nitrogen-fixing legumes, and, unexpectedly, by increasing nutrient concentrations in host leaf tissues. Besides vegetation, hemiparasitic plants affect higher trophic levels through cascading effects. Reduction of grasses and supporting forbs also supports forb-feeding insects and pollinators. Reduction of sward density and the resulting gaps create habitats for heliophilous arthropods. On a large scale, (hemi)parasitic plant occurrence is associated with high vegetation species richness, reflecting their multifaceted ecological roles. The impacts of hemiparasitic plants on communities and ecosystems are similar (and partly complementary) to those of large herbivores, which are recognised for their keystone ecosystem-engineering roles. Unlike them, hemiparasitic plants are still a ubiquitous component of European biota, though some have recently been identified among the most declining plant species at the large landscape scale. Considering hemiparasitic plants in nature conservation and ecological restoration schemes may enhance their effectiveness and thus facilitate biodiversity maintenance and ecosystem resilience.

Internal colonization of traditional knowledge and its holders since the Enlightenment and its consequences for understanding and managing vegetation dynamics

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The management of high nature-value grasslands in Europe needs complex ecological and practical knowledge. Much of this knowledge, however, is being lost with the disappearance of traditional herders and herding across Europe. We review the historical trends and discuss the potential future of traditional knowledge (TK) and practices, relevant for understanding vegetation dynamics and planning conservation, developed and maintained by traditional herders, through a colonization lens. We understand the term "internal colonization" as the process by which a dominant group, often the urban elite or a central government, exerts control and exploitation over peripheral or marginalized lands and human populations within its own country borders. We used the UN Declaration on the Rights of Indigeonus Peoples as a framework to identify lost and missing rights of TK holders in Europe, relevant for vegetational knowledge. We found that internal colonization of TK holders, specifically traditional herders, by urban elites and governments since the 18th century influenced land rigths, grazing mobility, knowledge generation and adaptation mostly negatively, and led to non-adequate agricultural and other regulations and substantial knowledge loss and abandonment of land-use practices relevant for biodiversity conservation. We argue that redressing lost and missing rights and securing and innovation of conservation-relevant traditional ecological knowledge and practices are highly needed to achieve more sustainable conservation and food production, for the successful adaptation to increased climate variability, but also in a potential post-crisis era when transportation and energy is expected to be limited, while the local use of local spontaneous biomass will be vital again in Europe. The International Year of Rangelands and Pastoralists (UN IYRP) in 2026 could provide a great opportunity to reconcile injustices and strenghten knowledge co-production with traditional herders and other TK holders in Europe - and beyond.

*Barbary Thuja dominated communities of North-West Africa

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The Barbary Thuja (*Tetraclinis articulata*) is a resinous, thermo-xerophilous tree endemic to the south-western Mediterranean basin. It exhibits a Euro-Mediterranean range, with core populations located in North-West Africa (Morocco, Algeria, and Tunisia) and smaller relict populations in south-eastern Spain and Malta. Given its biogeographical significance and threatened status, a comprehensive characterisation of the communities dominated by this species is required to understand its ecological niche fully and plan effective protection measures. This study aims to define the floristic composition and ecological drivers of *T. articulata*-dominated communities across their entire distribution range. We compiled a comprehensive dataset of 2,030 vegetation relevés derived from 18 published papers and 6 PhD theses, standardising the taxonomic nomenclature according to the Euro+Med PlantBase. To ensure a robust analysis of communities specifically dominated by this species, we applied systematic data cleaning steps. We retained only relevés with a *Tetraclinis* cover ≥ 13% (corresponding to Braun-Blanquet class 2) and excluded plots where other tree species exerted higher cover values. The final dataset consisted of 654 relevés comprising 285 taxa. Using Partitioning Around Medoids (PAM) clustering based on Bray-Curtis dissimilarity and validated using the Average Silhouette Width, we identified four distinct vegetation groups reflecting different ecological conditions. These were characterised by Indicator Species Analysis as: (1) widespread, thermophilic, semi-arid open woodlands degraded by grazing, defined by a high frequency of therophytes (e.g., *Valerianella discoidea*) and woody species such as *Olea europaea* and *Phillyrea latifolia*; (2) mesic, dense Mediterranean maquis concentrated along coastal areas at lower elevations, indicated by *Ampelodesmos mauritanicus*, *Quercus coccifera*, and *Pinus halepensis*; (3) semi-arid continental steppes found at higher elevations, dominated by *Macrochloa tenacissima*; and (4) warm, xerophilic garrigues characterised by *Thymus saturejoides* and *Lavandula dentata*. Furthermore, Principal Coordinate Analysis (PCoA) demonstrated that the floristic differentiation among these communities is primarily driven by gradients of moisture and continentality, as well as canopy cover structure. These results highlight the adaptability of the species across different environmental gradients, ranging from coastal mesic sites to inland continental steppes. This study will contribute to the understanding of the ecology of *T. articulata*-dominated communities and support their conservation in the Mediterranean region.

*Combined effects of root hemiparasite and mowing can suppress the expansion of *Calamagrostis epigejos* in grassland dolines

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Dolines harbour high microhabitat diversity and maintain microclimatic conditions that are partly decoupled from regional climate trends. Consequently, these topographic depressions are of high conservation value, particularly in the context of ongoing climate change. However, habitat degradation can reduce their conservation potential. In grassland dolines, the expansive spread of *Calamagrostis epigejos* poses a serious threat. Although the negative effects of *Calamagrostis* expansion on grassland biodiversity are well documented, carrying out conventional management options in doline grasslands runs up against technical issues. In a three-year field experiment, we tested four management approaches targeting *Calamagrostis*-dominated stands in three grassland dolines. These included the introduction of the hemiparasitic forb *Rhinanthus minor* as a potential biocontrol agent by sowing its seeds, mowing, a combination of sowing and mowing, and additional hay transfer from adjacent reference grasslands. We evaluated the effects these management options on vegetation diversity and productivity. Measurements of *Rhinanthus* biomass confirmed that mowing facilitates the establishment of the hemiparasite: *Rhinanthus* produced significantly higher biomass in the mown+sown plots (with or without hay transfer) than in plots where it was sown alone. Thus, sowing *Rhinanthus* alone did not increase either species richness or functional diversity in the doline grasslands. In contrast, mowing significantly enhanced both taxonomic and functional diversity, even without additional treatments. The highest diversity was observed in plots where mowing was combined with *Rhinanthus* sowing (i.e. mown+sown plots), while hay transfer did not further increase diversity. Plant species other than *Calamagrostis* reached their highest abundance in plots where mowing and *Rhinanthus* sowing were combined with hay transfer, although their abundance remained lower than in reference grasslands. Similarly, *Calamagrostis* biomass and abundance were lowest in the mown+sown plots, though the species was not completely suppressed. Litter biomass was lowest in the mown and mown+sown plots, where total biomass production was even lower than in the reference grasslands. Hay transfer partly mitigated this effect, resulting in biomass levels comparable to those of the reference sites. Our results indicate that sowing *Rhinanthus* without additional intervention is insufficient to suppress dense *Calamagrostis* stands in doline grasslands. Mowing improved all examined vegetation characteristics and reduced the dominance of *Calamagrostis*, while the combination of mowing and *Rhinanthus* introduction proved to be the most effective management strategy. Although hay transfer provided some additional benefits, it also increased litter accumulation, which may hinder *Rhinanthus* establishment. For long-term management, repeated sowing of *Rhinanthus* combined with mowing is recommended to promote the regeneration of diverse doline grassland vegetation.

Talk Sessions

Session 3: Vegetation monitoring and resurvey for biodiversity conservation in a global change context

The project WetFlorVegChange, an unusual resurvey project

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Wetlands are among the most threatened ecosystems in Europe, yet long term, continent wide evidence of floristic and vegetation change remains fragmented, geographically biased, and taxonomically uneven. Despite decades of concern over wetland degradation (1; 2) and numerous local case studies (3), comprehensive assessments of vegetation change across European wetlands are still lacking. Although the use of permanent plots and vegetation resurveys has expanded rapidly in recent decades (4; 5; 6), wetland habitats remain markedly underrepresented in continental scale databases such as ReSurveyEurope (7). *WetFlorVegChange* is a new project aimed at mobilizing and collecting new resurvey data and assessing short- and long-term floristic and vegetation changes in European wetlands. Wetland vegetation poses unique methodological challenges compared to terrestrial or forest systems. Many communities exhibit strong hydrological dependence, high interannual variability, and pronounced spatial instability (8; 9). Aquatic macrophyte assemblages shift with water-level fluctuations and management regimes, while annual amphibious communities (e.g., *Isoeto-Nanojuncetea*, *Littorelletea*, *Bidentetea*) occur only within narrow hydrological windows and change across microtopographic gradients (10). These dynamics make exact plot relocation often impossible or ecologically meaningless. To address these challenges, we developed a dedicated wetland resurvey protocol that ensures methodological comparability while respecting the ecological realities of wetland systems. The protocol emphasizes ecological matching over strict geographic relocation, guiding surveyors to prioritize habitat conditions, hydrological phases, and vegetation structure when the original plot cannot be meaningfully re established. It introduces standardized relocation confidence classes (A-D) following best practices for resurvey uncertainty (4; 11) and provides practical guidance for sampling in open water, drawdown zones, and fragmented amphibious habitats. Recommendations include shoreline based sampling, hydrological timing adjustments, and the use of multiple small plots when habitat patches are spatially discontinuous.

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Patterns of grassland and forest plant diversity in the Czech Republic revealed by integrated preferential and random stratified sampling

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Large vegetation-plot databases are increasingly used to model and map plant species richness across landscapes. However, these databases typically compile records from diverse projects that differ in sampling periods, objectives, and often use preferential sampling designs. As a result, vegetation plots in such databases are unevenly distributed across geographical and environmental space. Attractive protected areas with well-preserved or species-rich vegetation types and easily accessible areas near cities tend to be oversampled, while common, species-poor, or degraded vegetation types remain underrepresented. Such biases can substantially affect modelling and mapping results in large-scale assessments of local plant richness, especially in landscapes undergoing rapid environmental change driven by land abandonment, woody encroachment, and the spread of generalist and invasive species. To improve estimates of plant species richness in forests and grasslands across Czech landscapes, we integrated vegetation-plot records from existing databases with systematic random stratified sampling. For grasslands, we combined plots from the Czech Vegetation Database (CVD) with a random-stratified grassland survey conducted over the past five years (DivLand Project; 696 of 801 random-stratified plots sampled). For forests, we supplemented the CVD data with stratified National Forest Inventory (NFI) plots (1,756) provided by the Czech Forest Institute. Using these datasets, we produced maps of plant diversity for various forest (e.g., alluvial, beech, and dry pine forests) and grassland types (e.g., dry, mesic, and submontane to montane *Nardus* grasslands) and species groups (i.e., all species, threatened species, habitat specialists, and alien species). This enabled us to identify regional patterns of species richness hotspots specific to each vegetation type. Our results highlight the importance of systematic sampling strategies in reducing data bias and providing more accurate, ecologically realistic estimates of local plant species richness in fragmented, human-influenced landscapes.

Equine allies: The role of Polish Primitive Horse (Konik) in small-scale rewilding for habitat revitalization

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The Polish Primitive Horse (PPH or Polish Konik horse) is a primitive breed that is morphologically similar to the extinct Tarpan, although it shares no genetic connections. This breed is characterized by its low food requirements and excellent adaptability to challenging environmental conditions. The Polish Konik has been utilized for various revitalization and rewilding initiatives, not only in Poland but also across Austria, the Netherlands, Belgium, and other countries.

This study documents the first introduction of the Polish Konik horse to Slovakia, initiated with a herd sourced from Austria in 2019. To further enhance genetic diversity and overall herd health, a stallion was subsequently imported from the original breeding station near Białowieża National Park (Kalitnik) in Poland.

The research area is situated in the southeastern part of the Štiavnické vrchy Mountains (Central Slovakia), bordering the Krupinská Planina, within a protected landscape area on volcanic bedrock. The site features a mosaic of forest and non-forest plant communities, ranging from closed canopy forests to scrublands, as well as open grassland habitats, including mesophilous and xerophilous dry grasslands, and moist to wet meadows.

Our research involved establishing permanent plots prior to the introduction of the horses, that were resampled every year. Data loggers were arranged for monitoring temperature and soil moisture, recording acoustic diversity throughout the rewilding process, and employing UAVs to monitor landscape changes influenced by the horses. GNSS device with 1cm accuracy was used for sampling individuals of protected species. In addition, insect populations were monitored before and during the experiment.

After five years of grazing, significant changes in landscape structure were observed, including the retreat of grasses such as *Calamagrostis epigejos*, and shrubs like *Crataegus monogyna*, *Prunus spinosa*, and *Rosa canina*, in previously overgrown pastures. Notably, there was a marked decrease in the abundance of grasses and sedges relative to dicots, alongside a substantial increase in orchid populations, specifically *Anacamptis morio*, which surged to hundreds of individuals.

The expansion of dry grasslands has become evident, alongside an increase in biodiversity due to the opening of dry *Quercus cerris* forests and the continuous, albeit low-intensity, disturbance from trampling by horse hooves. This grazing activity has led to a decrease in invasive, non-native species such as *Aster lanceolatus* and *Conyza canadensis*. Additionally, the horses have been effective in suppressing the encroachment of non-native *Robinia pseudoacacia* trees by consuming young sprouts, despite their proclaimed toxicity for horses. Notably, no adverse effects on animal health have been observed.

In conclusion, PPH demonstrate significant potential for revitalizing various types of plant communities, enhancing their ecological quality due to their low resource requirements, cost-effectiveness, and substantial benefits. Furthermore, their well-behaved nature and ability to live freely in herds year-round make them easily trainable for riding purposes. These attributes create a vast, yet underutilized potential for revitalization and rewilding efforts.

Temporal changes in riparian forests vegetation: unexpected responses to streamflow alteration under climate change

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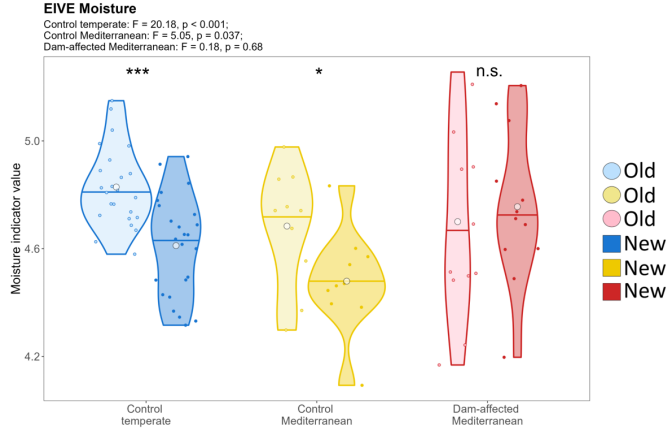
Riparian forests are highly dynamic and species-rich ecosystems, although they face multiple pressures. Recent vegetation-resurvey studies revealed mixed effects of river regulation on riparian forests, but the impacts of increased minimum flows remain understudied. We resurveyed historical plots to assess the ecological impact of a dam on the Irati River in northern Spain, located in a temperate-Mediterranean ecotone. This dam regulated the Irati River by altering flow peaks, reducing winter flow and increasing summer average discharge. We investigated how flow alteration and climate change affected riparian vegetation composition between Old (1997-2003) and New (2022-2023) plots, with a particular focus on moisture-demanding, alien and ruderal species. The plots were divided into three sections: (1) the temperate control, (2) the Mediterranean control, and (3) the Mediterranean dam-affected. A shift in species composition was observed in the studied forests, each section displaying a distinct pattern of change. We associated the changes in plant species composition to climate change and river regulation. Both control sections exhibited increases in thermophilous species and a decline in moisture-demanding riparian species. Conversely, the dam appears to support riparian species by maintaining summer flows, mitigating climate-induced drought impacts. Additionally, ruderal species increased in both Mediterranean sections, suggesting that their spread was more likely facilitated by industrial and agricultural development rather than by the dam. We conclude that dam-induced summer flows may partially buffer climate change effects on riparian forests, providing guidance for flow management prescriptions and highlighting the need for long-term, multifactorial assessments of river regulation.



Violin plot of unweighted mean indicator values (EIVE) for moisture for old and new plots within each section. Circles represent means and the horizontal lines represent the medians. Statistical significance within each section between old and new plots was assessed using permutation tests, with results displayed at the top of the figure.

Nitrophilization and Shrubification Vary Across Alpine Plant Communities: Evidence from the Central Apennines

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High-mountain ecosystems are widely recognized as biodiversity hotspots, hosting high plant species richness and large proportion of endemic and rare taxa (1), while being particularly vulnerable to climate and land use changes (2).

In this context, we evaluated floristic, ecological and structural changes over time in alpine and sub-alpine grasslands and Pinus mugo thicket in the central Apennines (Italy). We analysed 66 georeferenced phytosociological relevés (4x4 m) from the VIOLA database (3), originally sampled in the years 1992/2003 (T1), and resurveyed in 2017/2021 (T2). The dataset encompasses 4 plant community types: Apennine stripped grasslands (*Sesleria juncifolia* community, EUNIS Habitat R4532), wind edge swards (*Carex myosuroides* community, EUNIS Habitat R4521), snowbeds (*Trifolium thalii* community, EUNIS Habitat R41) and *Pinus mugo* thickets (EUNIS Habitat S264).

Temporal dynamics were assessed by calculating taxonomic turnover (Bray-Curtis distance to centroid) and analysing community homogenization and temporal trajectories via Non-metric Multidimensional Scaling (NMDS). Ecological and structural dynamics over time were analysed through Community Weighted Mean (CWM) for growth forms and Ecological Indicator Values for Europe (EIVE 1.0) (4).

The results showed a clear, but community-specific changes over time. Taxonomic turnover was highest in Apennine stripped grasslands and lowest in *P. mugo* thickets.

All communities displayed directional compositional shifts between T1 and T2. *P. mugo* thickets showed a pronounced shift associated with the increase in nitrogen-demanding species and scapose hemicryptophytes, such as *Hypericum richeri* subsp. *richeri*, *Valeriana montana*, *Helianthemum nummularium* subsp. *grandiflorum* and *Poa alpina*, offset by a decline in *Juniperus communis* and *Salix retusa*. In contrast, the grasslands communities exhibited more divergent trajectories. Wind edge swards shifted toward more mesic and nitrogen demanding species, accompanied by a decrease in alpine taxa such as *Festuca violacea* subsp. *italica* and *Oxytropis campestris*, and early signs of shrubification driven by the expansion of fruticose chamaephytes like *Salix retusa*. Conversely, Apennine stripped grasslands followed a divergent trajectory, shifting toward more xeric and nitrogen-poor demanding species, with a marked decline in alpine specialists such as *Plantago atrata* subsp. *atrata*, *Festuca violacea* subsp. *italica* and *Poa alpina*. The snowbeds, instead, appear to be the most stable community.

Overall, our results demonstrated significant but contrasting trajectories in the alpine and sub-alpine vegetation of the central Apennines. While general trends of nitrophilization and shrubification observed in European high-mountain ecosystems are confirmed (5, 6), these processes are neither universal nor uniform across all alpine plant communities. Notably, Apennine stripped grassland on steep slopes with rendzina soils, followed a divergent trajectory, exhibiting a marked decrease in these indicators.

Finally, the divergence in vegetation change trajectories underscores the importance of community-level monitoring and analysis for improving predictions of alpine biodiversity dynamics in Mediterranean mountain ranges.

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Effects of grazing management and temperature anomalies on stability of grassland production and CO_2 fluxes, does the plant community drift progressively, or fluctuate around a stable state?

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Temperature anomalies, including heatwaves, cold spells, and seasonal shifts, are becoming increasingly frequent and pose major challenges for ecosystem functioning, carbon sequestration, and land management. Although temperature anomalies are known to influence large-scale carbon flux patterns, their fine-scale effects, particularly in interaction with agricultural management, remain poorly understood.

This study, conducted within the ACBB-ANAEE-ICOS observatory, investigates the impact of air temperature anomalies on CO_2 fluxes in an upland (1040 m a.s.l.) mesic grassland under two contrasting grazing regimes: low cattle grazing intensity (LG) and high cattle grazing intensity combined with fertilisation (HG). Using 18 years (2003-2022) of CO_2 flux and climate data, we assessed net ecosystem exchange (NEE) responses to cold, warm, and extreme temperature anomalies, while accounting for standing biomass production, potential production, and senescent material (litter production.

The study site experienced on average about 40 anomalous temperature days per year, including approximately 10 extreme events. CO_2 fluxes were most sensitive to temperature anomalies during the early growing season. Warm anomalies generally enhanced CO_2 uptake in spring but reduced it during summer and autumn, particularly during extreme warm events lasting more than six days.

In spring, NEE indicated a stronger carbon sink under HG (0.760 Mg C/ha) than under LG (+24%,). This enhanced sink strength was mainly associated with lower senescent material under HG (-23%), while biomass production remained similar between grazing regimes. During summer and autumn, responses diverged more strongly between treatments. Under HG conditions, NEE remained close to neutral or represented a small carbon sink (0,08 Mg C /ha), reflecting a balance between production and vegetation mortality. In contrast, under LG conditions, NEE became positive, indicating net carbon release and suggesting different vegetation thresholds under increasing temperatures. This response was accompanied by higher levels of senescent material combined with relatively low production (-49%), indicating that biomass loss and associated ecosystem respiration dominated carbon dynamics under high thermal conditions.

At the same time, the stability (mean/standard deviation) of standing biomass and potential production was higher under HG than under LG, indicating smaller fluctuations relative to the average level and related to climate in the HG treatment. This suggests that the plant community may be better adapted to the climate-grazing equilibrium under higher grazing-fertilisation intensity.

Overall, our findings highlight the importance of management-climate interactions in shaping CO_2 flux and production responses and underline the value of long-term field observations for understanding grassland carbon sink resilience under increasing temperature extremes.

Freshwater ecosystems under pressure: modelling the future of riparian vegetation in a protected Alpine landscape

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Among the world's most threatened ecosystems, aquatic habitats have suffered dramatic losses, with roughly 87% of natural wetlands disappearing since the early 18th century (1). Additionally, over three quarters of river and riparian habitat types listed under the EU Habitats Directive remain in unfavourable conservation status (2). Within freshwater ecosystems, riparian vegetation acts as a key interface between aquatic and terrestrial environments, supporting high biodiversity and stabilizing riverbanks. In South Tyrol (autonomous province of Bolzano, Italy), the channelization of the Adige River and its tributaries have reduced riparian vegetation. This vegetation includes habitat types of high conservation concern, notably 3220, 3240, and the priority habitat 91E0*. Within the interdisciplinary research project FLASH (Flash floods prediction and impact in protected mountain areas), which investigates the interactions between extreme hydrological events and riparian ecosystems in protected areas of South Tyrol, we performed a Bayesian additive regression trees (BART) model aimed at mapping the potential distribution of riparian vegetation under current and future climatic conditions within parks in South Tyrol. Following a sensitivity analysis to optimize the sampling design, the model was projected under multiple emission scenarios and time horizons (mid and late 21st century) using an ensemble of global climate models, and the results were intersected with the existing network of eight protected areas. Climatic variables related to temperature seasonality and precipitation regimes emerged as the most influential predictors, followed by topographic and hydrological factors. Under baseline conditions (1981-2010), suitable areas covered approximately one fifth of the provincial territory, concentrated along valley floors and watercourse networks. Within the protected area network, habitat suitability varied markedly among individual reserves: the Stelvio National Park showed the highest proportion of suitable riparian habitat, covering approximately 20% of its territory. Future projections consistently indicated a substantial contraction of suitable habitat, with losses intensifying under higher emission pathways and toward the end of the century. The Stelvio National Park, despite holding the largest baseline suitable area, was also among the most severely affected reserves, with projected suitable habitat declining to less than 1% of its territory under mid-to-high emission scenarios by 2071-2100 (SSP370). Within the protected area network, the extent of suitable riparian habitat declined markedly under most future scenarios, with pronounced variation among individual reserves. These findings highlight the vulnerability of Alpine riparian ecosystems to climate change and suggest that the current protected area network may be insufficient to safeguard these habitats in the long term. By providing spatially explicit projections of habitat suitability change, this work offers a quantitative basis for identifying priority areas for riparian vegetation restoration and for reassessing the adequacy of existing conservation designations within the broader effort to protect freshwater ecosystems in mountain regions.

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Database of Permanent Monitoring Plots in the Czech Republic: 18 years of experience

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A Database of Permanent Monitoring Plots was established in 2009 by the Agency for Nature Conservation and Landscape Protection of the Czech Republic to document the status and long-term changes of important botanical sites mostly in nature protected areas. The database covers well-preserved forest and non-forest vegetation types across the entire Czech Republic. In its current form, it includes 1,358 permanently monitored plots of terrestrial vegetation, with a total of 3,089 vegetation relevés recorded by 2024. Each plot has been surveyed at least twice (75% of plots), some three times (24%), and a small proportion more frequently (<1%). This makes the dataset one of the largest consistently re-surveyed databases in Europe, characterized by systematic plot selection, relatively even spatial distribution within a single country, and a unified sampling methodology. The collection of such an extensive dataset over 18 years has involved several tens of contributors. The dataset provides a robust basis for analyzing the impacts of climate change on species composition and vegetation structure in natural and semi-natural habitats, assessing degradation across different habitat types, identifying indicator species and communities sensitive to environmental change, calibrating remote sensing approaches, and linking vegetation data with environmental variables such as climate, soil properties, nitrogen deposition, and management. In addition to its analytical potential, the dataset represents a valuable methodological resource for evaluating factors that influence the interpretation of temporal changes but are not directly related to actual vegetation dynamics. These include observer-related differences, phenological variability, taxonomic concepts, variation in the recording quality of the bryophyte layer, and the consistency of cover estimates for both dominant and rare species. Because the dataset contains repeated observations of the same plots, these sources of variation can be quantified and partially separated from true ecological changes. This allows for a more accurate interpretation of vegetation dynamics and contributes to improving the methodological framework of re-survey studies.

Long-term landscape dynamics and protected areas shape plant biodiversity change of Central European grasslands.

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Central European grasslands are biodiversity hotspots threatened by multiple anthropogenic impacts. While biodiversity declines are well-documented, the relative roles of long-term landscape dynamics, climatic conditions, and protected areas in shaping these changes over century-long timescales remain poorly studied. We utilized a multi-decadal natural experiment based on 411 pairs of survey-resurvey plot observations located in the borderland of two countries with diverging land-use histories (Austria and the Czech Republic). We modeled both community-level changes (species richness and species composition) and species-level dynamics (local extinction risk and colonization probability) as functions of elevation, protected area status, and landscape changes derived by comparing historical (~1870) to contemporary maps (2023). We found overall no net gain or loss in species richness but large composition shifts. Species richness declines were significantly higher at sites where landscapes transitioned toward higher aggregation index values (i.e., larger and more compact grassland patches) over the last century, with larger effects over longer survey intervals. Species-level models explained these richness patterns through a significant imbalance between extinction and colonization: higher landscape aggregation was associated with an increased extinction risk for historical resident species and a reduced probability of colonization. In addition, we found that protected areas and higher elevations significantly slowed turnover rates (Jaccard dissimilarity). Specifically, plots within protected sites exhibited about half of the temporal turnover rate of unprotected sites and 30% lower odds of local extinction for resident species. Overall, extinction risk was highest among specialists and moisture-demanding species, while colonizing species were predominantly generalists adapted to high nutrient availability and drier conditions. While European grasslands have largely undergone fragmentation over the last century, we demonstrate that plant biodiversity losses are paradoxically concentrated in landscapes that remained more connected over time. This finding could reflect a higher sensitivity to contemporary drivers (e.g., eutrophication and drainage) in historically diverse and connected landscapes, which may now be paying an extinction debt accumulated over the last few decades. In contrast, historically fragmented sites may have already experienced more losses earlier. Our study reveals the importance of long-term landscape change in shaping biodiversity trends and highlights the importance of protected areas in buffering large biodiversity declines of grassland vegetation.

Vegetation change in dry grasslands in Bulgaria: Preliminary results of a 15-year resurvey

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Resurveys of historical vegetation plots are essential for detecting vegetation dynamics under land use and climate change. In 2010-2012, a comprehensive vegetation survey of dry and semi-dry grasslands was undertaken across Bulgaria, as part of the first author's PhD research at the Vegetation Science Group at Masaryk University, Brno, Czechia. In total, 181 georeferenced vegetation plots were sampled using a nested plot design, resulting in over 369 plot records published in 2025 openly on GBIF[1]. Patterns of species richness in a subset of the data were analysed separately[2]. Here, we present preliminary results of a resurvey campaign carried out in northern Bulgaria by resampling the original plot locations 15 years later using identical methodology, with few plots from southern Bulgaria revisited a year earlier. Future plans include resampling the rest of the plots in southern Bulgaria in 2027.This contribution outlines the methodological framework, plot relocation strategy, and presents preliminary results on shifts in species composition and richness. Once the data from the entire resurvey become available, the study will evaluate temporal shifts in species richness, diversity and composition, and vegetation structure, in relation to potential drivers such as changes in land use and climate. The resurvey will also contribute to regional and European initiatives on monitoring long term vegetation change.

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Impacts of observation error on estimates of vegetation dynamics and biodiversity

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Observation error is known to be high in vegetation surveys, leading to inaccurate estimates of community composition and species abundances. These errors also limit our ability to accurately assess rates of biodiversity change across space and time. As part of the GRAssland Communities Experiment (GRACE) (1,2), we set out to quantify, and ameliorate, the impacts of these errors on estimates of biodiversity change drawn from vegetation resurvey data. To do so, we conducted a multi-site test of observation error rates in herbaceous vegetation surveys, spanning 25 locations and three continents from the Nutrient Network globally distributed experiment. In each site, plots were resurveyed repeatedly within a single growing season, either by the same surveyor, or multiple different surveyors. We then quantified error rates for estimates of cover and species identity, applied these error rate estimates to simulate hypothetical scenarios of species loss and species gain, and computed the resulting biases in estimates of diversity change and turnover (i.e. alpha diversity change and temporal beta diversity). Results showed that observation error rates were much higher for rare species, and generally higher when measurements were conducted by multiple different surveyors, and for graminoids relative to other species groups. Error was generally high for species-level statistics (e.g. upwards of 20% for both cover and species identity), but tended to be lower for abundant species, and for aggregate statistics (e.g. diversity, community-level cover). In the simulations of species gains and losses, corresponding biases in estimates of alpha diversity change were small, but increased somewhat at higher rates of simulated biodiversity change. In contrast, biases in estimates of turnover were high (5-15%) regardless of simulated rates of biodiversity change, and were maximised in scenarios where no actual biodiversity change took place. Jointly, these findings indicate that certain metrics (in particular, aggregate estimates of community-level cover, diversity, and alpha diversity change) are likely robust to even high rates of observation error, whereas others (e.g. species-level cover, presence of individual rare species, and temporal turnover) are likely to be biased even by moderate observation error. We note that these biases could at least partially explain why many studies of local-scale biodiversity change fail to find significant average directional trends, despite high reported turnover. Our results also demonstrate how maximum likelihood techniques could be applied to quantify and ameliorate these biases future analyses.

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Floreal 2.2: a tool linking plant functional traits to agroecological indicators for grassland assessment

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Natural grasslands represent a major conservation priority in France and across Europe, as they host high levels of biodiversity while providing multiple ecosystem services essential for livestock farming and rural landscapes. Addressing the challenges of conserving these habitats requires stronger dialogue between ecologists, agronomists, and farmers, as well as tools capable of translating ecological knowledge into operational indicators for grassland management and policy evaluation (1). In this context, the Floreal tool was developed in 2021 to bridge plant ecology and agroecological assessment. Floreal is based on phytosociological vegetation surveys and uses a plant functional trait database (FlorealData) (2) to compute agroecological indicators (FlorealIndices) (3) describing the ecological and agronomic properties of grassland plant communities. The new version, Floreal 2.2 (2026), is a free and open-access tool that substantially improves the robustness and analytical capabilities of the initial version. This new version also considerably expands the geographical scope of the tool. The FlorealData database currently includes 34 functional traits documented for 990 plant species, compiled from the scientific literature. These traits are used to generate 30 agroecological indicators that characterize key ecosystem services provided by grasslands, including species diversity, ecological specialization, ecological indicator values, productivity, management flexibility, forage phenology, attractiveness to pollinators and butterflies, and landscape and cultural value. Two user-friendly interfaces allow the operational use of Floreal 2.2 for both field diagnosis and large-scale ecological assessments. The first is a smartphone-based application designed to support in-field diagnosis of grasslands together with farmers or agricultural advisors (floreal.cbnpmp.fr). The second is an online platform enabling the computation of agroecological indicators for large vegetation datasets (floreal.desktop.cbnpmp.fr). The tool can be applied to grassland diagnosis and monitoring at multiple spatial scales, ranging from individual fields and farms to territories or public policy frameworks. Floreal is currently used to support farmer-advisor dialogue, to assess agri-environmental schemes, and to monitor the conservation status and restoration of habitats of European interest, including within Natura 2000 sites and in the context of the European Nature Restoration Law. By linking vegetation surveys, functional trait data, and agroecological indicators, Floreal provides an operational framework for integrating plant community ecology into grassland management, biodiversity conservation, and environmental policy evaluation across France and potentially throughout Europe.

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*Leveraging the European Vegetation Archive to Resolve Visual Ambiguity in Automated Biodiversity Monitoring

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The accurate identification of plant species within their natural communities is a critical aspect of vegetation science, yet it remains a major challenge for large-scale biodiversity monitoring. While deep learning models have achieved remarkable success in single-specimen identification, their performance is still often poor when applied to complex plant community images. In these contexts, high taxonomic diversity, visual occlusion, and the presence of visually similar (cryptic) taxa introduce significant bias. This study presents a novel framework that disentangles visual morphology from ecological structure to enhance the automated identification of plant species across an entire national flora of 8,000 species. To bridge this gap, we developed a probabilistic approach that combines computer vision with macroecological data. Visual ambiguity is quantified using interspecific ambiguity probabilities estimated from large-scale single species image data, while species co-occurrence is derived from co-occurrence probabilities computed from the European Vegetation Archive (EVA). By integrating ecological co-occurrence priors, into a multi-label visual identification framework, we demonstrate that such a model can help to resolve taxonomic ambiguities that are impossible to settle through visual data alone. In this framework, the visual model generates a set of candidate taxa, which are then refined by an ecological prior that assesses the statistical likelihood of those species co-existing within a specific habitat or environmental context. The effectiveness of this method was rigorously validated across a diverse range of European ecosystems using a comprehensive dataset of in-situ plot image. Crucially, we show that these performance gains are robust across both categorical and continuous environmental gradients. The framework maintains its corrective power regardless of habitat type, from dense forests to open grasslands, and remains invariant to abiotic stressors such as light availability, temperature, and soil moisture. By demonstrating that ecological structure can act as a corrective layer for visual ambiguity, this work provides new insights into the relationship between plant traits and species coexistence. This framework offers a scalable, robust solution for non-destructive vegetation sampling, enabling researchers to monitor complex plant communities at a taxonomic resolution and geographic scale previously inaccessible with traditional computer vision methods. Ultimately, this integration of phytosociological data with deep learning provides a more ecologically grounded approach to automated biodiversity assessment.

*Deriving CSR Values from Traits: A Proof of Concept for the German Flora

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The CSR framework proposed by Grime is widely used to describe plant ecological strategies along the axes of competitiveness, stress tolerance and ruderality, and it remains an important tool in vegetation science for interpreting species composition, community assembly and ecological responses to environmental conditions. At the same time, trait-based approaches now make it possible to calculate CSR values from measurable plant traits, providing a more standardized and reproducible alternative to empirical strategy assignments. However, the relationship between empirical CSR values and trait-based CSR values has not yet been sufficiently explored across a broad set of European plant species. This study compares empirical and trait-based CSR values for European plant species in order to assess the degree of agreement between both approaches. Empirical CSR values are compiled from published sources, while trait-based CSR values are calculated from available trait data following established methods. Particular attention is given to the question of whether trait-based CSR estimates reproduce the main ecological patterns represented in empirical classifications, or whether certain parts of the CSR spectrum are more sensitive to the method of assignment. This is highly relevant because CSR-based classifications are widely used in vegetation analyses, but their comparability across data sources and methodological approaches is rarely evaluated explicitly. By clarifying the relationship between empirical and trait-based CSR values, the project will contribute to a more critical use of CSR classifications in European vegetation science and may support future large-scale analyses of plant strategies across floras, vegetation datasets and environmental gradients. Although still ongoing, the study is expected to provide a first methodological basis for assessing the consistency and transferability of CSR assignments.

Secondary succession on islands coupled with species richness decrease: first insights from resurveying vegetation plots on small Mediterranean islands

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Resurvey studies are increasingly considered by ecologists, given the excellent opportunity to study temporal dynamics of plant communities. European science community is particularly active on this side, with numerous studies carried out in the continent, but with few investigating plant dynamics on island ecosystems. With this contribution we aimed to provide the first insights on how small Mediterranean islands are responding to ongoing global phenomena (e.g., human driven land use change, alien species spread). We selected small Mediterranean islands (0.01-1 km^2) with vegetation plot data recorded at least 10 years ago. After relocation of historic plots, we resurveyed them, adopting the same technique and surface area as in original surveys. We obtained a dataset of 183 historic and resurveyed plots, belonging to 47 islands distributed on five countries (Croatia, France, Greece, Italy, and Spain). We investigated patterns of change at species, plot, and island scales, focusing on positive or negative shifts in plot species richness and in cover abundance of single species. We found a significant reduction in island species diversity, coupled with an increase in cover of shrub species (*Myrtus communis*, *Phillyrea latifolia*, *Pistacia lentiscus*). These patterns combined suggested ongoing secondary succession on the islands. We also found a slight increase of ruderal species (e.g., *Hordeum murinum*, *Malva arborea*, *Solanum nigrum*) presumably linked with seagulls' presence on the islands and suggesting habitat degradation. Integrating our resurvey dataset with repeated floristic inventories at island scale will give a better view on the processes occurring on small Mediterranean islands and will aid conceiving sound conservation policies.

Talk Sessions

Session 4: Vegetation classification: a tool for better understanding and improving management of European habitats

Coastal *Juncetea maritimi* in southeastern France

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Juncetea maritimi Braun-Blanquet in Braun-Blanquet, Roussine & Nègre 1952 cover perennial grasslands and herb-rich vegetation of saltmarshes. In southeastern France, this class occurs mostly in a coastal context that will be the focus of our study. This type of vegetation is very sensitive to the water quality and to the hydrological functioning of the surrounding area. The coastal context involves high anthropic pressure directly on the vegetation and indirectly through the use of water resources. Consequently, *Juncetea maritimi* communities are regularly on the top of conservation lists. In order to better understand how *Juncetea maritimi* function and to communicate about them more effectively we need clearly delineated vegetation units and well-defined distinguishing criteria. The study begins with an extensive bibliographical review of *Juncetea maritimi* relevés, followed by their digitization. The validity of previously published names is then assessed in accordance with the latest edition of the International Code of Phytosociological Nomenclature. More than 700 vegetation relevés - both published and unpublished - have been analyzed using k-means clustering, based on a hierarchical classification performed with the Wards method. Dissimilarity was computed using the Bray-Curtis index. The resulting clusters are compared with previously published syntaxa to see if they fit concept-wise or if they contain a nomenclatural type. The distinctive floristic features of each syntaxon are identified and structured into a determination key inspired by the hierarchical classification. The vegetation relevés cluster in two main groups corresponding to the *Juncion maritimi* Braun-Blanquet ex Horvatić 1934 and to the *Plantaginion crassifoliae* Braun-Blanquet, Roussine & Nègre 1952. Inside these clusters the structure of the data is less clear with many relevés, mainly recent ones (from the 1970's onwards), being very species-poor. While the status of these species-poor subclusters deserves to be discussed, some "classical" associations can still be recognized. These results will be translated into identification tools that will be used for data collecting, ecological monitoring, natural areas management and new conservation programs.

*Classification of European aquatic vegetation (*Lemnetea* and *Potamogetonetea*) to the association level

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Traditional classification systems for aquatic plant communities often lack methodological consistency, resulting in divergent interpretations and limited applicability at the European scale. To overcome these inconsistencies, we developed a comprehensive, consistent and unequivocal phytosociological classification of European free-floating (*Lemnetea*) and rooted (*Potamogetonetea*) aquatic vegetation to the association level. We analysed a European dataset comprising 125,029 vegetation plots and applied heterogeneity-constrained random resampling to derive representative subsets. Associations were delimited using explicitly defined classification attributes and transparent floristic criteria. Overlaps among vertically stratified aquatic communities were resolved through the application of a growth-form hierarchy. Percentage similarity calculations were used to define association groups. Formal expert-system definitions were established for all associations, alliances and orders of the classes. Compositional relationships were explored using ISOMAP ordination, and communities were ecologically characterised based on measured environmental parameters (pH, electrical conductivity and water depth), ecological indicator values for Europe, and a targeted literature review. In total, we recognised 15 associations within five alliances and one order of *Lemnetea*, and 59 associations within seven alliances and three orders of *Potamogetonetea*. The resulting expert system provides formal and reproducible assignment rules. Ordination analyses show that alliances and associations are primarily differentiated along nutrient and reaction gradients; however, hydrological factors (e.g., water depth and flow velocity) are of comparable importance, while overall ecological ranges remain broad. Most associations exhibit wide geographic distributions, with the highest diversity recorded in central to western Europe. By contrast, several associations are restricted to boreal regions and are of particular conservation concern in the context of ongoing eutrophication and climate change. This classification represents the first pan-European, association-level, protocol-based synthesis of aquatic vegetation, providing reproducible and field-applicable definitions. Although largely consistent with established syntaxonomic concepts, it proposes selected modifications to the EuroVegChecklist and demonstrates that the applied protocol is well suited for species-poor aquatic plant communities.

Bryophyte communities in Switzerland: a proposal for a list of alliances and microhabitat typology

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Some habitats, whether urban or natural, are characterized by the dominance of bryophytes. In rocky habitats like natural cliffs or urban walls, these organisms form specific communities, depending on the type, exposure, and context of these stony substrates. In forests, bryophyte microhabitats play a crucial role for the equilibrium of these ecosystems. Used as bioindicators for water quality assessment, bryophytes are essential to understanding and managing wetlands and running watercourses. Several studies have contributed to our knowledge of the communities and microhabitats harboring mosses in Europe. In Swizerland there is a reference guide for natural habitats which includes mostly vascular plant communities and only four moss communities. There isn't a reference document for Swiss bryophyte communities yet. Paying particular attention to these communities would help to refine management proposals in these habitats. The objectives of this study are: 1) to propose a syntaxonomic system of alliances for bryophyte communities in Switzerland; 2) to develop a typology of bryophyte microhabitats; 3) to propose the inclusion of some new large bryophyte-dominant communities for the national habitat guide. The syntaxonomic system of bryophyte communities present in Switzerland will be elaborated according to the ecological and nomenclatural choices recognized in Europe (1). The units present in Switzerland will be identified and briefly described using data in the literature and personal observations for lesser-known communities. Based on bryophyte syntaxa descriptions, the microhabitats occurring in Switzerland will be cataloged. The Swiss bryophyte syntaxonomic system is comprised of four classes including 15 alliances of bryophytes growing on the soil (epigeic vegetation), 16 alliances of communities growing on mineral substrates (epilithic vegetation) and 20 alliances associated with various substrates (epiphytic and epixylic vegetation). Microhabitat typology was organized hierarchically according to the substrate type (tree, soil, stone, dead wood). Thus, they will not necessarily correspond to the same hierarchical levels structuring the bryophyte syntaxonomic system. Regarding the Swiss guide of habitats, 12 bryophyte alliances were proposed: *Brachythecion rivularis* (calcareous fast flowing rivulets and rivers at low altitudes), *Racomitrion acicularis* (cool and acidic running waters in mountainous regions), *Pellion endiviifoliae* (base-rich spring water), *Pellion epiphyllae* (acidic spring water), *Physcomitrellion patentis* (silty loam in the supralittoral of lakes), *Grimaldion fragrantis* (alluvial soils and rooftops), *Racomitrion lanuginosi* (moraines), *Grimmion tergestina* (exposed limestone rocks and screes), *Andreaeion petrophilae* (exposed siliceous screes and cliffs), *Andreion nivalis* (shady siliceous screes and cliffs), *Fissidention taxifolii* (disturbed soils) and *Phascion cuspidati* (agricultural fields). Overall, this work fills an important gap in Swiss habitat classification by formally recognizing bryophyte-dominated communities. By integrating syntaxonomy and microhabitat typology, it provides a clearer ecological framework that will support biodiversity conservation, ecological monitoring, and more precise habitat management strategies in Switzerland.

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Look on alpine willow communities: from lowland alluvial forests to dwarf thickets of the subalpine zone

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Alpine willow forests have already been the subject of reviews (1,2), but some of their units remain poorly understood. This paper aims to present a new classification of these willow groves, i.e. plant communities dominated by willows as shrubs, small trees or large trees across an altitudinal gradient ranging from lowland to alpine zones (from 200 to 2,400 m above sea level). It is based on biotic and abiotic data collected during recent fieldwork (2009 to 2020), as well as on unpublished data and data from the literature. The geographical area covered extends across the northern and central Alps, mainly in Switzerland and France, but plots have also been characterized in Italy and Austria. In total, 407 vegetation surveys were collected within the study area, drawn from various successive projects conducted in the Arc region, the subalpine zones of the French and Swiss Alps, the Upper Rhône, the Fribourg Pre-Alps, and various other preliminary studies. 94 published reference vegetation surveys were included. The surveys were classified using Ward's hierarchical clustering. The resulting groups were validated using statistical methods and characterized by species composition ranked according to fidelity and other variables (physiognomy, altitude, phytoindicators). Statistical comparisons were carried out to explain the differentiation of the units. Our results identify 18 associations falling within 9 different alliances. They corroborate the European classification proposed by Mucina *et al.* (3), comprising three alliances for the Alps within the order *Alnetalia viridis* (*Alnion viridis*, *Salicion pentandrae*, *Salicion helveticae*), but suggest the recognition of additional entities dominated and characterised by *Salix hastata* and *S. foetida* or *Salix appendiculata*. In addition to the work of Kalníková *et al.* (4), we also propose recognizing two autonomous alliances: a pre-forest tree vegetation dominated by *Salix elaeagnos* in hilly and mountainous areas and by *Salix daphnoides* in the subalpine zone, which form an intermediate stage in the succession between the shrubs of gravel banks and white alder forests. This communication will present the diversity of structure, composition, geographical and ecological determinants, and dynamic links between this different associations.

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WALTER - An R package to plot worldwide climate diagrams and issue multiple bioclimate and biome classifications

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Climate diagrams, especially that of Walter and Lieth (1967), are graphical depictions of average monthly pattern of soil water availability to plants. These came to be of paramount importance in vegetation science, in all spatial scales, from community to biome. Several worldwide bioclimatic classifications have been produced, namely those of Koppen & Geiger (1936), Holdrige (1947) and the latest of Rivas-Martínez (2011). Such systems correlate the climatic resultant, that is relevant to plants, to ecosystem spatial distribution. Thus, given climatic parameters, these systems yield bioclimatic diagnoses from thresholds corresponding to ecosystem borders. The referred bioclimatic systems vary in their explicit definition of ecological units. Moreover, some authors developed biome systems that are strongly defined by bioclimate. We may cite Walter's zonobiomes (Walter & Box, 1976), Loidi *et al.* (2022) and Mucina (2023). We present the prototype of an 'R' - language package 'WALTER', that plots the Walter & Lieth climate diagram for any location in the World, by input of its toponymy, and approaches with great accuracy the correspondent bioclimatic, or biome classification, in the systems of Koppen; World Bioclimate Classification System of S. Rivas-Martínez; the bioclimate-biome system of J. Loidi *et al.*; and L.Mucina's Global Hierarchical Biome System. The script is based on geocoding the coordinates in OpenStreetMap (Haklay & Weber, 2008), to retrieve climatic parameters in WorldClim (Fick & Hijmans, 2017), which then follow probabilistic keys incorporating the authors bioclimate or biome definitions. The acronym is an homage to H. Walter (1898-1989).

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cocktailr: fast and reproducible Cocktail clustering for vegetation classification

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The Cocktail method is a valuable approach for vegetation classification because it identifies hierarchically structured groups of co-occurring species and translates them into explicit membership rules. However, its broader application to large vegetation datasets has been limited by computational and methodological constraints. We present *cocktailr*, a new open-source R package that implements Cocktail clustering in a fast, reproducible and transparent way. The package uses efficient sparse-matrix operations and deterministic tie handling, making it suitable for large datasets. In addition to constructing the Cocktail hierarchy, *cocktailr* provides tools for selecting strong clusters, exploring species-cluster relationships through φ profiles, comparing clusters based on plot co-membership, and assigning relevés to vegetation units using alternative scoring strategies based on species presence, cover and φ-weighted information. We demonstrate the workflow on regional grassland datasets from Europe, showing how the package can support formalized vegetation classification and reproducible relevé assignment. *cocktailr* thus bridges the gap between diagnostic species-group detection and practical classification workflows and provides a flexible framework for vegetation classification in R.

Why Regionalization Matters in the EUNIS Habitat Classification

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This presentation demonstrates how a regionalization framework for the EUNIS habitat classification may advance biodiversity conservation in Europe. Using the Ibero-Atlantic region in NW Iberian Peninsula as a case study, we develop and implement a regionalization framework using vegetation plot data (Figure 1). Our approach combines the use of the expert system at European scale for higher EUNIS levels with a nested numerical classification to define lower hierarchical units optimized to regional habitats. We found that the European expert system successfully classified 91% of plots at EUNIS level 1, but only 55% were classified at level 2, with major assignment problems detected for heathlands. Using a semi-supervised classification to accommodate overlooked regional habitats with vegetation data, we defined a total of 99 habitats at EUNIS level 4, of which 36% were absent from or described at other levels in the official EUNIS habitat list. 64 out of 99 habitats were assigned to the Annex I of the Habitats Directive, with 87% of them showing univocal one-to-one conceptual relationships. All EUNIS level 4 habitats showed a high number of indicator species and clear environmental differentiation, with detailed descriptions available at https://iberoatlantica.eu/. Our results indicate that the regionalization of European EUNIS classification is a necessary step to develop meaningful regional descriptions, providing strong links with phytosociological classifications and Annex I habitats. A regionalization of EUNIS is also essential for developing the next generation of high-resolution habitat maps for regional and continental ecosystem accounting.

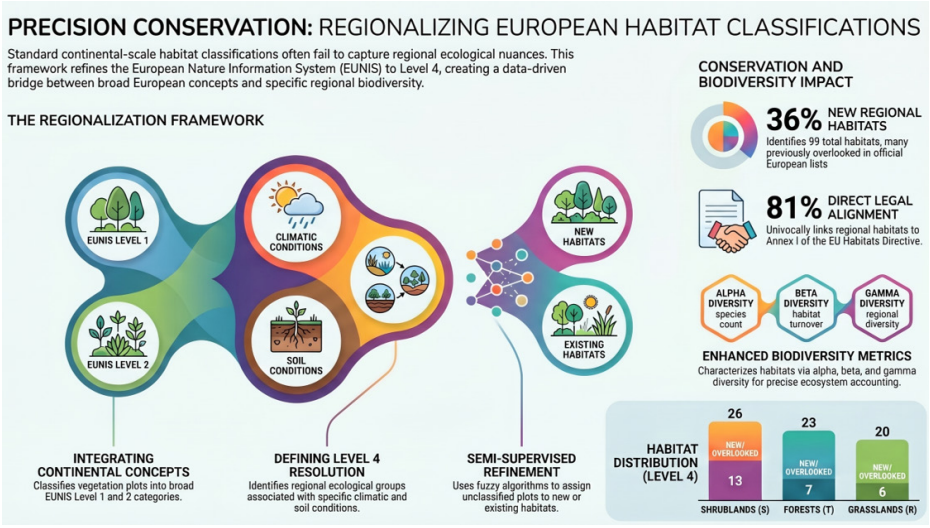

Figure 1. Synthesis of the conceptual framework developed for regionalization of EUNIS classification.

Unlocking the potential of diverse grasslands: typology and diagnostic tools for grassland livestock farming in the Massif central

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In upland areas, grasslands form the basis of ruminant livestock farming systems. The French Massif Central, considered to be Europe's largest grassland, is a prime example. The grassland ecosystem, which accounts for more than 60% of the agricultural area, has attained an exceptional level of biodiversity through the interaction between diverse soil and climate conditions and a wide range of agricultural practices. However, this natural wealth is often perceived by farmers as a constraint rather than a lever for strengthening agroecological potential or a relevant option for adapting systems to climate change. To raise awareness among local stakeholders regarding grassland diversity, and thus recognize their full potential, several interdisciplinary, multi-stakeholder projects have been conducted to better understand the multifunctionality of these areas. Using an approach combining ecology, phytosociology, agronomy, and animal husbandry, a network of 143 grasslands spread across 70 farms was studied. The floristic, agronomic, and pedological data, supplemented by information on farming practices, made it possible to identify 60 distinct types of grassland. This grassland diversity has been structured into a typology in book form (1) featuring an intuitive identification key that provides direct access to descriptive sheets for each type. Each sheet offers an accessible description of the plant communities and assesses both agronomic potential and ecosystem services, as well as their contribution to the quality of animal products (dairy and meat). The typology is further enhanced by an expert assessment that highlights critical species and habitat conservation points, while proposing potential succession trajectories resulting from management changes, such as increased fertilization or land-use shifts. The partners' expertise has enabled the development of a diagnostic tool (DIAM2) that assesses the coherence of livestock farming systems regarding the use of on-farm grasslands. It highlights the balance between production, environmental services, and product quality - for instance, by determining the proportion of milk production derived from grass. These tools are now widely used by agricultural advisory and conservation organizations. Understanding the agroecological properties of different types of grassland facilitates constructive dialogue with farmers about the specific characteristics of their land, while raising their awareness of the broader ecosystem services provided to society. Furthermore, it demonstrates that certain practices, such as over-fertilization, can compromise grassland multifunctionality, enabling farmers to align their practices with the actual needs of the vegetation. By empowering farmers as key players in the management of their grassland areas, these tools foster dialogue and the emergence of collective projects that promote the sustainable management of grassland biodiversity.

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Ecosystem services characterisation of phytosociological associations of permanent mid-mountain grasslands of the Chaîne des Puys (Auvergne)

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Knowledge of ecosystem services (ES) is a key point in understanding ecosystem multifunctionality within a territory (1). Phytosociology enables a detailed characterisation of ecosystems (2, 3), such as grassland communities. Studying the ES provided by phytosociological associations opens up the possibility of gaining a detailed understanding of the multifunctionality of a territory, facilitating the reconciliation of uses and the improvement of sustainable environmental management (4, 5). The Chaîne des Puys is a UNESCO World Heritage and a Natura 2000 labelled area, where diverse expectations and uses of multiple stakeholders intersect. On the grasslands, breeders-who are involved in the management of these ecosystems—may encounter tourists and locals, who hike and admire the landscape for example. The objectives of this work are (i) to measure selected ecosystem services provided by a wide range of grasslands that have been characterised using a phytosociological approach, and (ii) to investigate synergies and trade-offs between these ES. Ultimately, this work aims to provide foundational knowledge to support improved management and the reconciliation of uses across the territory. The study site comprises 27 semi-natural grasslands spread across the Chaîne des Puys, representing nine phytosociological associations. Eighteen of these are permanent grasslands managed by breeders and shepherds, while the remaining nine are located within an experimental research station. First, the assignment of grasslands to a phytosociological association has been performed using a fuzzy classification of field vegetation surveys projected onto a multidimensional space (DCA) (6), constructed with phytosociological reference surveys (7, 8). Expert opinions have then been used to account for local conditions and management practices (9). For each grassland, measurements have been taken to evaluate six ecosystem services: fodder provision, provision of medicinal and edible plants, soil carbon stock, pollination, grassland aesthetics, and grassland heritage. The capacities of each ES for each phytosociological association have been characterised, and the relationships between them have been investigated. Among the associations under scrutiny, the *Festuco rubrae-Genistetum sagittalis* strongly supports the ES Heritage, while the *Knautio arvernensis-Arrhenatheretum elatioris* supports the ES Pollination. Overall, oligotrophic and mesotrophic habitats appear to be more multifunctional than eutrophic ones. The distribution and intensity of ES capacities are related to the studied environmental variables, such as floristic composition, altitude, and agropastoral management practices. Four ES bundles have been identified and linked to the beneficiaries' preferences, as collected through field surveys (63 respondents). The analysis of these preferences highlights potential synergies and trade-offs, particularly between fodder production needs and the conservation objectives of agropastoral habitats. In perspective, these results provide a valuable foundation for implementing an integrated and sustainable management approach to the grasslands of this territory.

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Effects of climate, land use and connectivity on native and alien urban floras: Insights from local and continental scales

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Cities are the fastest-growing ecosystems globally, rich in native plant species and hubs for the introduction, establishment, and spread of alien plants. Urban floras are shaped by interacting processes that operate at local and regional scales and differentially affect native and alien species. Here we present results combining data from two spatial scales to examine how urban characteristics, climate, and inter-city connectivity shape plant diversity and species compositional patterns. At the local scale, we analysed floristic mapping in the city of Brno, Czech Republic (population of 402,000; divided into 102 grid cells of 1.5 km × 1.3 km, 1,458 vascular plant species recorded, presence/absence data) using ten predictors describing land use and local climate. Random Forest models explained 8.5-27.1% of variation in species counts across selected species groups and indicated that native species richness was mainly associated with land-use factors - especially forests, larger urban greenspaces and higher land-use diversity, whereas alien species richness correlated primarily with higher local temperature and with residential areas. Neophytes and naturalized species showed overlapping responses, archaeophytes were poorly predicted, and invasive species were relatively more linked to residential, riparian and industrial zones. Ordination analysis (db-RDA, R^2adj = 16.5%) mirrored these patterns. It separated highly urbanized vs forested parts of the city and distinguished marginal agricultural areas from zones dominated by residential/grey infrastructure (increasing invasive species) or diverse urban greenspaces (increasing native species), with riparian sites showing distinct assemblages and higher affinity for invasives. To understand how results from one city transfer to others, we ran analyses on the continental scale. Using species lists from 60 European cities, we quantified pairwise compositional similarity for native and alien floras and tested effects of geographic, climatic, and socioeconomic distance, and transport connectivity. Our first results suggest that all distance measures reduce similarity, but geographic and climatic distance affect native floras more than alien ones. In contrast, transport connectivity increases similarity among alien species more than among natives, suggesting human-mediated links help aliens overcome geographic barriers. Our results indicate scale-dependent drivers: local land use and greenspace structure primarily support native diversity, urban climate promotes alien diversity within cities (at least in the Central European context), and inter-city connectivity drives homogenization of alien floras across the continent. This highlights the need for scale-aware biodiversity policies that would combine targeted habitat management (including valuable human-made habitats and ecological restoration) with measures to prevent introductions and limit the spread of alien species. Further research on the roles and dynamics of different habitats in promoting urban flora across biogeographic contexts is needed.

Synonyms and syntaxonomic crosswalks: a pitfall for natural habitat management

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Numerous classification systems are available to land managers, but they do not all address the same objectives. Some classification systems designed to characterize habitats (e.g., EUNIS, Habitats Directive Annex I) are primarily intended to meet policy and reporting requirements. In France, other classification systems describe vegetation at different spatial scales: European (1), national (2,3), and regional (catalogues developed by the National Botanical Conservatories). These phytosociological classification systems support the assessment of habitat conservation status and guide management actions through a detailed description of plant communities. However, these phytosociological classification systems are not easily interoperable, which makes syntaxonomic identification, and therefore the implementation of appropriate conservation measures, challenging for managers. To facilitate the work of managers, some reports, such as habitat handbooks in France (4), provide synonymies and establish crosswalks between different classification schemes. However, as these crosswalks are often based on expert judgement, they may lead to inappropriate management practices. It is precisely this type of synonymy, such as the one established between *Alopecuro bulbosi-Juncetum gerardii* and *Carici divisae-Lolietum perennis*, which are assigned in the habitat handbooks to the same Annex I habitat type (1410-Mediterranean salt meadows) despite distinct ecological drivers, that should be examined through the implementation of an experimental phytosociological approach. In this perspective, expert judgement should be considered as a hypothesis to be evaluated using experimental designs aimed at assessing its validity. Ensuring the validity of management choices may benefit from linking classification systems with experimentally validated syndynamic knowledge. These questions were investigated in the Natura 2000 Poitevin marsh site (France) using long-term experimental plots under different grazing regimes over approximately twenty years to study its impact on vegetation dynamics. Experimental results indicate that *Alopecuro bulbosi-Juncetum gerardii* and *Carici divisae-Lolietum perennis* are not synonymous syntaxa but represent distinct stages within a vegetation dynamic, with the former tending to develop into the latter when grazing pressure decreases. This dynamic perspective provides the basis for management aimed at achieving a favourable conservation status of the habitat.

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PhytoS, an online database of plant community names: current status

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PhytoS is an online nomenclatural database developed between 2023 and 2026 with financial support from IAVS (1). Its purpose is to register the names of plant communities, particularly those of the Braun-Blanquet school, at the rank of association and above. However, PhytoS is not limited to specific schools: names of plant communities at any rank (e.g. subassociation or variant), or without a rank (e.g. plant community type), can also be registered. This presentation will demonstrate the main functionalities of PhytoS, such as registering a name of a new syntaxon, a change of rank, a replacement name, the mutation, inversion, correction and the type of a name, and also the registration of a publication and authors' names.

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Interpretation of EU habitats: a never-ending story

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The European Union Habitats Directive is a key instrument in European nature conservation. Member states are required to map and monitor the habitats listed in Annex I of the directive on a regular basis and ensure a good conservation status of these habitats. However, some habitat types are not well defined, and their interpretation is inconsistent among EU member states. The preparation of a determination key for the EU habitats occurring in the state of Lower Austria (Niederösterreich) in Eastern Austria provided an opportunity to revisit some of these interpretation problems and to propose new solutions. In my talk, I will discuss a few examples that are relevant beyond the bounderies of Austria: habitat type 2340 (Pannonic inland dunes), erroneously restricted to acidic sand grasslands of the *Corynephorion* alliance (1); 3130 (Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoeto-Nanojuncetea*), which seems to exclude a large portion of the eponymous class *Isoëto-Nanojuncetea*, in particular those occurring along running water (however, most of these stands can be included in another habitat type); 3150 (Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation), which might include more than just the two eponymous alliances; 6430 (Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels), which better not includes some of the syntaxa mentioned in the Interpretation Manual; and 91M0 (Pannonian-Balkanic turkey oak-sessile oak forests), which includes two associations assigned to other habitat types or no habitat types at all in some member states. Finally, I suggest that the European Vegetation Survey working group takes a more active role in the interpretation and harmonisation of EU habitats.

1) W. Willner, T. Schernhammer (2024) BCBEA, 8(1): 55-60.

Identifying and characterizing weed and ruderal species. Case study from Slovenia

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Arable land and ruderal sites represent some of the most disturbed and dynamic habitats. Their plant communities are highly diverse, both in species composition and in the environmental factors influencing their structure, ranging from natural to strongly anthropogenic drivers. Weed species of arable land are of major concern for agriculture and nature conservation, while ruderal species are receiving increasing attention in remediation and invasion ecology. The aim of this study was to identify and characterize the most typical plant species of arable land (with a further distinction between cereal and row crops) and ruderal sites in Slovenia. We used the Vegetation Database of Slovenia (1), a stratified dataset comprising approximately 19,000 relevés and 3,000 species. Relevés were grouped in two ways: i) arable land, ruderal sites, and all other vegetation types; and ii) cereal fields, row crop fields, and all other vegetation types. For each group, species fidelity was calculated using the phi coefficient (Tichý & Chytrý, 2006). Ecological indicator values and disturbance indicator values were then plotted against phi values to characterize the species groups. Higher phi values were recorded for arable fields compared to ruderal sites, and for cereal fields compared to row crop fields. No overlap in species composition was found between arable land and ruderal sites, and only minimal overlap between cereal and row crop fields when considering the 15 highest-ranking species. Arable weed species showed higher tolerance to soil disturbance than ruderal species with high fidelity, while weeds of row crops were more nitrophilous than those of cereal fields. Several other ecological indicators showed similar correlative patterns when compared across groups. By identifying species of arable land and ruderal sites against the background of all vegetation types, our approach provides species lists with increased robustness, although they are region-specific. The results can contribute to i) improving national habitat typologies, ii) monitoring temporal changes in vegetation cover, iii) optimized planning of agrotechnical practices, iv) archaeological interpretations based on archaeobotanical remains, and v) informing nature conservation policy and restoration planning.

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*Data-driven habitat-based bioregionalisation of the Alps for conservation assessment

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The establishment of protected areas is recognised as one of the most efficient ways to address the biodiversity crisis; nevertheless, countries rarely protect a representative portion of their national biodiversity, as reported in the Biodiversity Strategy for 2030. Their targets are the protection of at least 30% of land and the strict protection of one third of it (IUCN categories Ia, Ib or II; 1). To assess whether the European protected area network represents the habitat diversity of the Alps, we developed a new regionalisation. We then evaluated whether the European targets in the Biodiversity Strategy for 2030 have been achieved in all the resulting bioregions. We performed a spatially constrained hierarchical cluster analysis based on the structural similarity of Natura 2000 habitat types, as collected from the reports of Article 17 of the Habitats Directive. Following the identification of six bioregions, we then characterised them using the phi coefficient of association and five environmental variables (temperature, precipitation, elevation, slope, and terrain ruggedness). Each bioregion represents a section of the Alps and has associated habitats that are coherent with the environmental variables. To assess the biodiversity representativeness of the European protected area network, we overlaid the protected areas (all, strict, only non-strict, Natura 2000 sites) with the bioregions. One bioregion is covered by less than 30% of all protected area types, thereby failing to meet the first target of the Biodiversity Strategy for 2030. However, only one bioregion in the core area of the Alps is covered by more than 10% of strict protected areas. Additionally, to examine the importance of the Natura 2000 network in the context of bioregions, we analysed the ratio of the Natura 2000 sites not covered by other protected areas to the total protected area within each bioregion. The results demonstrate the varying contributions of the Natura 2000 network to the protection of the bioregions. Specifically, the proportion of land area encompassed exclusively by Natura 2000 sites ranges from 9.5% to 51.7% of the total bioregion surface protected. Finally, to assess the ecological uniqueness of the cells, we calculated the Local Contribution to Beta Diversity (LCBD) for all cells in the study area and examined its relationship with habitat richness. Other than the cells located within the transition zones of the Alps (i.e., the borders), high values of LCBD are correlated with low habitat richness. This new habitat data-driven regionalisation of the Alps is reproducible across other mountain environments, allowing for a new comprehension of the biodiversity distribution of such areas.

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An overview of habitat patterns in italy

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Habitat diversity in Italy is remarkable; however, its spatial organisation remains insufficiently understood, and a comprehensive analysis of habitat distribution patterns is still lacking. Here, by leveraging habitat occurrence data, we provide an overview of patterns of habitat richness and diversity. A dedicated working group of thematic and territorial experts from the Italian Association of Vegetation Science (SISV) collected and validated habitat distribution data supplied by the Italian Administrative Regions and Autonomous Provinces and compiled by the Italian Institute for Environmental Protection and Research (ISPRA) within the framework of the fifth report under the Habitats Directive, covering the period 2019-2024. The dataset consists of a grid of 3,725 cells (10 km × 10 km) including 124 types of terrestrial and inland water habitats. We mapped habitat richness per cell for all habitats combined and for nine macrohabitats, according to the first hierarchical level of the Natura 2000 habitat classification. Furthermore, to divide Italy into ecologically homogeneous regions, we performed a hierarchical cluster analysis based on the beta similarity index. The optimal number of clusters was selected using Mantel statistics with the Pearson correlation coefficient. Results show the highest habitat richness in the Eastern Alps and the Northern Apennines, while the lowest richness is observed in the Po Plain and in the inner areas of the Italian Peninsula. When the database is partitioned by macrohabitats, distinct spatial patterns emerge for all habitat types. In terms of similarity, the analysis suggests an optimal solution of five clusters, broadly corresponding to the Alpine region; the Po Plain and Eastern Alps; the coastal areas; Peninsular Italy; and, finally, Sicily, Sardinia, and Apulia grouped together. These findings, in addition to their relevance for Article 17 reporting, help to identify key areas of high ecological heterogeneity and can inform future conservation strategies by highlighting territories characterised by high habitat co-occurrence.

Vegetation classification: a tool for better understanding and improving management of European habitats. *Pinus heldreichii* and *Pinus peuce* forest communities in Pirin Mountains of Bulgaria

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The *Pinus peuce* Griseb. (Macedonian pine) and the *Pinus heldreichii* Christ. (Bosnian pine) are Tertiary relicts, with the first species being endemic to the Balkan Peninsula and the second one also found, albeit to a limited extent, in the Southern Apennines. These two species do not form communities everywhere within their range, but the Pirin Mts. in Bulgaria, are the only place in the eastern part of the Balkan Peninsula, where there are extensive communities of both species. These communities in the Pirin Mts., were investigated in this study using the Braun-Blanquet's methodology, based on both- previously published relevés and collected new ones. The results of analysis emphasizes that the *Pinus heldreichii* communities are part of ass. *Festuco penzesii-Pinetum heldreichii* with two subassociations: *typicum* and *seslerietosum coerulantis*. They are characterized by their distribution at high elevations, on marbles, and are distinctly oromediterranean. By contrast, the *Pinus peuce* communities in the Pirin Mts. were left at the community level - *Festuca valida-Pinus peuce* community. They are also distributed at high elevations, but on silicate terrains and, in terms of their ecological characteristics and floristic composition, are oroboreal. These results are also based on the comparison with the previously studied and published syntaxa of these species in neighboring countries, mostly Kosovo, Montenegro, Bosnia and Herzegovina and N. Macedonia, but also Greece and Italy. The associations of *Pinus heldreichii* have a limited range, but due to the openness of their forests and their location on limestone and serpentine terrains, many regional and even local endemics penetrated in them. Although the communities of *Pinus peuce* are also divided into geographically isolated associations, the presence of a group of species characteristic of oroboreal forests with high constancy practically everywhere puts this approach into question. However, this will be resolved after a comprehensive revision of the *Pinus peuce* forests within its range. Both species are sensitive relicts with a very limited range mainly in the Balkans. Currently, the most representative forest communities of *Pinus peuce* and *P. heldreichii* are included within the boundaries of "Pirin" National Park and the "Bayuvi Dupki-Dzhindzhiritsa" Reserve, as well as being protected as a natural habitat 95A0 High oro-Mediterranean pine forests in the Natura 2000 site of the same name. However, the peculiarities of their ecology, as well as their location in the upper forest boundary, which is highly sensitive to the climate changes, make their future conservation a scientific and practical challenge.

Hotspot in a hotspot - Caucasian extremely species-rich plant communities in the Eurasian context

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The Caucasus, a mountainous region on the boundary of Europe and Asia, is recognised as one of the world's top biodiversity hotspots and centres of vascular plant endemism (1). Here, we review the most species-rich Caucasian non-forest and forest plant communities based on mostly unpublished vegetation-plot data sampled in the field during the last several vegetation seasons. They were supplemented by data from the literature stored in the Transcaucasian Vegetation Database (2). The most species-rich non-forest plot was sampled in a xeromesophilous grassland (order *Brachypodietalia pinnati*) in northern Armenia (90 species/10 m² and 104 species/25 m²). The most species-rich forest plots contained 127 species/100 m² (*Carpinus orientalis* forest, northern Armenia) and 83 species/200 m² (*Alnus incana* forest, central Georgia). Regarding further extremely species-diverse forest plots (>70 species of rooted vascular plants), their most frequent dominants were *Carpinus orientalis*, *Pinus sylvestris*, and *Quercus macranthera* (phytosociological classes *Quercetea pubescentis* and *Erico-Pinetea*). All these species are relatively light-demanding and often form an open canopy layer (average cover 63%). The most common understory species encompassed *Clinopodium vulgare*, *Campanula rapunculoides*, *Primula veris* subsp. *macrocalyx*, *Origanum vulgare*, *Poa nemoralis*, *Viola alba*, *Veronica peduncularis*, *Brachypodium sylvaticum*, *Trifolium canescens*, *Cruciata laevipes*, *Polygonatum glaberrimum*, *Teucrium chamaedrys* and *Silene italica* (sorted by decreasing frequency). These species-rich forests predominantly occupied neutral to alkaline soils, with an average measured pH of 6.6. They mostly thrived in the temperate continental bioclimate with submediterranean features and considerable seasonality in both temperature and precipitation. The plots were characterised by a mean annual temperature of 6.7 °C, mean annual precipitation of 913 mm, and relatively harsh winters. The determinants of the exceptionally high species richness were diverse and interconnected. They included local (e.g. soil properties, traditional management practises), landscape (e.g. fine-scale mosaic of habitats and management regimes), and regional factors (e.g. species-rich flora). Final results will be presented during the meeting.

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Poster Sessions

Session 1: Importance of historical data for assessing dynamic trends of vegetation and landscape

Long-term vegetation changes in the high-altitude grasslands of the Maiella Massif: a 53-year resampling study

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High mountain vegetation is widely recognized as one of the ecosystems most affected by the ongoing global change. Although temporal analyses of mountain and alpine communities have increasingly become a key tool for detecting their responses to environmental transformations, most studies (e.g., (1); (2)) rely on a simple two-point comparison (historical vs. recent data), which can obscure non-linear trends or recent accelerations in vegetation dynamics. In this study we present a three-point time series analysis to detect consistent trends of grassland communities on the Maiella Massif (central Apennines) providing a robust assessment of long-term vegetation trajectories. In 2025, we resampled 28 semi-permanent phytosociological relevés originally surveyed in 1972 by Feoli and Feoli-Chiapella (3) and again in 2014 by Evangelista *et al.* (4). To comprehensively highlight community trends over time, we analyzed shifts in both taxonomic (alpha and beta-diversity) and functional diversity, and in ecological indicators. Hill indices (species richness, exp(Shannon), 1/Simpson) and Evenness were computed at plot level to account for shifts in alpha-diversity. Beta-diversity was quantified as the multivariate dispersion (PERMDISP) and compositional turnover (PERMANOVA) among sampling years, based on Bray-Curtis dissimilarity. For what concerns functional diversity, Grime's CSR strategies were computed using the StrateFy tool based on three leaf functional traits (leaf area, specific leaf area, and leaf dry matter content) derived from the FUNViola database (5) and integrated with field measurements. Community-weighted mean values (CWM) for Grime's strategies were then calculated per each plot. To infer underlying environmental drivers, for each relevés we computed the mean Ellenberg indicators (EIVs) for light, temperature, moisture, continentality, reaction, and nutrients. Temporal similarities of plot composition and their relationship with the community-level attributes (CSR and EIVs) were visualized through multivariate ordination techniques based on Bray-Curtis dissimilarity. To test for significant temporal trends in diversity indices, Grime's strategies, and mean EIVs, we ran hierarchical models (GLMMs) including plot as a random effect to account for repeated measurements. To jointly analyze species compositional changes and their relationship with species strategies and environmental drivers, we used Hierarchical Modelling of Species Communities (HMSC) in a Bayesian framework. This approach allowed us to estimate species-specific changes across time and, through variance partitioning, assess how species CSR strategies and Ellenberg indicator values shape these trends, providing insights into the resilience and trajectory of high-altitude grassland communities in the central Apennines.

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Mobilising vegetation data from arable fields in Germany for biodiversity trend analysis

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Arable fields have seen strong biodiversity losses since the 1950s due to intensive agriculture. They take up a large part of German landscapes, but analysing the long term changes on a nationwide scale is hampered by a missing data collection. Due to missing scientific interest, historical records of arable vegetation have been less digitised and included in vegetation data bases than records from other habitats. Data on the vegetation of arable fields is recorded and held in Germany by various disciplines ranging from botany and vegetation science to agricultural sciences, especially weed science. This data is published in scientific publications, project reports, and graduation theses. But arable field vegetation is also part of official monitoring programmes of the federal states, particularly in the context of longterm soil observation, and high nature value farmland assessment. A third source of data includes organisations involved in nature protection and land management, often supported by volunteers. A new network between organisations collecting datasets on arable vegetation in Germany has been initiated aiming to establish a comprehensive national collection and to analyse the diversity, community composition, changes over time and conservation status of arable vegetation, especially with inclusion of viewpoints of different stakeholders, In a first step, the collection concentrated on data which is already available in digital form. Nearly 60 datasets have been contributed so far, spanning the time mainly between 1980 and 2025, with some going back to 1916. The research questions addressed by the data originally include: inventory of weed species in a certain crop, elucidating main factors influencing taxonomical and functional diversity, monitoring purposes, inventories of a region, phytosociological efforts, and monitoring of rare species. Most datasets comprise vegetation plot data (~ 28.000 relevés), with various abundance scales or presence-absence information. A small proportion of the datasets involves occurrence data, i.e. without complete species lists. The vegetation plot data were harmonised to percent-cover and taxonomically aligned according to GermanSL 1.5. Many datasets include information on field management, at least regarding crops and cropping system (i.e. organic vs. conventional farming). Crucial information on the position of the survey plots in the field (margin, edge and field center) is included as these field parts represent different habitats. We will present the harmonised dataset with preliminary results regarding arable plant diversity development between 1980 and 2025. Of particular interest are the differentiations between crop types and the different field positions.

Do European protected areas make a difference for plant species conservation? Evidence from long-term vegetation plot data

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Protected areas are key elements in conservation efforts designed to preserve biodiversity and mitigate the adverse impacts of anthropogenic activities on ecosystems, yet their effectiveness is still under debate (1). We combine a temporal vegetation plot database (ReSurveyEurope, 2) with the World Database on Protected Areas (WDPA, 3) to study the effects of protected areas on temporal vegetation dynamics across Europe. By intersecting plot locations with WDPA polygons, we identify vegetation plots located inside and outside protected areas. To account for uncertainties in plot location accuracy, we implement a probabilistic assignment of protection status by buffering plot coordinates and calculating the proportion of protected area coverage within each buffer, thereby estimating the likelihood that plots fall within protected areas. The compiled dataset comprises over 30,000 re-surveyed vegetation plots spanning more than 80 years and covering a broad range of European biogeographic regions and environmental conditions. Using this large dataset, we quantify several dimensions of temporal vegetation changes including species richness and community composition; and assess how these responses vary among habitats (EUNIS level 1 habitat types) and IUCN protection categories. Specifically, we study i) whether vegetation composition changes in protected areas differ from unprotected re-surveyed plots, ii) whether different protection status categories are reflected in different trajectories of vegetation composition changes, iii) whether the time elapsed since establishing protected areas affects vegetation dynamics, and iv) if vegetation dynamics differs between major habitat types (e.g., grasslands, forests, wetlands). The results will provide important insights into the effectiveness of the European protected area network in mitigating biodiversity loss and evaluate how effectiveness varies among IUCN Protected Areas categories and habitat types. These findings will inform future conservation planning by guiding prioritization within the expanding protected area network; and support evidence-based policy aimed at achieving biodiversity targets.

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The fate of the alkaline fen vegetation (H7230) in a small Dutch nature reserve - Natura 2000's loss might be nature conservation's gain

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The "Put van Bullee" is a very small nature reserve which is part of the Natura 2000 network in the Dutch province of Gelderland. It is the type location of the *Equiseto variegati-Salicetum repentis* Westhoff & Schaminée 1994 (*Caricion davallianae*) (1), which qualifies for habitat type H7230 (calcareous fen). The future prospects for this habitat type here are uncertain though, because the uncertain developments in ground water quality and quantity. Anecdotal observations let believe that the species numbers of the vegetation decline over the last few years. We analysed historical vegetation relevés from the location with the question what the vegetation development could learn us about the future prospects of the calcareous fen habitat type. Our analysis shows a succession of the *Equiseto-Salicetum* in the pioneer situation towards *Calthion palustris* meadows. Analysis of data from a pq in the original area from which the *Equiseto-Salicetum* was described, shows a similar development, with a clear change in vegetation structure, from an open pioneer vegetation towards grassland. This development was missed before because of failing analyses. The number of species in the pq rose slightly between 1983 and 1999, and sharply until 2018. Since 2019, the number of species has fallen sharply again. The site conditions for the *Equiseto-Salicetum* appear to be suitable for this vegetation type over large areas in the Put, and recent research shows that over decades there are no significant changes in groundwater levels and quality that could explain the changes in vegetation. Based on a comparison of the *Equiseto-Salicetum* and the closely related *Junco baltici-Schoenetum nigricantis* of primary dune valleys, it can be deduced that the changes in vegetation in the Put van Bullee are caused by autonomous succession, influenced by an initial soil development (formation of a humus profile) and controlled by hay meadow management. The prospects for the sustainable conservation of the calcareous fen habitat type in the Put van Bullee are unfavourable. The development towards (also qualifying) *Cirsio-Molinietum* meadows is questionable, and *Calthion* meadows do not qualify for the desired habitat type. However, such hay meadows can be very species-rich, especially in places under influence of calcareous seepage, and it may arguably be possible to maintain sustainable populations of currently occurring rare and endangered species in such grasslands, like *Epipactis palustris* and *Dactylorhiza incarnata*. From a nature conservation point of view, this development is to be welcomed. Sod cutting as a measure to 'reset' succession and restore the *Equiseto-Salicetum* leads to changes in the relative groundwater level, which ultimately will result in a vegetation that is different from the targeted one. A close examination of historical relevés gave us a better understanding of the vegetation processes and the possible management measures at the location.

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Towards a quantitative validation of Swiss peatland syntaxonomy within the PhytoSuisse framework

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Peatlands host some of the most specialized, conservation-relevant and ecologically distinctive plant communities in Switzerland, yet their syntaxonomical delimitation remains difficult when expert-based classifications are confronted with large and heterogeneous phytosociological datasets. This master's thesis, conducted at ETH Zürich in collaboration with HEPIA Geneva within the PhytoSuisse framework, addresses that challenge by developing a reproducible, data-driven assessment of peatland vegetation units at the national scale. PhytoSuisse was developed as a Swiss phytosociological reference system to provide a unified synthesis of phytosociological typology, and this study contributes to that effort by focusing specifically on peatland vegetation and on the formal evaluation of the units retained by the PhytoSuisse expert committee. The central objective is to test whether peatland associations recognized by expert knowledge can be recovered as floristically coherent, statistically supported and ecologically meaningful groups when analysed with a large integrated vegetation-plot database. More broadly, the project seeks to bridge traditional syntaxonomy and modern numerical vegetation science by combining hierarchical classification, diagnostic-species analysis, expert interpretation, reference relevés and literature-based comparison. This strategy is aligned with current methodological discussions in broad-scale vegetation classification, which emphasize transparent protocols, explicit criteria for defining vegetation types, and rigorous evaluation of classification outcomes. The analytical framework is designed to move from broad delimitation of peatland vegetation to progressively finer syntaxonomical interpretation, while accounting for key sources of variation such as taxonomic harmonization, plot comparability and the treatment of bryophytes. A major strength of the project lies in its explicit validation strategy: candidate vegetation units are not only assessed for internal floristic coherence, fidelity and stability, but also evaluated against external ecological evidence, including environmental differentiation, spatial structure and consistency with published syntaxonomical concepts. Particular attention is given to the challenge of linking data-driven clusters to historically described peatland associations. By quantitatively testing expert-defined units on a large national dataset, this work aims to strengthen the scientific basis, reproducibility and ecological interpretability of Swiss peatland syntaxonomy, and thereby to support future integration of robust peatland vegetation units into the PhytoSuisse reference system.

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Poster Sessions

Session 2: Vegetation dynamics knowledge for optimizing biodiversity management and restoration strategies

Establishment of sown semi-natural grassland plant species in an urban grassland restoration experiment

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Urban grasslands provide important ecological functions, including habitat provision, pollinator support and microclimate regulation. Although they have the potential to support high biodiversity, many remain species-poor due to intensive mowing and limited seed banks. As urban areas seek to enhance ecological value, effective grassland restoration approaches are increasingly needed to counteract declining biodiversity and promote the establishment of target species. The grassland restoration experiment is located in Riga, University of Latvia Botanical Garden. The experiment was launched in 2021 and vegetation monitoring was carried out every growing season until 2025. The experiment included six management options for urban lawns, combining mowing regimes and various lawn restoration methods. Three treatments consisted of unsown plots managed under different mowing regimes, while the remaining three involved sowing of semi-natural grassland plant species; turf removal was used in two of these, and only one combined turf removal with meadow soil addition. A total of 119 vascular plant species were identified. Across the entire experimental period, sown species showed pronounced differences in establishment success: some became widespread across plots, while others remained rare. Several semi-natural grassland species established successfully, with the highest establishment rates in treatments with turf removal and added meadow soil. Among the 21 sown target species, *Leucanthemum vulgare*, *Rhinanthus minor* and *Leontodon hispidus* reached the highest frequencies, whereas species such as *Filipendula vulgaris*, *Briza media* and *Knautia arvensis* established only moderately, and a few occurred only sporadically. Two species - *Rhinanthus angustifolius* and *Trifolium montanum* - did not establish. Species addition significantly promoted the introduction of target grassland species and increased overall diversity in the plots, especially in the treatment with turf removal. These results confirm that active habitat restoration, combining management with targeted species introduction, is an effective method for improving the quality of urban grassland.

Contrasted responses of vegetation diversity to agricultural practices in space and time: lessons from a long-term grassland experiment

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Biodiversity is recognized to support the multiple ecosystem services provided by temperate permanent grasslands. Maintaining or restoring those services requires thus to select appropriate agricultural practices promoting vegetation diversity. Numerous studies have reported strong effects of grassland management regimes on different facets of diversity. However, the variability of these effects in space and time is still scarcely acknowledge. In this study, we examine how taxonomic and functional diversity have responded to changes in grazing intensity and nutrient availability in a long-term experiment (AnaEE-ACBB-Theix). We specifically report on the variability of management effect along the course of the experiment (temporal variability) and between repetitions of the same treatments (spatial variability). Over twenty years, vegetation dynamics were monitored in 24 experimental plots located in a productive upland grassland in the Massif central. Management treatments separated changes in grazing intensity (from abandonment to high grazing pressure) and changes in fertilization regimes under mowing (from no to high nutrient inputs). Each treatment is applied on four plots replicated in two distinct blocks showing slight differences in soil characteristics. Botanical surveys were conducted annually and key plant functional traits -height, leaf dry matter content, specific leaf area- were measured within each plot during two campaigns, 10 years apart. Taxonomic responses were analyzed using Principal Response Curves (PRC), while functional responses were assessed through temporal changes in community-weighted mean (CWM) trait values and functional diversity indices (FD). Grazing abandonment produced clear ecological shifts. Species richness and eveness declined significantly since the beginning and plant communities converged functionally toward taller species with higher LDMC. Functional differences between low and high grazing pressure were unclear over the course of the experiment. However, taxonomic diversity fluctuated considerably between years, at the beginning, and then diverged so that species richness became higher under low than under high grazing pressure. Responses to nutrient availability in the fertilization regimes were more complex and differed strongly in space between the grasslands plots replicates. At the beginning, species richness remained relatively stable, while species evenness decreased under high nutrient inputs, but only in the most productive block. Over time, species richness gradually increased in the least fertilized plots. Under NPK fertilization, species assemblages converged toward taller plants while SLA diverged, but mainly in the most productive block. Taken together, the results show that the response of grassland diversity to changes in agricultural management cannot be anticipated unequivocally. The strongest shifts occurred under extreme management modifications, but the magnitude and direction of the effects varied in time, according to the facet of diversity considered, and in space according to - even weak- differences the initial productivity, vegetation composition and soil properties. We discuss how to deal with such effect variability for optimizing biodiversity management in temperate permanent grasslands.

Patterns of species richness in high-mountain vegetation of Montenegro

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Montenegro hosts a diverse landscape with extensive subalpine and alpine vegetation, situated at the transition between temperate and Mediterranean climatic zones. Despite this diversity, the high-mountain vegetation and the factors driving its species richness remain poorly understood. To address this gap, we sampled over 360 vegetation plots (16 m²) across elevations of 1236-2427 m a.s.l., covering carbonate and siliceous bedrocks throughout Montenegro's alpine and subalpine belts between 2022 and 2025. Vascular plants, bryophytes, and lichens were recorded in each plot, along with soil pH, electrical conductivity, and environmental variables derived from digital elevation models (TWI, WEI, HLI, TPI, VRI), Sentinel-2 satellite imagery (NMDI), and Chelsa models (mean annual temperature, mean annual precipitation). Using generalized additive models (GAMs) and model selection based on Akaike's Information Criterion (AIC), we assessed the influence of environmental factors on species richness. Results reveal distinct drivers for vascular plants and cryptogams, reflecting different ecological responses to environmental gradients. Notably, vascular plant richness was higher on carbonate substrates compared to siliceous substrates.

Drivers of vegetation composition change in subalpine grasslands after extreme weather events: The role of soil chemistry and microbial activity

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Extreme climatic events are becoming more frequent as a consequence of ongoing climate change. Total vegetation diebacks, previously reported mainly from dry grasslands and semi-arid ecosystems, were recently observed even in mountain habitats, including subalpine grasslands above the upper treeline. Recently, large-scale diebacks associated with extreme heat and drought waves have affected extensive areas of subalpine grasslands in the Jeseníky Mountains (Eastern Sudetes). While the impact of drought on vegetation have been documented, the role of soil processes and microbial activity in shaping post-disturbance vegetation dynamics remains completely unexplored.

We investigated how soil chemistry and microbial parameters influence vegetation composition in subalpine grasslands affected by recent large-diebacks. Specifically, we used distance-based redundancy analysis (dbRDA) to analyze vegetation shifts and structural equation modelling (SEM) to explore causal links between dieback, soil stoichiometry, and microbial activity.

Our results indicate that vegetation composition was highly associated with soil nutrient stoichiometry, particularly the soil C:N ratio. Structural equation modelling revealed that grassland dieback had a strong indirect effect on vegetation composition by influencing soil C:N ratio. Notably, we found that grassland dieback triggered a significant increase in microbial phosphodiesterase activity. However, instead of enhancing phosphorus availability for plants, this activity led to rapid phosphorus immobilization within the microbial biomass. This microbial "sink" effect, evidenced by the positive correlation between enzyme activity and microbial biomass, decoupled the link between soil nutrient release and plant uptake.

Overall, our findings suggest that vegetation changes following climate-induced dieback in subalpine grasslands are largely mediated by altered nutrient balance and microbial resource hoarding. The results highlight that extreme climatic events do not only stress plants directly but also shift soil-microbial feedbacks toward nutrient sequestration, potentially hindering rapid vegetation recovery. Understanding the feedbacks between soil, microbial and plant communities is essential for predicting future trajectories of subalpine grassland ecosystems under increasing climatic severity.

*Invasion of *Mahonia aquifolium* in the city of Brno

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The escape of non-native plant species from gardens is a frequent pathway of plant invasions. One species spreading this way is *Mahonia aquifolium*, an evergreen shrub native to North America, which has been cultivated as an ornamental plant in the Czech Republic since the 19th century. In recent decades, it has begun to spread significantly into semi-natural and natural habitats. Its invasion is a manifestation of the laurophyllization of Central European deciduous forests, a process partially linked to climate warming. Although the invasion of *M. aquifolium* has been documented in several European countries (Austria, Belgium, Germany, Poland, Slovakia, etc.), the role of cultivated populations as a source of propagule pressure has received limited research attention. Our objective was to document the current occurrence of *M. aquifolium* within the city of Brno and to describe the habitats it invades. During the 2020 and 2021 growing seasons, a field survey was conducted in selected forest complexes and adjacent landscapes in Brno, located near garden areas and residential districts. The survey mapped individual occurrences of *M. aquifolium*, recording 2,708 individuals along a 144 km route. Vegetation plots were recorded to represent the primary vegetation types occupied by the species. Using the gathered data, distribution maps were created to show the relationship between *M. aquifolium* occurrence and the distance to the nearest garden. The results indicate that the probability of occurrence of Mahonia in the immediate vicinity of gardens was 6.5%. As the distance increased, this probability decreased, and approximately 450 m or more from the gardens, the probability of the occurrence of Mahonia was almost 0%. The species spreads into partly abandoned mesic hay meadows (*Arrhenatherion elatioris*), oak-hornbeam forests (*Carpinion betuli*), mesic and xeric scrub (*Berberidion vulgaris*), nitrophilous ruderal scrub (*Aegopodio podagrariae-Sambucion nigrae*), acidophilous thermophilous oak forests (*Quercion petraeae*), black locust stands (*Chelidonio majoris-Robinion pseudoacaciae*), pine plantations, and abandoned gardens. Observed habitat characteristics suggest that *M. aquifolium* lacks specialized ecological requirements in the study area and can occupy diverse ecological niches. These findings contribute to understanding the invasion dynamics of *Mahonia aquifolium* and its relationship to cultivated source populations.

Diversity and abundance of nitrophilous species as proxies of grazing pressure across wet and dry high-mountain grasslands in the central Apennines (Italy)

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High-mountain grasslands host a high biodiversity and provide essential ecosystem services, but they are increasingly affected by changes in land use, grazing regimes, and climate conditions (1). In Mediterranean mountain systems, the interaction between grazing regime and climate change can strongly influence vegetation structure and composition (2,3). As part of the Biodiversa+ project PRESINMED (PREserving the SINgularity of MEDiterranean High mountain biodiversity hotspots: a NbS Approach), encompassing five high-mountain areas across four Mediterranean countries (Spain, Portugal, Morocco, and Italy), we are currently evaluating the effects of grazing, tourism, and climate change on Mediterranean cooler high-altitude grasslands. Here, we present the preliminary results of a vegetation survey aimed at assessing the diversity and abundance of nitrophilous species across wet and dry high-mountain grasslands as proxies of the grazing pressure at the Maiella national park, in the central Apennines (Italy). We conducted a vegetation survey at lower-elevation (1900-2100 m a.s.l.), and higher-elevation (2500 m a.s.l.) Within each sampling area, paired wet and dry grasslands were sampled on previously mapped polygons using 86 randomly distributed circular plots (1 meter radius). For each plot we recorded the total plant cover, the richness and the cover of nitrophilous plant species (4). In addition, indicators of grazing pressure were quantified by recording the presence and the cover of livestock and wild herbivore excrements (cattle, sheep/goats, and Apennine chamois), together with basic habitat descriptors such as bare soil, disturbed soil, and detritus cover. To explore the role of environmental gradients, altitude (high vs. low) and moisture conditions (wet vs. dry) were used as explanatory factors in data analyses. Linear mixed models were used to test the effects of altitude and moisture and grazing pressure on nitrophilous plant composition and cover. The results indicated that both altitude and local moisture conditions significantly affected vegetation cover and nitrophilous plant assemblages. In particular, moisture had a strong effect on the cover and richness of nitrophilous species, while total vegetation cover decreases with altitude and increases with higher moisture, suggesting that water availability becomes a stronger limiting factor at higher elevations. Although preliminary, these results highlight the importance of small-scale environmental heterogeneity and grazing-related nutrient inputs in shaping alpine and subalpine grasslands in central Apennines. This contribution constitutes a first step toward a comprehensive assessment of grasslands within the PRESINMED project network, while also contributing to the development of nature-based solutions aimed at preserving plant diversity in Mediterranean high-mountain grasslands.

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Horticultural potential of karstic dolines in the northern Dinarides

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Karst dolines are unique geomorphological and ecological features of limestone landscapes, characterised by strong microclimatic and edaphic gradient. These concave landforms form natural microrefugia that harbour a variety of plant species. This study investigated dolines in the northern Dinaric Kras plateau with the aim of evaluation their horticultural potential. Vegetation surveys along edge-to-bottom transects revealed a pronounced species turnover and differentiation of functional traits. Besides supporting biodiversity conservation by acting as microrefugia, dolines preserve cultural heritage through ethnobotanical species, and provide species pool for the selection of plants with horticultural potential. We selected the plants of horticultural importance (HPs) and analysed them within the dolines. Dolines' bottoms are dominated by shade-tolerant geophytes and early-flowering perennials, while the edges harbor drought-tolerant aromatic herbs. Culturally and horticulturally important taxa such as *Paeonia officinalis* and *Dictamnus albus* were found on the intermediate slopes. Doline also represent a species pool of underutilised and climate-resistant species with ornamental, medicinal, and culinary value. By linking biodiversity conservation with applied horticulture, this study emphasises the multifunctional role of dolines as small natural features of disproportionate ecological and horticultural importance. We suggest that integrating of doline species into horticulture utilization could improve sustainability, diversify plantings, and strengthen climate adaptation strategies.

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Vegetation diversity and community composition across successional stages in forest clear-cuts in Lithuania

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Forest ecosystems are dynamic systems characterized by continuous structural and functional changes driven by both natural processes and anthropogenic disturbances. Forest harvesting represents one of the most significant human-induced disturbances, as it markedly alters plant communities, community structure, as well as environmental conditions such as microclimatic conditions, and soil characteristics. Changes in light availability, temperature, moisture regimes, and nutrient dynamics strongly influence vegetation composition and diversity. After harvesting, secondary succession processes are initiated, during which plant communities gradually reassemble and ecosystem functions begin to recover over time. In Lithuania, forests cover more than one third of the country's territory, making their sustainable management and regeneration important from both ecological and economic perspectives. Early regeneration processes in forest clear-cuts play a crucial role in shaping the future structure of forest communities, influencing species composition, vegetation dynamics, and overall biological diversity. This study investigates forest clear-cuts representing different stages of secondary succession in the hemiboreal forests of Lithuania. Study plots were distributed across different regions of the country to capture variation in forest management practices as well as biogeographical and climatic gradients. In total, 100 vegetation plots, each covering an area of 100 or 400 m^2, were surveyed. Within each plot, overall vegetation cover and the abundance of individual plant species were recorded. Several analytical approaches will be used to evaluate vegetation patterns in forest clear-cuts. Changes in species richness and diversity will be analysed to assess how plant diversity varies across different stages of succession. Community composition analyses, such as ordination methods, will be applied to identify major vegetation gradients and differences among plots. Additionally, indicator species analysis will be used to determine plant species characteristic of succession stages. Finally, relationships between vegetation patterns and environmental will be explored to better understand the drivers of vegetation development in forest clear-cuts.

Low-density reintroduction of threatened arable plants supports biodiversity restoration in agroecosystems without reducing crop yield

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The decline of arable plant species across Europe represents a major ecological challenge in agricultural landscapes and is largely driven by agricultural intensification and the loss of species historically adapted to cereal cropping systems. Active restoration through seed-based plant reintroduction has been proposed as a promising strategy to restore arable plant biodiversity and support the recovery of threatened species within productive agricultural systems. However, restoration implementation remains limited because farmers are often concerned that the presence of arable plants within crop fields may reduce crop productivity through competition for resources. Empirical evidence quantifying the effects of arable plant reintroduction on cereal yield under realistic agronomic conditions remains scarce. In this study we tested whether seed-based restoration through low-density reintroduction of threatened arable plant species is compatible with wheat production and whether functional trait responses provide insight into coexistence mechanisms between crops and arable plants. A two-year field experiment was conducted in northern Italy in winter wheat fields using 36 experimental plots established under standard agronomic conditions. Two declining arable species historically associated with cereal systems, *Agrostemma githago* and *Centaurea cyanus*, were reintroduced into winter wheat (*Triticum aestivum*) at low densities corresponding to 5% and 10% of crop density. Wheat yield components, including ear number and thousand-seed weight, were measured to assess crop productivity. Functional traits of both crop and arable species were also analysed, including leaf chlorophyll content, specific leaf area, leaf dry matter content and root-to-shoot ratio, in order to investigate the mechanisms underlying species coexistence. The reintroduction of both species did not significantly affect wheat yield components, indicating that the presence of these arable plants does not compromise crop productivity under the tested conditions. Wheat functional traits remained largely stable across treatments, suggesting strong resistance of the crop to interspecific competition. In contrast, the reintroduced species showed plastic functional trait responses across treatments and years, indicating physiological adjustment to environmental variability and crop presence rather than competitive dominance. These results demonstrate that low-density reintroduction of threatened arable plant species can be compatible with productive cereal systems and represents a feasible strategy to restore arable plant biodiversity within working agricultural landscapes.

Hemiparasites vs. legumes: does the species identity affect parasitism-mutualism balance?

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Root hemiparasites are a specialized group of plants that attach to the roots and rhizomes of host plants via haustoria and uptake mineral nutrients, water, and organic carbon. In natural ecosystems, they function as ecosystem engineers, suppressing competitive dominants. The impact of parasites on host plants varies among species - while some species serve as good hosts for parasites and their growth is suppressed, others are good hosts but tolerate parasites without strong growth suppression, and some other species are resistant to parasitism and do not allow parasite attachment at all. However, the above- and belowground competition among species in the vegetation may have a stronger effect on biomass reduction than parasitism. Thus, the parasitic suppression of dominant competitors may lead to an indirect, mutually beneficial effect on other hosts, even increasing biomass and fitness despite parasitism. These complex effects may strongly influence species coexistence in vegetation. We decided to study the relationships among three functional groups of plants: two species of the hemiparasitic genus *Rhinanthus*, two species of grasses, and 15 species of legumes with different growth characteristics (annual, perennial, rhizomatous above- or belowground). While grasses often present strong competitors that suffer from parasitism, legumes are usually weak competitors, with varying tolerance to parasitism. We established a large common-garden experiment on arable land with various combinations of the presence of species in each functional group, resulting in 93 combinations of species in 590 plots. The plots were sized 0.8 m x 0.8 m. In the first year, the grass and legume species established a vegetation cover in the plots, and hemiparasites were added the following autumn. We measured dry biomass of all functional groups in May during parasite flowering and analysed the level of host suppression. We believe these results will disentangle the complexity of hemiparasite-legume interactions in the context of competition with grasses, which is crucial for understanding vegetation dynamics and community ecology of European grassland vegetation.

Importance of cryptic species in the characterisation and dynamics of certain habitats

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Many Ericales are key species in subarctic vegetation. The number f arctic-alpine plants decreases as one moves southwards in Europe, where they become increasingly rare and localised. An in-depth cytogenetic study has led us to identify new taxa considered subarctic in the Massif Central, which represents a refuge at the southernmost limit of their range. The identification of cryptic species (*Empetrum nigrum* & *Vaccinium* sp.pl.) is difficult and their taxonomic status controversial. In any case, analysis of the ploidy levels of these taxa in the different types of vegetation where they are present shows that in Europe, diploid *V. uliginosum* s.l. are found from the Sierra Nevada to beyond the Arctic Circle (71° - 37° lat. N), while the southernmost tetraploid populations have just been discovered in the Massif Central (44°4 lat. N). Diploid species characterise certain mountain heathland communities (e.g. *Genisto pilosae-Vaccinion uliginosi*, *Vaccinietum uliginosi-myrtillli*, etc.) and are common in dry grasslands. On the other hand, tetraploids sometimes form a significant part of the vascular vegetation of low marshes and raised bogs (cf. *Scheuchzerio palustris-Caricetea fuscae*, etc.). At the microhabitat level, the precise location of the different ploidy levels (= cryptic taxa) of crowberries and cranberries (*Empetrum nigrum* s.l. and *V. oxycoccos* s.l.) in the Massif Central highlights the extreme ecological specialisation of some cytotypes: hexaploid cranberries colonise the wettest habitats (lacustrine mire), while diploid cranberries preferentially colonise the dry tops of peat.

Considering the different ploidy levels of certain species with sometimes quite wide ecological ranges (dry grasslands ↔ marshes) provides a better understanding of the vegetation and its dynamics. “One species” correspond to several cryptic taxa, each living in a highly specialised habitat.

Poster Sessions

Session 3: Vegetation monitoring and resurvey for biodiversity conservation in a global change context

resample: A new R tool for stratified resampling of vegetation plots

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Large vegetation-plot databases, such as the European Vegetation Archive (EVA), have become indispensable data sources for modern community ecology and macroecology. However, these databases are inherently biased due to non-random preferential sampling, with vegetation in botanically attractive areas recorded more frequently than in others. This results in a highly uneven density of vegetation plots, which are often spatially clustered and compositionally redundant in intensively sampled regions. Such imbalances can lead to overrepresentation of certain ecological signals and may violate the assumption of independence of observations in statistical analyses. To address this challenge, I introduce a new and highly flexible R function called resample. This function is designed specifically for vegetation-plot data to perform data thinning based on a combination of geographic proximity and species composition similarity. Unlike simple spatial filters, this tool identifies pairs of plots within a user-defined distance threshold and evaluates their compositional similarity using metrics such as Bray-Curtis, Simpson, Sørensen, or Jaccard indices. The thinning process is iterative: the function identifies the most similar pair of plots within the specified distance, removes one based on a selection rule, and repeats this until no conflicting pairs remain. The function also allows incorporation of environmental strata (or other plot classifications), so that resampling is performed within each stratum separately, and prioritization of plots based on various rules, such as the number of species, year of sampling, etc. This ensures that the resulting subset minimizes redundancy while preserving maximum ecological information. The function uses a highly optimized data.table approach, which enables processing of large datasets on standard hardware in a reasonable time. The practical utility of this approach was demonstrated through the creation of the CzechVeg-OpenStrat dataset, a new open-access resource for the scientific community. By applying this stratified resampling workflow to the Czech Vegetation Database, which contains 116,148 georeferenced plots, a more spatially, compositionally, and environmentally balanced subset of 61,282 plots was produced. The CzechVeg-OpenStrat dataset, accompanied by a comprehensive processing tutorial, provides a standardized, high-quality foundation for ecological modeling and biodiversity assessment. By making both the resample function and the dataset publicly available, the goal is to facilitate more robust, transparent, and reproducible research in vegetation science.

Decade of change in Šventoji grasslands: Insights from vegetation resurvey data

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This study investigates changes in grassland vegetation over the past decade in the Šventoji River valley (Lithuania). Phytosociological relevés were conducted in July–August 2025 at sites previously surveyed in 2012-2017. In each plot, vegetation was recorded at two spatial scales (100 m^2 and 1 m^2), assessing species composition and percentage cover of vascular plants, bryophytes, shrubs, and trees. Vegetation height was estimated based on the tallest herbaceous species. Species identification was carried out in the field and, when necessary, supplemented by laboratory analysis of collected specimens. Data analysis was performed in R using the vegan package. A total of 62 relevés were recorded and incorporated into the Lithuanian vegetation database (EU-LT-001). The surveyed mesophilous and steppe grasslands contained 161 vascular plant species. Mean species richness per plot slightly decreased from 26.7 in earlier surveys to 25.6 in the resurvey; however, this difference was not statistically significant. Detrended Correspondence Analysis (DCA; axis lengths: 3.3 and 3.1) revealed that vegetation changes were heterogeneous and strongly dependent on management regimes and local environmental conditions. Dry and thermophilous grasslands remained relatively stable over time, with observed variation likely reflecting stochastic processes. In contrast, formerly managed but subsequently abandoned grasslands showed signs of nutrient accumulation, litter build-up, and altered light and temperature conditions, which were reflected in species composition and Ellenberg indicator values. Grasslands that remained under active management exhibited only minor compositional changes and an increase in light-demanding species.These findings highlight the key role of management intensity and environmental conditions in shaping grassland vegetation dynamics and emphasize the importance of appropriate conservation and management practices for maintaining grassland biodiversity.

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*Substrate-specific drivers of bryophyte and lichen species richness in temperate managed oak forests

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Forests provide a wide range of microhabitats colonised by different groups of organisms, including bryophytes and lichens. Assemblages of these organisms form distinct microcoenoses within plant communities, particularly on specific substrates such as tree bark or decaying wood. Although their distribution may be associated with particular forest types, their usefulness in distinguishing forest communities is usually limited, as their occurrence is influenced by numerous environmental factors. Understanding these drivers is important for the conservation and management of forest ecosystems, especially because most forests are subject to management pressure and human activities strongly shape environmental conditions within forest landscapes. Despite extensive knowledge of the diversity and dynamics of European forests, the diversity of bryophytes and lichens occurring on different substrates and the factors shaping this diversity remain insufficiently understood, particularly in managed forests. To address this gap, we analysed the relationships between species richness of epiphytic, epixylic and epigeic bryophytes and lichens and a set of habitat and landscape variables in a managed forest complex in south-western Poland (Bory Stobrawskie Mesoregion). Oak stands were selected because oaks are dominant species in many natural forest communities of Central Europe. The study included 100 circular plots (300 m^2) located in stands ranging in age from 40 to 180 years. For each plot, data necessary for plant community identification were collected and then bryophytes and lichens were recorded on three substrates: living tree trunks (up to 130 cm height), decaying wood (logs, stumps and fine woody debris), and the forest floor. Each plot was characterised by variables describing habitat conditions and landscape context within a 1000 m radius. Relationships between species richness and environmental variables were analysed using generalized linear models (GLM). Separate models were fitted for six species groups: epiphytic, epixylic and epigeic bryophytes and lichens. The studied groups showed contrasting responses to the analysed variables. Both habitat and landscape factors influenced all epiphytic and epixylic groups, whereas the richness of epigeic bryophytes and lichens was associated with only a single, but different, landscape variable. The largest number of predictors affected the richness of epiphytic bryophytes and epixylic lichens. Fragmentation of oak stands influenced the highest number of groups, with a positive effect on epiphytic and epixylic lichens but a negative effect on epixylic bryophytes. Plant community type was a significant predictor only for epiphytic bryophytes and lichens, with clear differences between riparian floodplain forests and acidophilous oak forests. These results indicate that the diversity of organisms inhabiting different forest substrates is shaped by multiple habitat and landscape factors, and that different organism groups respond to environmental conditions in different ways. Consequently, formulating universal forest management recommendations supporting high biodiversity remains challenging.

Bryophytes and lichens across substrates in different types of managed deciduous forests

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Most plant communities, including forest vegetation, are identified primarily on the basis of vascular plants. Nevertheless, forests provide numerous microhabitats and substrates that support the diversity of bryophytes and lichens. Deciduous forests, characterised by a complex vertical structure and high spatial heterogeneity, may particularly promote their biodiversity. Natural forests constitute the most important refugia for these organisms because of their diverse age structure and abundant decaying wood resources. In contrast, managed forests are often considered impoverished habitats due to the limited availability of old trees and large pieces of decaying wood. However, because European forest landscapes are largely dominated by managed stands, they should also be regarded as important habitats for forest species, and management practices supporting biodiversity should be developed. Effective biodiversity conservation requires a thorough understanding of species inhabiting different forest substrates and microhabitats. The aim of this study was to assess the species richness and composition of bryophytes and lichens occurring on different substrates in deciduous forests shaped by regular forest management. The study was conducted in lowland forests of Central Europe, within the Bory Stobrawskie Mesoregion in south-western Poland. A total of 100 circular plots (300 m^2) were established in acidophilous oak forests, oak-hornbeam forests, and riparian floodplain forests. In all stands, economically important oaks (*Quercus robur* and/or *Q. petraea*) were the dominant tree species. Within each plot, bryophyte and lichen species were recorded on different substrates without estimating their cover. The survey included trunks of living trees (up to 130 cm height), the largest stump, the largest log, fine woody debris, and the forest floor. To characterise diversity patterns, we calculated the total number of species recorded in each forest type and the mean species richness of bryophytes and lichens, including epiphytic, epixylic, and epigeic groups. Differences in species richness were tested using the Kruskal-Wallis test. We assessed species associations with forest types and substrates. Moreover, detrended correspondence analysis (DCA) was used to evaluate the role of bryophytes and lichens in differentiating forest communities. The studied forest types differed in the species richness of bryophytes and lichens. Moreover, bryophytes and lichens exhibited somewhat different preferences among forest types. Bryophytes more often occurred on two or three substrates, whereas most lichen species were restricted to a single substrate. Overall, bryophytes and lichens weakly differentiated the analysed forest communities, although bryophytes showed slightly greater diagnostic value. Our results indicate that managed deciduous forests may support diverse assemblages of bryophytes and lichens and that habitat variability among forest types plays an important role in shaping their diversity. Increasing the availability of suitable microhabitats may enhance biodiversity in managed forests, but conservation measures should take into account the diversity of forest types within forest landscapes.

Functional diversity of urban flora declines with urbanization

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Urbanization acts as a strong environmental filter, altering plant species composition. As a result, plant communities in urban environments tend to consist of species with similar traits that enable them to tolerate urban conditions. However, the effects of urbanization may differ across distinct axes of trait variation due to varying environmental pressures and human preferences affecting urban floras' composition. In this study, we used a trait-based approach to examine the impact of urbanization on the functional diversity of plant assemblages in Brno, Czech Republic.

The flora of Brno was systematically surveyed between 2011 and 2021. The presence of all spontaneously occurring plant species was recorded within grid cells measuring 1.1 × 1.5 km across the entire city, covering a pronounced urban gradient from the city centre to suburban habitats. In total, we compiled a dataset of 1,492 spontaneously occurring vascular plants and combined these records with trait information available in trait databases.

We analysed the effects of urbanization on functional diversity separately for several axes of trait variation related to survival, reproductivity, and dispersal ability. We also included traits related to aesthetic and functional value, such as flower and fruit color, thorn presence, etc. We compared separate indexes for both functional and human-valued traits. Our results show that urbanization significantly affects community trait diversity across all examined trait axes. Specifically, functional diversity decreases with increasing levels of urbanization.

*Bogovađa – A Case Study of Forest Understory Vegetation Change in Central Serbia

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Forest ecosystems across Europe are currently undergoing rapid structural and compositional shifts. While the trends in understory plant communities have been well-documented in Western and Central Europe through repeated vegetation records from permanent or "quasi-permanent" plots, comparable data from other parts of the continent are lacking. Additionally, the Western Balkans is considered one of Europe's hotspots for forest plant species richness, and in some regions in the Balkan Peninsula, traditional practices like coppicing or forest grazing still persist, unlike in better studied areas of Europe. We provide first insights into forest vegetation changes in Southeastern Europe by presenting results of a vegetation resurvey in the Bogovađa Monastery forest in Central Serbia (44.3° N, 20.2° E). The forest is situated in the peripannonian region of Central Serbia, where the landscape is dominated by lowland oak forests with *Quercus cerris* and *Q. frainetto* and with beech forests occupying stream valleys. Historically, the forest was managed extensively; it served as a pig pasture in mast years, and the wood was used for the monastery. After WWII the forest was a state property, until it was restituted in 2009. Currently, it is an overgrown coppice, and forest management practices encompass both selective and clear-cutting systems to produce timber and biomass fuel. It also serves as a hunting ground. In 2024, we resampled 33 plots originally recorded in the 1960s. Although the original coordinates were unavailable, localization to forest compartments allowed highly accurate plot relocation. The results indicate a significant shift in understory species composition, manifested in a decline in light-demanding species and, in beech forests, also an increase in moisture-demanding species. In both oak and beech forests, there was a significant decline in disturbance-tolerant species. This study represents the first step toward understanding the changes of forest vegetation in Southeastern Europe.

Vegetation is worth being described by large datesets: progress of the National French data base

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Datasets describing vegetation species composition and structure along years, space and seasons are extremely valuable for assessing plant communities' dynamic and their response patterns to global or local changes. Analysis based on large data set are also a requirement for reliable vegetation classification. Large data set structure and dissemination were pioneered by the European Vegetation Survey group, and such effort enabled significant advancements in vegetation science since then. The national database VegFrance was set up 15 years ago, in close connection with the EVS objectives and European dynamics. The data base is designed to store and deliver both local vegetation relevé and synoptical table. Two tables are associated for each relevé or table: i) the relevé table with up to 70 fields provided key information on the date: provider, precision of localization, completeness of the species list, method used, etc. while only 3 are mandatories; ii) the vegetation table providing the species list observed and an expression of the abundancy when available, both being mandatory fields. The data model was recently improved, the date base is now in Postgresql and the data may be visualized, provided and demanded on the web site https://vegfrance.cnrs.fr. A safe and powerfull data storage will be provided by the CNRS tool, an additional reason for providing data to VegFrance database. Data may be provided to users either with a free-acces (régime 1), or conditionnaly to providers' authorization (régime 2). At present, 60933 relevés stationnels are available in the VegFrance data base, covering a large variety of vegetation types, periods of observation and regions. Any additional data, fitting with the few mandatory information will be welcome to improve this resource of high common interests.

Poster Sessions

Session 4: Vegetation classification: a tool for better understanding and improving management of European habitats

*Arable plant communities and species diversity across the Aegean islands: bridging knowledge gaps in Mediterranean agro-ecosystem research

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Arable plant communities in Greece are underrepresented in Mediterranean vegetation research, and their syntaxonomy is transferred from on descriptions and diagnostic species from the Western and Central Mediterranean. This study aims to help fill this gap by characterizing arable plant communities and their diagnostic species in the Eastern Mediterranean, using the Aegean islands as a model region. In addition, we examined abiotic drivers of community composition, including geological substrate and climatic variation, and assess floristic diversity across islands. We conducted vegetation surveys on multiple Aegean islands during the spring pre-harvest period, focusing on fields of winter cereals, pulses, and rotational fallows. We analyzed the data using Two-Way-INdicator-SPecies-Analysis (TWINSPAN) for individual islands and the full dataset to identify both island-specific and general patterns of community differentiation. Furthermore, we applied non-metric multidimensional scaling (NMDS) to assess the floristic patterns and the influence of environmental variables on plant community differentiation. For each island, we quantified arable plant species richness and assessed the frequency of rare and common taxa, as well as the occurrence of facultative and obligate arable species and neophytes, enabling an evaluation of inter-island species turnover. We used synoptic tables to display the arable plant communities of the Aegean. The establishment and persistence of arable plant species were preconditioned by agricultural practices, particularly shallow tillage depth, the absence of herbicide application, and at most moderate amounts of fertilizers. These management factors contributed to the development of a core species pool of arable plants shared across the islands. Community composition was primarily structured by soil properties such as base content and texture, with additional differentiation along moisture and biogeographic gradients. Islands dominated by calcareous parent material supported higher overall species diversity. Species turnover among islands was also partly related to their geographical position within the archipelago, potentially reflecting influences of adjacent mainland floras and regional climatic variation. Overall, our study addresses a major gap in Mediterranean agro-ecosystem research by documenting the composition, diversity, and environmental drivers of Greek arable plant communities. The results contribute to the European syntaxonomic standard *EuroVegChecklist* (1) by expanding the plant syntaxonomic framework and identifying new diagnostic species, and they provide new insights into the distribution of obligate and facultative arable species and neophytes in the Aegean. Our findings highlight the Aegean islands as a hotspot of agro-biodiversity with high conservation value within the Mediterranean region.

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Segetal vegetation of Ukraine: current state and syntaxonomical overview

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Anthropogenic pressure is the one of the major drivers of the degradation and fragmentation of natural vegetation and habitats, resulting in the large-scale development of agricultural phytocoenoses and associated segetal vegetation. To assess the current state of segetal vegetation in Ukraine, its study were conducted within the national research project coordinated by the M.G. Kholodny Institute of Botany NAS of Ukraine, whith the involvement of many Ukrainian phytosociologists. The results showed that the segetal vegetation represents a complex system of agrophytocoenoses characterized by a well-defined syntaxonomic structure, pronounced zonal and edaphic differentiation, high floristic diversity, and a considerable level of invasion contamination. Based on 1,817 phytosociological relevés, vegetation communities belonging to seven classes of the vegetation (*Papaveretea rhoeadis*, *Digitario sanguinalis-Eragrostietea minoris*, *Sisymbrietea*, *Artemisietea vulgaris*, *Chenopodietea*, *Polygono-Poetea annuae* and *Oryzetea sativae*) were identified. In total, 59 associations belonging to 19 alliances and nine orders were recorded. Two associations (*Violo arvensis-Chaenorhinetum minoris* and *Bromo squarrosi-Eriochloetum villosae*) were described as new for a science, while four associations were reported for the first time in Ukraine. The database EU-UA-011 Anthropogenic Vegetation of Ukraine was substantially expanded. Results of ordination and phytoindication analyses revealed that temperature, light, and hydrological gradients are the main ecological determinants for the vegetation differentiation in Ukrainian agricultural landscapes, whereas soil reaction and salinity belong to secondary environmental factors. The territorial differentiation of vegetation communities highlights the high specificity of the Crimea, which represents a centre of several distinctive syntaxa wich are absent in other regions of Ukraine. This specificity is explained by a unique combination of climatic conditions, diverse soil types, and a high contribution of thermophilous Mediterranean species to the regional flora. The level of alien plant invasion in Ukrainian agroecosystems reaches 27.7%, indicating a strong anthropogenic transformation. Particularly high levels of invasion were recorded in row-crop agrocoenoses of the Steppe and Forest-Steppe zones. The strategy for the agrobiodiversity conservation in Ukraine has been developed. Rare phytocoenotic diversity was identified and the Red List of rare vegetation communities of agricultural ecosystems was compiled,the latter includes 10 associations. The important role of segetal communities as refugia for rare and threatened arable weeds (*Agrostemma githago*, *Bromus secalinus*, *Camelina alyssum*, *Lolium remotum*, and *Spergula linicola*) was emphasized.

Gordi R package: Bridging the gap between the multivariate models and *ggplot2* graphics

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The multivariate analyses serve as a fundamental tool in vegetation ecology, providing the statistical framework for description of complex community patterns across space and time, from interpreting species composition and environmental gradients to visualizations of vegetation classification results. Over the last decade, R has become the primary environment for statistics in ecology, with various packages for model calculations and visualisation. While the mathematical implementation of these models is well established most notably within the *vegan* package, a gap remains in the transition from statistical outputs to publication-ready visualisations. Modern scientific publishing is inclined towards visually appealing graphical presentations of analytical results, such as those provided by the *ggplot2* framework. While *ggplot2* has become a standard for most types of graphs from scatterplots to network graphs, there is still a disconnection between the complex objects produced by ordination models and the data structure required by *ggplot2*. Bridging this gap typically means manual data extraction, scaling, and alignment with various metadata that are not included in the multivariate models directly. This manual data wrangling is not only time-consuming but might also increase the potential of errors. To close the gap between the calculation and visualisation of a wide range of multivariate models, we created a new R package, *Gordi*. *Gordi* is compatible with outputs of the vegan package and it specifically supports both unconstrained ordinations, such as Principal Component Analysis (PCA), Correspondence Analysis (CA), Detrended Correspondence Analysis (DCA), Non-metric Multidimensional Scaling (NMDS), as well as constrained ordinations, including Canonical Correspondence Analysis (CCA), Redundancy Analysis (RDA) and distance-based RDA (db-RDA). *Gordi* introduces pipe-based syntax that automates the extraction and scaling of species and site scores, and integrates them with environmental variables and traits, ensuring the metadata is preserved throughout the plotting process. The package also functions as a bridge, returning a standard *ggplot2* object that allows an extensive post-hoc customization through native *ggplot2* layers and themes. Overall, we hope that *Gordi* will simplify and speed up the model-to-plot workflow, enabling the production of reproducible, high-quality graphics without unnecessary technicalities, allowing researchers to remain focused on biological interpretation.

Assessing traditional medicinal plants across forest types in eastern Alps

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Traditional medicinal plants (TMP) supply numerous services spanning across provisioning, regulating and cultural ones. Among TMP, some can be defined as both ecological and cultural keystone species, meaning that these plants are important for both biodiversity and cultural aspects mostly linked to medical care. Despite their millennial role in human diets and folk medicine, TMP use and associated knowledge have largely vanished, persisting mainly in marginalized landscapes such as the Eastern Alps, where medicinal plants retain both ecological relevance and ethnobotanical value. Given the important role in biodiversity and in alpine culture of TMP, we provide a habitat assessment of forest habitats, focused on TMP in eastern Alps. More precisely, we i) assess the number of TMP in different forest habitat types, indicating their contribution to the entire plant community and the environmental conditions mostly affecting their presence; ii) assess the potential use of TMP across the forest habitat types, in order to identify forests with higher ecological and biocultural value that may deserve conservation priority, and iii) assess the influence of human pressure on TMP. To do so, we selected 705 vegetation plots spanning the eastern Alps area. We classified each plot into major forest habitat types, specifically: broadleaved deciduous forests, temperate montane *Pinus* forests and temperate montane *Picea* and *Abies* forests. Higher numbers of TMP occur in temperate montane *Pinus* forests, followed by temperate montane *Picea* and *Abies* forests, while broadleaved deciduous forests show the lowest values. TMP account for a mean of 46% of the diagnostic species in the investigated forest habitat types, acting as key indicators for habitat identification and for assessing their favorable conservation status. The effects of altitude and soil pH on TMP varied among forest types. Altitude showed a positive relationship with TMP in broadleaved deciduous forests, a negative relationship in *Picea* and *Abies* forests, and a very weak positive relationship in *Pinus* forests. In contrast, pH has a negative effect on TMP in broadleaved deciduous forests but positive in both conifer-dominated forest types. Across forest types, cardiovascular medicinal use was the most represented in both temperate montane *Picea* and *Abies* forests and temperate montane *Pinus* forests, whereas medicinal use for skin was the most frequent in broadleaved deciduous forests. A weak but significant positive correlation between population density and TMP richness in conifer-dominated forests suggests that moderate anthropogenic disturbance may slightly promote TMP occurrence, whereas the non-significant relationship in broadleaved deciduous forests indicates negligible human influence on TMP distribution. Integrating TMP into community and landscape ecology offers a novel tool for habitat assessment and restoration, supporting the co-design of multifunctional landscapes in the Eastern Alps Living Labs and linking biodiversity conservation with cultural heritage revival and sustainable land management.

Vegetation units and habitat types on Mt Parnassos, central Greece

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Mt Parnassos (central Greece) is amongst the most prominent massifs in Greece due to its high ecological, aesthetic and cultural value. Several botanical excursions have been taken place, the earliest probably from J. Sibthorp during 1786-1787. The floristic research has substantially increased our knowledge regarding the mountain's flora, yet there remains a significant gap in our knowledge regarding the vegetation communities of the mountain. This is striking given the proximity of Mt Parnassos to large urban centres (Athens and Lamia) and the considerably dense road network which ensures easy access. During 2022 and 2023 we sampled vegetation data from 45 phytosociological relevés with the aim of identifying and describing the priority habitat types of the special area of conservation GR2450005 (Notioanatolikos Parnassos-Ethnikos Drymos Parnassou-Dasos Tithoreas, Spileovarathro). This work was conducted within the framework of a project founded by the Natural Environment and Climate Change Agency. The present vegetation survey complements the only extensive vegetation study of the mountain known to us which was carried out within the frame of the project "Identification and description of habitat types in sites of interest for the protection of nature" during 1999-2000. Vegetation was sampled form *Juniperus foetidissima* thickets and from dry to wet, mid- to high-elevation grasslands. Cluster analysis of the relevé data, using Bray-Curtis distance measure and Ward's linkage method, resulted in the identification of seven vegetation units. For each unit indicator taxa were identified and based on these, each unit was assigned to phytosociological classes and habitat types of the 92/43/EU Directive. For the assignment we calculated the weighted average contribution of the diagnostic taxa of each phytosociological class, using taxon cover values as weights for each relevé and aggregated these values at the vegetation unit level. Four vegetation units were assigned to the priority habitat types: 3170 (*Mediterranean temporary ponds), 6220 (*Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea*), 6230 (*Species-rich *Nardus* grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)) and 9560 (*Endemic forests with *Juniperus* spp.). The former habitat type was described on the mountain for the first time. The remaining grassland vegetation units correspond to habitat types of national interest, some of which are also described for the first time on the mountain. In addition, we identified the most important pressures acting on the vegetation units. Our results indicate that the vegetation description of the mountain is far from being considered comprehensively described, and that a substantial knowledge gap remains, particularly regarding the classification of grassland communities. The authors acknowledge the contribution of the Natural Environment and Climate Change Agency for funding this research through the Operational Programme «Transport Infrastructures, Environment and Sustainable Development" (OP TIESD) 2014-2020 –MIS id:5032966.

Vegetation of oak forests in southeastern Europe

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Deciduous and semideciduous oak forests of the classes *Quercetea pubescentis* and *Quercetea robori-petraeae* represent one of the most widespread vegetation types in southeastern Europe. Despite numerous local studies, a comprehensive phytosociological synthesis of these communities across southeastern Europe is still lacking. The aim of this study is to revise the syntaxonomy of deciduous and semideciduous oak forests in this area and to characterize their physiognomy and ecology. The study is based on the numerical classification of vegetation plots obtained from the European Vegetation Archive (EVA) and our own field surveys. We provide a preliminary classification of oak forests in this region. The northern part of the study area is strongly influenced by the continental climate of the Pannonian Basin and Wallachian Plain. This zone is characterized by lowland thermophilous forests of the alliance *Aceri tatarici-Quercion*. These forests are usually dominated by *Quercus pubescens* or *Q. petraea* and develop on deep base-rich soils on loess. The central inland parts of southeastern Europe are characterized by a more humid temperate climate, diverse relief, and heterogeneous geological substrate. Calcareous bedrocks in this region are often colonized by communities dominated by *Quercus pubescens*, usually assigned to the alliance *Quercion pubescenti-petraeae* or related units of sub-Mediterranean distribution. Acidic bedrocks support meso-thermophilous stands dominated by *Quercus cerris*, *Q. frainetto*, and *Q. petraea*, prevalently belonging to the alliance *Quercion confertae*. In mountainous areas, mesic oak forests of the class *Quercetea robori-petraeae* occur locally. Sub-Mediterranean oak forests of the alliance *Fraxino orni-Ostryion* are found in transitional zones between the temperate and Mediterranean climates. These communities are characterized by thermophilous and xerophilous species adapted to prolonged summer drought. The dominant tree species are usually *Quercus cerris* or *Q. pubescens*, accompanied by taxa with southern European distribution such as *Acer monspessulanum*, *Carpinus orientalis*, *Fraxinus ornus*, and *Ostrya carpinifolia*. In coastal areas, deciduous oak forests of the alliance *Carpinion orientalis* are common. These forests are dominated by *Quercus pubescens* and *Carpinus orientalis*, forming dark, closed-canopy stands with Mediterranean species in the understory. A specific type related to the *Carpinion orientalis* alliance is vegetation with *Quercus frainetto* in the Mediterranean zone, mostly occurring on sedimentary bedrocks. The southern part of the study area is characterized by a drier Mediterranean climate that supports communities with semideciduous oaks such as *Quercus trojana* and *Quercus ithaburiensis* subsp. *macrolepis*.

Illyrian oak-hornbeam forests (*Erythronio-Carpinion*) in Slovenia

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Illyrian oak-hornbeam forests (*Erythronio-Carpinion* (Horvat 1958) Marinček in Wallnöfer *et al.* 1993) in Slovenia comprises south-eastern hornbeam associations: extrazonal in the submediterranean area, while others are found within the Illyrian floral province (prealpine, predinaric and subpannonian region). We have carried out a supervised classification of oak-hornbeam forests in Slovenia using the Cocktail method at the association level. We used the Vegetation of Slovenia database, which was extended with data from other institutions and contained 28,425 vegetation relevés. Classification was performed on a stratified dataset of 21,471 relevés of all vegetation types. A total of 12 associations with dominant *Carpinus* species were identified using formal definitions. They are classified into *Pseudostellario-Carpinetum betuli, Carici albae-Tilietum cordatae, Asperulo odoratae-Carpinetum betuli, Helleboro nigri-Carpinetum betuli, Carici umbrosae-Quercetum petraeae, Carici albae-Carpinetum betuli, Vaccinio myrtili-Carpinetum betuli, Abio albae-Carpinetum betuli, Pruno padi-Carpinetum betuli, Seslerio autumnalis-Carpinetum betuli* and *Asaro-Carpinetum betuli*. For each association, we presented a formal definition and determined diagnostic, constant and dominant species. For ecological interpretation, we used Pignatti's ecological indicator values. The distribution of syntaxa was represented by grid maps.

Diversity of urban meadows in Latvia: The case of Jelgava city

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In the last decade, grasslands have increasingly entered cities as an alternative to the existing intensively managed grasslands. In cities, grasslands can occupy up to ¼ of the total urban area, which is a significant area (1). Frequently mowed grasslands are characterized by lower biological and structural diversity, which reduces the adaptive capacity of the urban environment to climate change. Consequently, research on urban grasslands largely focuses on studying the ecosystem services they provide and comparing them with traditional grasslands. Urban grassland research is dominated by findings that meadow-type vegetation, which structurally resembles natural grasslands, creates new habitats in urban environments and increases plant and animal diversity, providing regulatory services (improving the microclimate, rainwater infiltration, pollution reduction). Jelgava city area (60.56 km^2) is divided into squares - the central part is 500x500 m, and the peripheral part is 1x1 km. A vegetation plot of 1x1 m was created in each square. A total of 104 plots were established. The projective cover of vegetation in % was determined, all plant species were listed and the projective cover in % was determined for each species. Totally 130 vascular plant species were identified. In general, it was found that in all the study plots, a large proportion of native species are found (98% in total), while the proportion of alien species is 2%. It is known that the urban green areas are more exposed to impacts compared to natural ecosystems. The most common native species in the Jelgava city plots are *Trifolium repens* L., *Taraxacum officinale* F.H.Wigg.s.l., *Achillea millefolium* L., *Poa pratensis* L., *Cerastium holosteoides* Fr., *Medicago lupulina* L. The most common alien species is *Solidago canadensis* L.s.l.. The largest projective cover in the vegetation plots of Jelgava city was found for the following species: T*rifolium repens*, *Poa pratensis*, *Achillea millefolium*, *Trifolium pratense* L., *Lolium perenne* L., *Taraxacum officinale*, *Aegopodium podagraria* L. Meadows can become important elements of urban green infrastructure, due to their structural structure (low and medium vegetation) and undemanding nature (no need for improved soil, regular watering), they can be successfully integrated into underused green areas, parks and green areas of residential areas, roadsides, traffic separation zones and areas where tree plantations are not possible. Due to the flexible placement of meadows in the urban environment, they can often serve as linear or point connections or biocorridors between larger green areas, promoting the continuity of ecological processes. Often we can start with extensive management of existing grasslands (less frequent mowing, removal of biomass after mowing, no use of fertilizers and pesticides). Extensive grassland management is often the main condition for the gradual increase in biodiversity and the provision of broader ecosystem services compared to intensively managed grasslands (2,3).

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An Integrated Approach to the Restoration of Annex I Wetland Habitats: The LIFE IMAGINE Project (LIFE19 IPE/IT/000015 "Integrated Management and Grant Investments for the Natura 2000 Network) in Umbria Central Italy

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The LIFE IMAGINE project aims to implement a coordinated, participatory strategy for the integrated management of the Natura 2000 Network in Umbria, in accordance with the conservation objectives defined by the Habitats and Birds Directives and the Prioritised Action Framework (PAF). Within this framework, several actions focus on the conservation and restoration of rare wetland habitats with limited regional distribution.

Following an initial assessment of conservation status based on structural and functional parameters, as well as the identification of pressures and threats, site-specific restoration measures were implemented for selected Annex I habitats.

Habitat 7210 (Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*) is restricted to the shores of Lake Piediluco, where restoration actions aimed at increasing habitat extent through the planting mostly of *Cladium mariscus* and *Carex pseudocyperus*, including the use of artificial floating islands to support the re-development of original floating vegetation mats.

Habitat 7230 (Alkaline fens), rich fens of *Caricion davallianae* occurring in the Colfiorito Marsh, is currently threatened by natural succession due to the abandonment of traditional management practices. Restoration activities focused on the control of secondary vegetation, the collection and propagation of typical species, and the establishment of a dedicated nursery to support reintroduction phases (e.g. *Eriophorum latifolium*, *Carex panicea*, *Carex viridula*, *Anacamptis laxiflora*, etc.)

Habitat 7140 (Transition mires and quaking bogs), D2.23 – Apennine oligo-mesotrophic peat bogs on acidic (karstic, decarbonated) substrates occurring in the Monti Sibillini area – is currently threatened by mowing and grazing practices. Restoration activities focus on the management of these practices under future climate change scenarios.

Habitat 6420 (Mediterranean tall humid grasslands of the *Molinio-Holoschoenion*) is represented in Umbria by small and highly fragmented stands associated with fluctuating hydrological conditions at Lake Trasimeno. Conservation actions addressed the main pressures affecting this habitat-including hydrological alterations, agricultural intensification, and invasive species-through measures aimed at restoring appropriate moisture regimes, reducing external disturbances, and promoting the recovery of characteristic plant communities: plants targets: *Juncus acutus* and *Scirpoides holoschoenus*.

Habitat 92A0 (*Riparian galleries* of *Salix alba* and *Populus alba*) shows a generally poor conservation status along the Tiber River, mainly due to habitat fragmentation and the spread of invasive alien species such as *Robinia pseudoacacia*. Restoration interventions included the mechanical control of invasive species over large areas and the reintroduction of native woody species to improve habitat structure and ecological functionality.

Overall, the project highlights the importance of integrating ecological and phytosociological knowledge, traditional management practices, and active restoration measures to enhance the conservation status of priority habitats within the Natura 2000 Network.

Keywords: Annex I Habitat Restoration, LIFE Integrated Projects, Natura 2000 Network

*The vegetation database of Gran Paradiso National Park (Italy)

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National parks play a key role in biodiversity conservation by protecting species and habitats while supporting the collection of ecological data. Structured vegetation databases provide a solid foundation for environmental management, long-term monitoring, and scientific research. Here we present the vegetation database of the Gran Paradiso National Park, Italy's first national park, established in 1922. Located in the Graian Alps, the park spans approximately 71,000 hectares across the Aosta Valley and Piedmont regions. Characterized by a massive elevational gradient (800–4,061 m a.s.l.) and complex geology, it supports a mosaic of habitats ranging from mixed broadleaf-conifer forests to alpine grasslands and nival pioneer communities. Consequently, the park hosts a high floristic diversity, including over 1,100 vascular plant species and more than 500 bryophytes, with over 80 Alpine endemics and more than 40 species of conservation interest. This database integrates decades of botanical research, spanning from 1970 to 2023, through structured field surveys and targeted research projects. Vegetation was sampled using different methodologies, including traditional phytosociological relevés, point-quadrat, and linear methods. To ensure consistency and interoperability, all records were georeferenced and harmonized by converting diverse abundance scales into standardized percentage cover values. The database comprises four interconnected tables: a species information table; a species-by-relevé matrix; a relevé metadata table incorporating environmental variables; and a formalized EUNIS habitat classification utilizing an R-based expert system. The database includes 860 taxa (816 vascular plants and 43 bryophytes) recorded across 1,203 relevés, largely collected in high-elevation environments above 2,000 m a.s.l. Notably, nearly 7% of these taxa are Alpine endemics, and more than 100 species are assigned to regional, national, or European conservation categories. Most relevés were successfully assigned to an EUNIS habitat category, with a dominance of grasslands (N = 888), followed by wetlands, sparsely vegetated inland habitats, heathlands, and forests. This database provides a robust baseline for ecological research and long-term ecosystem monitoring. By offering high-resolution data on community composition, it facilitates evidence-based conservation strategies, restoration planning, and habitat management. Ultimately, these standardized data enable large-scale comparative studies and offer crucial insights into alpine vegetation dynamics under the synergistic pressures of climate change and shifting land-use patterns.

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* Take part in the young researchers' competition

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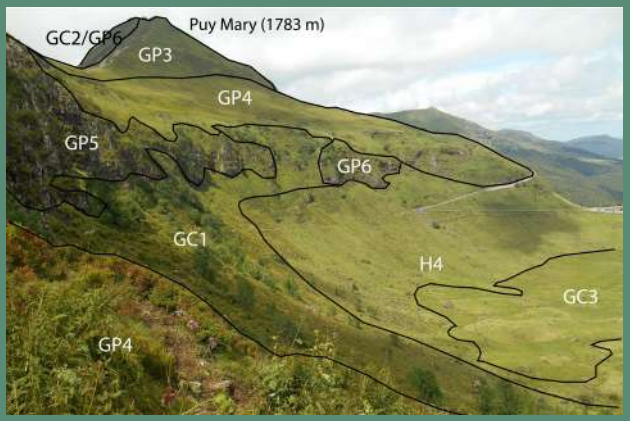

European Vegetation Survey 34th conference 2026
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Excursion booklet

UniVegE collective / BIOM 7(1) (2026) : 105-146

UniVegE - Herbarium CLF, University of Clermont-Ferrand

UniVegE is a service of the University of Clermont-Ferrand, responsible for the conservation and management of herbarium collections, and conducting research and expertise in botany and phytosociology applied to knowledge of natural habitats.

The herbaria of the University of Clermont Ferrand constitute the 4th national collection and are referenced in the 100 largest herbaria in the world. They comprise a total of 660,000 specimens organized into 78 collections, including 47 of tracheophytes and 31 of cryptogams.

It is an international herbarium that includes plants from all continents, listed in the New York Botanical Garden's Index Herbariorum (acronym CLF).

It also constitutes a historical heritage, with acquisitions spanning the period from 1784 to the 21st century. The collections contain over 700 nomenclatural types, including reference specimens from the French Massif central.

It is an active scientific collection to which numerous specimens are added annually by various users and the UniVegE team.

A part of the herbarium CLF at 3 boulevard Lafayette 63000 Clermont-Ferrand.

Notable historical collections include the herbaria of Dutour de Salvert (early 19th century) and Martial Lamotte (second half of the 19th century). Major 20th-century collections include those of d'Alleizette (Mediterranean basin, Francophone Africa), Chassagne (Auvergne, etc.), Lassimonne, Le Grand, and Chouard. More recently, the herbaria of Deschâtres (Crete, etc.), Loiseau (Loire basin, sub-Saharan Africa), Brunel (Togo), and Chaffin have been deposited at CLF, alongside the Billy herbarium, whose publications serve as a key reference for the phytosociological understanding of the Auvergne region. Aimé Luquet's herbarium, part of the MPU herbarium, has been placed on deposit in Clermont-Ferrand for research purposes. A general tracheophyte herbarium comprising over 75,000 specimens brings together numerous collections.

Cryptogam herbaria include the Pierrot herbarium (European bryophytes, 23,000 specimens), the Skrzypczak herbarium (11,000 specimens), and a general herbarium of approximately 44,000 specimens. A general lichen herbarium, currently being assembled, contains around 14,000 specimens.

Details regarding the Clermont collections are available at: https://herbiers.uca.fr/version-francaise/collections-dherbiers/presentation

UniVegE has carried out extensive digitization (340,000 images) and data computerization (180,000 specimens) work as part of various programs (ReColnat, IMHAGES), making it the second most computerized botanical collection in France. This database supports historical data analyses conducted by UniVegE, notably within the framework of the IMHAGES program (2020–2022).

UniVegE currently consists of a two-person team: Dr. Camille Roux, curator and research engineer, and Léa Brocard, master's degree. Gilles Thébaud, Dr HDR, a retired curator, is a regular contributor. The team maintains connections with a network of correspondents and users.

The UniVegE team. From left to right: Camille Roux, Léa Brocard and Gilles Thébaud.

UniVegE conducts phytosociological research focusing on plant bio-indicators to understand changes in natural habitats, particularly regarding plant communities in the French Massif central. The SurVegE software, developed by Camille Roux and Gilles Thébaud, is a tool for the diachronic analysis of vegetation changes; it is used in assessments commissioned by local authorities (such as the département du Puy-de-Dôme, natural parks, and the Clermont-Ferrand metropolitan area); the monitoring plots associated with it are integrated into the ReSurveyEurope temporal database.

The UniVegE phytosociological database-hosted on Turboveg and adapted to French standards-compiles nearly 20,000 historical and current vegetation splots, mainly from the French Massif central.

UniVegE publishes BIOM, a scientific journal dedicated to the biodiversity of the French Massif central and mid-mountain regions (https://revues.polen.uca.fr/index.php/BIOM), and participates in the *Prodrome des végétations de France* (PVF2) project led by the French Phytosociological Society.

Recent papers

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Société Française de Phytosociologie (SFP)

Established in 2002, the French Phytosociological Society is a non-profit association dedicated to promoting and developing both fundamental and applied phytosociology. It fosters scientific exchange—notably by organizing symposia and field sessions-develops national or regional prodromus (overviews of plant communities) and disseminates knowledge through the production of books and scientific publications.

Our activities advancing cognitive research and scientific exchange in the field of phytosociology; preserving and showcasing bibliographic heritage, as well as gathering published and unpublished phytosociological documentation; developing synopsis or syntheses of regional, national, and international synsystems, and establishing their correspondence with other classification systems; applying phytosociology to: conducting inventories, expert assessments, and biological and coenotic mapping, evaluating natural and human-altered environments, managing and conserving phytogenetic, floristic, coenotic, and landscape heritage; writing phytosociological works and publications, whether scientific or educational; publishing phytosociological documents of all types and levels: scientific (journals, bulletins, etc.), educational, informational, etc.; organizing symposia, study days, field sessions, training courses, etc.

Part of the SFP team. From left to right: Erwan Glemarec, Corentin Chevrollier, Frédéric Bioret and Christian Gauberville.

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Abstract

This article is the excursion booklet for the 34th conference of the European Vegetation Survey, the European group of the International Association of Vegetation Sciences, which is being held in Auvergne from September 7 to 13, 2026. Several excursions are being organized during this congress in honor of Josias Braun-Blanquet and Aimé Luquet as part of the centenary of phytosociological studies in Auvergne published in the Revue d'Auvergne in 1926. The conference is taking place in Clermont-Ferrand from September 7 to 11. The mid-conference excursion takes place on September 9th in the Dore mountains. An evening excursion is scheduled for September 10th to the summit of the puy de Dôme, coinciding with the social dinner. A post-conference excursion, from September 11th to 13th is being held in the Cantal mountains. The first part of the booklet presents the physical environment, human uses, and major vegetation types of the region. Each of the three mountain ranges visited is then the subject of a detailed description of its environment, the plant communities present, their dynamic relationships, its landscape compartments, and its typical flora. The excursion routes prioritize returning to sites surveyed a hundred years ago, some of which are *classici loci* of phytosociological alliances described for the first time in 2026 by Braun-Blanquet and/or Luquet as *Nardion*, *Genisto-Vaccinion*, *Adenostylion*, *Festucion variae*, *Cardamino-Montion*, *Fagion*, *Calamagrostion*, *Caricion fuscae*, *Arrhenatherion*, *Piceion*. In the Dore mountains, the participants visited the Chaudefour valley, the cirque of Monneaux, The Pavin lake, and the Capucin. On the puy de Dôme, they observed the summit vegetation as well as the lanscape of the Chaîne des puys. In the Cantal mountains, the subalpine areas of the northern part of the Chaîne of the Plomb du Cantal and the cirque of Impradine below the Puy Mary were explored, as well as the basaltic hill of the Chapelle Sainte Anne north of Murat. In total, 81 plant communities are mentioned and described in this booklet, resulting from the most recent and in-depth researches, integrated within the hierarchical system of the French (Prodrome des végétations de France, PVF2) and European (EuroVegChecklist) phytosociological classification.

Keywords
Vegetation
Auvergne
Braun-Blanquet
Luquet
Dore mountains
Cantal mountains
Puy de Dôme
Phytosociological alliances
Excursion

Résumé

Cet article constitue le guide d'excursions de la 34ème conférence de l'European Vegetation Survey, groupe européen de l'Association internationale des sciences de la végétation, qui se tient en Auvergne du 7 au 13 septembre 2026. Plusieurs excursions sont organisées durant ce congrès en hommage à Josias Braun-Blanquet et Aimé Luquet dans le cadre du centenaire des études phytosociologiques en Auvergne publiées dans la revue d'Auvergne en 1926. Le congrès a lieu à Clermont-Ferrand du 7 au 11 septembre. L'excursion de milieu de congrès a lieu le 9 septembre dans les monts Dore. Une excursion en soirée a lieu le 10 septembre au sommet du puy de Dôme, à l'occasion du social dinner. Une post-excursion, du 11 au 13 septembre est conduite dans les monts du Cantal. La première partie présente le milieux physique, les usages humains et les grands types de végétation de la région visitée. Chacun des trois massifs visités fait ensuite l'objet d'une description détaillée de leur environnement, des communautés végétales présentes, de leurs liens dynamiques, de leur compartimentation paysagère et de leur flore typique. Les itinéraires d'excursion priorisent le retour sur les lieux prospectés il y a cent ans, dont certains sont des *locus classicus* d'alliances phytosociologiques décrites pour la première fois en 2026 par Braun-Blanquet et/ou Luquet comme le *Nardion*, *Genisto-Vaccinion*, *Adenostylion*, *Festucion variae*, *Cardamino-Montion*, *Fagion*, *Calamagrostion*, *Caricion fuscae*, *Arrhenatherion*, *Piceion*. Dans les monts Dores les congressistes visitent la vallée de Chaudefour, le cirque de Monneaux, le lac Pavin et le Capucin. Sur le puy de Dôme ils observent la végétation du sommet ainsi que les paysages végétaux de la Chaîne des puys. Dans le Cantal les espaces subalpins de la partie nord de la Chaîne du Plomb du Cantal et du cirque de l'Impradine sous le puy Mary sont prospectés ainsi que la butte basaltique de la Chapelle Sainte Anne au nord de Murat. Au total 81 associations végétales sont mentionnées et décrites dans ce guide, issues des recherches les plus récentes et les plus approfondies concernant la végétation de ces sites, intégrées au sein du système hiérarchique de la classification phytosociologique française (Prodrome des végétations de France, PVF2) et européenne (EuroVegChecklist).

Mots-clés
Végétation
Auvergne
Braun-Blanquet
Luquet
Monts Dore
Monts du Cantal
Puy de Dôme
Alliances phytosociologiques
Excursion

Introduction - The centenary of phytosociological studies in Auvergne

The French Society of Phytosociology (SFP) and the International Association for Vegetation Science (IAVS) are organizing the 34th European Vegetation Survey (EVS) conference in Clermont-Ferrand (Auvergne, France) from September 7 to 11, 2026, in partnership with Clermont Auvergne University (UCA) and the University of Bretagne occidentale (UBO). Since 1992, when the EVS was created, this is only the second time that the annual conference has been held in France.

It brings together around two hundred European researchers specializing in vegetation science, who will speak and exchange views on topics such as historical vegetation data, vegetation dynamics and monitoring, conservation and restoration strategies, and the classification of vegetation and natural habitats.

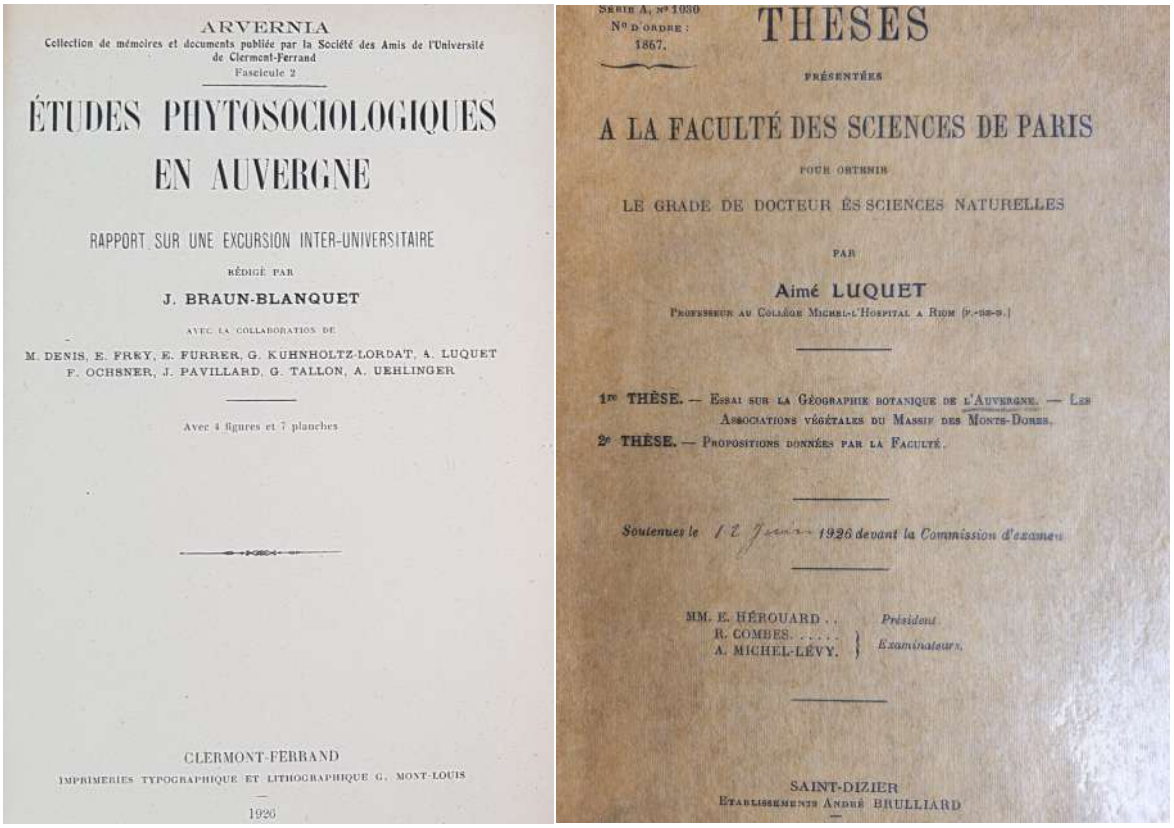
This event is being held in honor of Josias Braun-Blanquet and Aimé Luquet as part of the centenary of phytosociological studies in Auvergne (1926, Fig. 1). It is enriched by various excursions allowing participants to discover the main volcanic massifs of Auvergne: mid-symposium excursion on September 9 to the Dore mountains, climb to the puy de Dôme, summit of the "Chaîne des puys", on September 10 during the social dinner; post-symposium excursion to the Cantal mountains, from September 11 to 13.

In 1924, Braun-Blanquet and Luquet organized a phytosociological excursion in the Auvergne region, which resulted in several articles included in a collection of memoirs and documents concerning Auvergne region, under the title Arvernia 2, published in the Revue d'Auvergne in 1926. Among these was J. Braun-Blanquet's article, «le climax complexe des landes alpines (*Genisteto-Vaccinion* du Cantal)». Simultaneously, in 1926, Luquet published his thesis under the editorship of Brulliard in Saint-Dizier, entitled «Essai sur le peuplement végétal de l'Auvergne. Les associations végétales du Massif des monts Dore».

At that time, these authors collaborated closely, as Roux *et al.* (2026) point out. In his thesis, Luquet thanks Braun-Blanquet because, in the spring of 1920, when they were together in the Dore mountains, Braun-Blanquet asked him to undertake a study of their vegetation (Luquet 1926: p. 11). Traces of these joint excursions have been revealed by consulting the herbaria of Braun-Blanquet in Montpellier (MPU), of Luquet in Clermont-Ferrand (deposited at CLF), where it can be seen that they collected plants together on the puy de Sancy in May 1920, as well as during joint outings over the following three years.

In July 1923, Braun-Blanquet traveled alone to the Cantal mountains, and in August returned to the Dore mountains to see Luquet. We have indeed found herbarium sheets collected during this period in this mountain range on the same day by each of them. It was surely at this time that they decided to organize the phytosociological excursion to Auvergne in 1924, published in 1926 in the Revue d'Auvergne.

Braun-Blanquet and Luquet continued their collaboration for many years after this period, the former as director, the latter as treasurer of the office of the "Station internationale de géobotanique méditerranéenne et alpine" founded in Montpellier, which would play a major role in the rise and international influence of phytosociology.


ARVERNIA
Collection de mémoires et documents publiée par la Société des Amis de l'Université de Clermont-Ferrand
Fascicule 2

ÉTUDES PHYTOSOCIOLOGIQUES EN AUVERGNE

RAPPORT SUR UNE EXCURSION INTER-UNIVERSITAIRE

RÉDIGÉ PAR

J. BRAUN-BLANQUET

AVEC LA COLLABORATION DE

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F. OCHSNER, J. PAVILLARD, G. TALLON, A. UEHLINGER

Avec 4 figures et 7 planches

CLERMONT-FERRAND
IMPRIMERIES TYPOGRAPHIQUE ET LITHOGRAPHIQUE G. MONT-LOUIS

1926

SÉRIE A, N° 1030
N° D'ORDRE :
1867.

THÈSES

PRÉSENTÉES

A LA FACULTÉ DES SCIENCES DE PARIS

POUR OBTENIR

LE GRADE DE DOCTEUR ÈS SCIENCES NATURELLES

PAR

Aimé LUQUET

PROFESSEUR AU COLLÈGE MICHEL-L'HOSPITAL A RIOM (P.-DE-D.)

1re THÈSE. — ESSAI SUR LA GÉOGRAPHIE BOTANIQUE DE L'AUVERGNE. — LES ASSOCIATIONS VÉGÉTALES DU MASSIF DES MONTS-DORE.

2e THÈSE. — PROPOSITIONS DONNÉES PAR LA FACULTÉ.

Soutenues le 12 Juin 1926 devant la Commission d'examen

MM. E. HÉROUARD . . Président
R. COMBES. . . . . Examinateurs.
A. MICHEL-LÉVY.

SAINT-DIZIER
ÉTABLISSEMENTS ANDRÉ BRULLIARD

Figure 1 - Left, field trip report on phytosociological studies in Auvergne, Arvernia 2, published in the Revue d'Auvergne, volume 41 (4) 1926, Braun-Blanquet as editor; right, Aimé Luquet's thesis, defended on June 12, 1926.

The mountain ranges visited and the excursion sites

The three mountain ranges visited during the excursions form a biogeographical group of mountains located to the west parts of the Massif central and of the Auvergne (Fig. 2), which can be defined as an area with an oceanic climate on volcanic substrate (Fig. 3).

Relief and geology

The "Chaîne des puys", the northernmost of the three mountain ranges, is a group of 80 volcanoes, aligned from north to south, formed between 95,000 and 8,000 BP. It consists mainly of Strombolian cones, some with craters, overlooking a layer of lapilli and long flows of fluid basaltic or trachyandesitic lava. There are also a few Pelean-type domes, made up of trachyte, a more viscous lava, such as the puy de Dôme, the highest peak in the chain at 1,465 m. There are also numerous "maars", bowl-shaped, of phreato-magmatic origin.

The massif of the "monts Dore" is a result of an older volcanism whose formation began 3 Ma ago. It is a complex stratovolcano of 35 km from north to south and 16 km from east to west, made up of many imbricated edifices and various lava formations, such as basalts, trachyandesites, and rhyolites. It was the site of a collapsed caldera with debris avalanches. It peaks at 1,886 m at puy de Sancy, the summit of the Massif central.

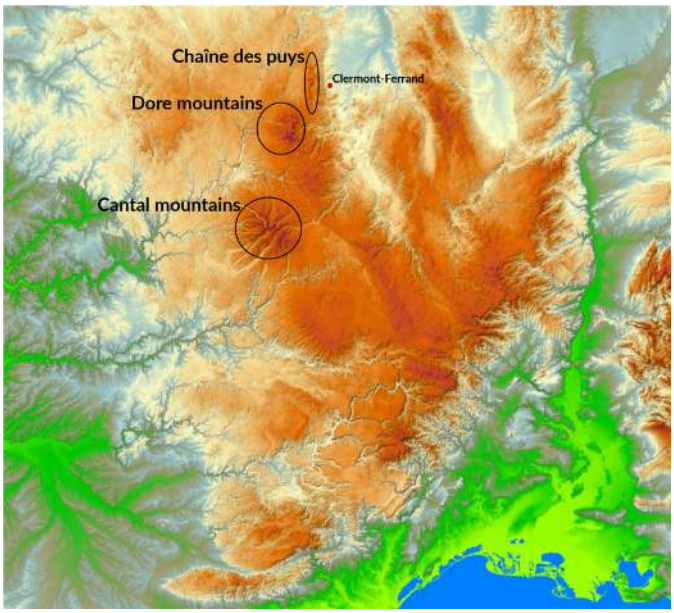


Figure 2 - Location of the three main mountain ranges in Auvergne visited during the field trips of the 34th European Vegetation Survey conference in Clermont-Ferrand.

The Cantal massif is also a stratovolcano, even older, formed between 8.5 and 7 Ma ago, and twice as large as the Dore mountains. It is the largest volcano in Europe. It is thought to have reached an altitude of nearly 3,800 m before a gigantic caldera formed, with a central collapse, triggering debris avalanches that covered the trachyandesite lava. Phonolites and trachytes are less common. Around the stratovolcano, there are basalt formations known as "supra-cantaliens," which are between 7 and 2 Ma old.

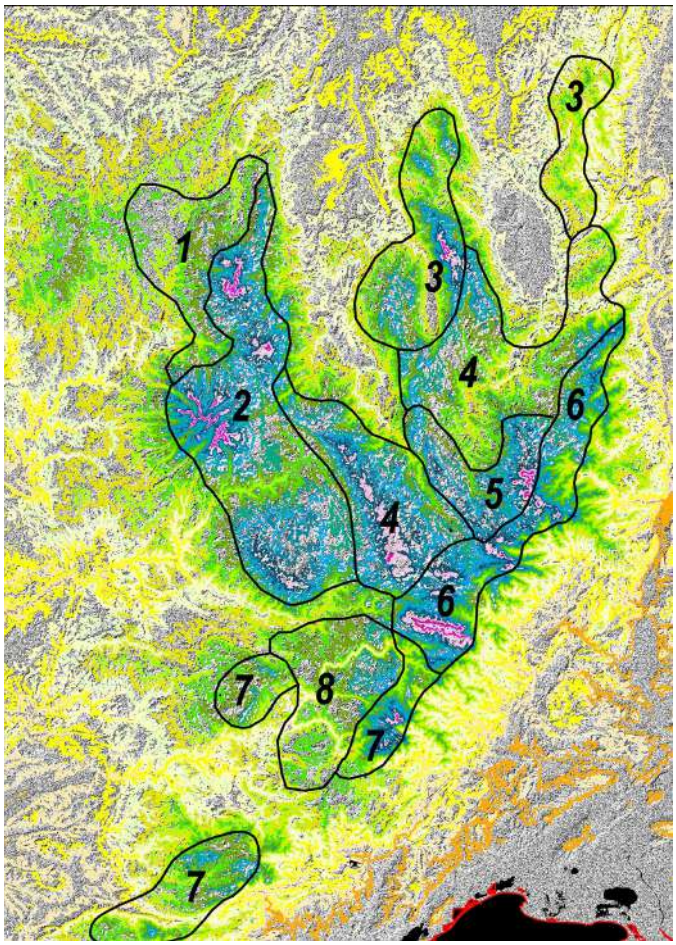


Figure 3 - Biogeographical zones of the Massif central according to Thébaud & Roux (2018). The EVS 2026 excursions cover the mountains of zone 2, an area influenced by the ocean on volcanic substrate, from north to south: the Chaîne des puys, the Dore mountains, the Cézallier plateau, the Cantal mountains, and the Aubrac plateau. Map source: Earth Explorer.

These volcanic structures formed along basins and faults located to the east, including the Limagne basins, which constitute the southern part of the northwestern continental rift system (Limagnes, Bresse, Rhine) formed between the Eocene (60 million years ago) and the Oligocene (30 million years ago) during the Alpine orogeny.

Climate and recent trends

These mountain ranges are influenced by the oceanic climate. Weather stations in the Chaîne des puys, Dore mountains, and Cantal mountains show significant precipitation, averaging over 1,000 mm per year at an altitude of 1,000 m, and often much more, between 1,500 and 2,000 mm (1991–2020 period, Météociel) on the western slopes, such as at Lioran in the Cantal mountains (2,129 mm at 1,236 m) or at the town of Mont-Dore (1,783 mm at 1,050 m). This precipitation is evenly distributed throughout the year, as shown in the rainfall diagrams.

The average temperatures are low, generally below 8 °C above 1,000 m and below 5 °C above 1,600 m, and remain cool in summer. The westerly winds, snow and late frosts, strong cloudiness, and periods of milder temperatures in the middle of winter are other characteristics of this climate. Only the parts of

the mountains sheltered from western influences show a drier, warmer, and more contrasting climate, with a semi-continental sheltering character in the basins, where annual precipitation can fall below 600 mm, as is the case of the Limagnes.

According to the classification by Rivas-Martinez (2007), the whole area corresponds to an oceanic temperate bioclimate. The calculation of simple continentality indices yields a temperate oceanic bioclimate that varies from the eu-oceanic subtype to the semi-continental subtype.

Recent climate trends are manifested by a marked increase in temperatures in the recent period, for example in the Monts Dore: a rise of 0.91 °C between the periods 1951-1980 and 1981-2010, particularly noticeable at higher altitudes and during the growing season (Serre 2015). A decrease in snow cover is also observed during this same period 1980-2010 in the Massif central, where the number of days with snow on the ground decreased by 16 % (Serre 2010) compared to the period 1950-1980.

Soils

The decomposition of volcanic rocks in a cold and humid climate without significant drought forms particular soils called Andosols, very rich in organic matter, which gives them a black color. They contain characteristic amorphous compounds called "allophanes", and complexes of aluminium/organic matter (Hétier 1975). Among the volcanic soils of the region, one distinguishes Brunisols at low altitudes and in a climatic shelters, Silandosols, moderately or slightly acidic, forming under precipitation less than 1,100 mm, and Aluandosols, the most acidic, developed under significant rainfall, and very rich in aluminium (Coquillard 1994). They are dominant in the mountain foothills. On the highest peaks, due to the short vegetation period, organic matter accumulates in the soils, forming Rankoaluandosols.

Grazing use

In the montane belt, extensive cattle grazing is widespread. Two-thirds of livestock are for meat production, and the remaining third is for dairy and cheese production. The main local cattle breeds are "Salers", "Limousine", "Aubrac", and "Charolaise", more rarely "Ferrandaise". Sheep herds are only in the Chaîne des puys, with light filtering soils. This cattle-based economy, which constitutes a very lively sector, maintains the open landscapes in the montane belt where mowed meadows and extensively grazed pastures dominate. The transhumance takes place in summer pastures, large expanses of grassland, which receive the herds from June to October, and where we find traditional buildings located above the permanent habitat, the "burons".

Vegetation

Auvergne is in the Eurosiberian biogeographical region, Alpine-Caucasian subregion, Pyrenean-Cévennian province, Arverno-Cevennian subprovince (Rivas-Martínez 2007). The vegetation is arranged according to altitude, following the pattern of vegetation belts defined for the Alps and peripheral massifs by Ozenda (1985; 2002).

The hilly (or colline) belt is divided into an Atlantic-type hilly belt with *Quercus robur*, between 200 m and 500 m at the western limit, a warm hilly belt dominated by *Quercus pubescens*, present in the sheltered climate of the Limagne basins between 300 and 700 m, and a medio-European belt, with *Quercus petraea*, found further east, between 500 and 900 m. Above this is a temperate montane belt that is omnipresent in the Massif central. This is divided into a lower montane (submontane) belt, with oak-beech forests, a middle montane (mesomontane) belt, dominated by *Fagus sylvatica*, *Abies alba*, and *Pinus sylvestris*, and an upper montane (altimontane) belt, which reaches 1,450/1,550 m. Above this, in the highest mountain ranges, particularly in the Cantal and Dore mountains, there is a subalpine belt (Thébaud *et al.* 2014).

In the Massif central, given the oceanic climate, we note the absence of trees such as *Picea abies*, *Pinus cembra*, and *Larix decidua*, and the rarity of indigenous stands of *Pinus mugo* subsp. *uncinata*, confined to a few peat bogs. The subalpine area is mainly treeless, as neither beech nor fir trees grow there. However, we can distinguish a lower subalpine belt consisting of heathland and grassland where thickets, tall grasses, and shrub species are abundant, such as *Sorbus aucuparia*, *Aria edulis*, *Sorbus* sp., *Betula pubescens*, *Salix* sp., and an upper subalpine belt above 1,600 m, in the form of low heathland and grassland without trees or shrubs, and where several species of alpine belt (*Juncetea trifidi*) are regularly found (Thébaud *et al.* 1992; Michalet & Philippe 1994; Coquillard *et al.* 1994).

Description of the excursion sites, sources, and tools

The excursions take participants to the Dore mountains (September 9), the puy de Dôme (September 10), and the Cantal mountain (September 11 to 13).

This excursion booklet presents the physical characteristics of the sites visited and the different types of vegetation encountered, generally up to the level of plant association as defined in the sigmatist phytosociological approach (Braun-Blanquet 1932; 1964; Guinochet 1973; Géhu 2006). A hierarchical classification system for the vegetation encountered is presented at the end of the article, based on Mucina *et al.* (2016) or on the PVF2 (Roux *et al.* 2024). The nomenclature of taxa refers to TAXREF (v. 16, INPN).

Numerous phytosociological studies have been conducted in the mountain ranges and sites visited. They are cited in the bibliography section. Similarly, numerous recent plots (releves), carried out by various researchers, mainly from Clermont Auvergne University, in the Chaîne des puys, the Dore mountains and the Cantal mountains, have supplemented these data and have also been used to characterize communities and vegetation dynamics.

Here, we have adopted the principles and definitions of landscape or dynamic-catenal phytosociology, as explained by numerous authors, in particular Biondi (1994), Lazare (2009) and Bioret *et al.* (2019), as a way of presenting the dynamic and ecological links between the different communities. Among the various units identified by these authors, we have selected those most relevant to the region visited, as listed below.

According to Bioret *et al.* (2019), the vegetation series is a conceptual dynamic unit gathering plant communities with the same potential vegetation the final stage of which is called “series head”. Vegetation series is linked to an ecologically homogeneous spatial unit, or “tessela”. There is climatophilous series, related to the mesoclimate and edaphophilous series mainly influenced by edaphic constraints. Among the latter, several can be distinguished, including edaphoxerophilous series or the edaphohygrophilous ones.

The “holoseries” is a complete series, whose mature stage is the forest.

The “curtaseries” is a truncated series, whose mature stage, due to ecological constraints, is not forest but often shrubby.

The “permaseries” consists of a single permanent stage within a tessella characterized by severe ecological constraints. It may, however, include vegetal stages of anthropogenic degradation.

The “geoseries” is a conceptual unit that includes different series within a “catena”. Catena is forming a homogeneous geomorphological and bioclimatic spatial entity of variable size, made up of several tessellas. There are also “geopermaseries”, comprising several permaseries, and “geocurtaseries”, comprising at least one curtaseries.

Only the Chaîne des puys has been the subject of an in-depth study in landscape phytosociology (Roux 2017), unlike the Cantal mountains and the Dore mountains, where the units described are only a rough outline.

The Dore mountains (mid-symposium excursion 9th September)

Chaudefour valley-Monneaux-Sarrevielle (groups 1 and 2, morning)

The first group's excursion takes place in the lower Chaudefour valley, from the Sainte-Anne chalet at the entrance to the national nature reserve to the beech forests below the Crête du Coq (4 km round trip, 100 m elevation gain) (Fig. 4).

The second group's excursion takes place in the Monneaux cirque, starting from the car park of the restaurant Les Cinq Cents Diables to the ridge south of puy Jumel at 1,430 m (4 km round trip, elevation gain 280 m), where there is a panoramic view of the upper Chaudefour valley (Fig. 4).

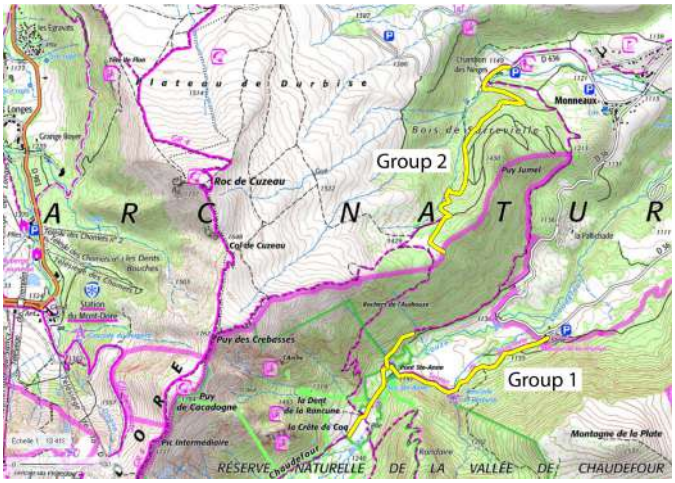


Figure 4 - Itineraries of the two groups (in yellow) in the Chaudefour valley and the Monneaux cirque. Map source: French national geographic institute (IGN).

The Monneaux cirque is a small ancient glacial cirque attached to the larger Chaudefour cirque. It is characterized by its U-shaped profile with steep slopes, abrupt cliffs, and a flat bottom. The north-facing slope and the plateaus overlooking the valley are composed of trachyandesite. The puy Jumel and the ridges to the south are formed of basaltic lava corresponding to the third phase of the formation of the Dore stratovolcano. The valley floor consists of fluvial-glacial deposits and recent alluvial deposits.

The Chaudefour valley is the second largest valley in the Dore mountains after the vallée des Bains. It forms a cirque, upstream culminating in the puy Ferrand peak at 1,856 m. It was formed by a powerful and thick glacier, several hundred meters deep, which flowed downstream to lake Chambon, more than 10 km away. The steep slopes are composed of trachyandesites and trachyandesitic screes, topped by dikes-volcanic veins injected into the surrounding rock and brought to the fore by erosion: Crête du Coq, Dent de la Rancune, and Arche. These light gray lavas are richer in silica than basalts and are remarkable for their abundance of phenocrysts. The valley floor upstream is filled with scree and coarse volcanic deposits, obscuring the underlying formations.

Vegetation series and plant communities visited:

Several vegetation series are expressed across different ecological compartments (tesselas), mainly depending on altitude, aspect, and soil moisture. These have not been studied in detail, but an outline can be drawn given the good state of knowledge of the area's plant communities, which have been extensively surveyed for nearly a century and mapped (Bock & Prelli 1975; Combe & Rameau 1994).

Only the series and communities present along the routes followed by the participants, from the mesomontane belt to the base of the subalpine belt, will be presented here (Fig. 5).

The subalpine plant formations of the Chaudefour valley, which are very rich and diverse, will not be described in this booklet. Readers are referred to the bibliography listed at the end.

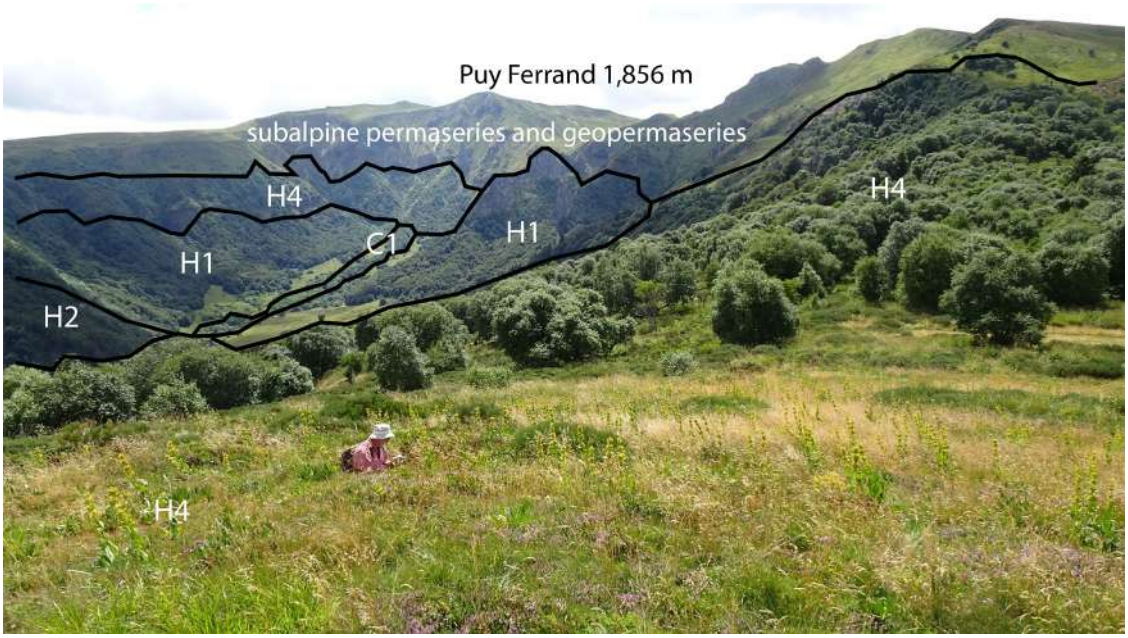


Figure 5 - Sketch of the vegetation series of the Chaudefour Valley as seen from the Sarrevielle woods. **H1**: mesomontane holoseries of the neutrophilous beech forest *Adoxo-Fagetum*. **H2**: mesomontane holoseries of the acidiphilous beech forest *Luzulo sylvaticae-Fagetum*. **H4**: uppermontane holoseries of the chionophilous beech forest *Doronico austriaci-Fagetum*. **C1**: edaphic-hygrophilous curtaseries of the willow scrub *Salicetum pentandro-atrocinereae*.

The landscapes have changed in the Chaudefour valley since the 19th century, as in all the mountains of Auvergne, as shown in the drawings of Delécluze (Photo 1, Fig. 6). The mowed meadows at the bottom of the valley have become pastures, and the forests have progressed on the slopes.

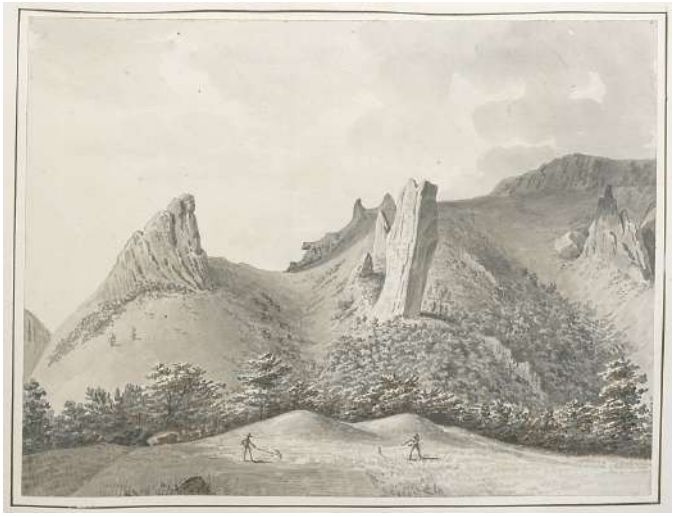


Photo 1 and Figure 6 - Chaudefour valley according Étienne-Jean Delécluze (1821, MARQ Art Museum). In 2025, it can be observed that the hay meadows (*Agrostietum capillaris* Luquet 1926, *Triseto-Polygonion*) have given way to extensive pastures (*Nardo-Agrostion tenuis*) and the forest is more widespread. In the foreground on the left: the rock crête de Coq (cockscomb) and on the right the rock "dent de la Rancune" (tooth of rancor).

In the riverine habitats and wet flats on hydromorphic soils at the bottom of the valley, with river or groundwater flooding, a mesomontane eutrophic edaphohygrophilous curtaserie develops, which leads to the willow grove with *Salix pentandra* and *S. atrocinerea* (C1).

Following the abandonment of the maintenance of the drainage ditches of the wettest meadows, the pastures of these areas are transformed into mesotrophic hygrophilic meadows (*Calthion palustris*), then after total abandonment, into tall-forb communities (*Ranunculo aconitifolii-Filipenduletum ulmariae*) with *Filipendula ulmaria*, *Angelica sylvestris*, *Cirsium palustre*, *Veratrum album*, *Chaerophyllum hirsutum*, *Ranunculus aconitifolius*, and *Equisetum fluviatile*. The *Salix atrocinerea* and *S. pentandra* willow grove (*Salicetum pentandro-atrocinereae*), eutrophic to meso-eutrophic, establishes itself at the expense of these formations and constitutes the series head.

On the lower slopes, colluvial flats, in particular in concave landforms, on deep, well-drained volcanic andosol, we find the climatophilous neutrophilous mesomontane Atlantic beech forest holoseries with *Adoxa moschatellina*, well represented upstream of the Chaudefour cirque (H1, Photo 2). It includes hay meadows (*Violo luteae-Trisetetum = Agrostietum capillaris* Luquet 1926). *Trisetum flavescens*, *Avenula pubescens*, *Knautia arvernensis*, *Agrostis capillaris*, *Poa chaixii*, *Centaurea nigra*, *Phyteuma spicatum*, *Geranium sylvaticum*, *Lathyrus pratensis*, etc., are found there in abundance. Mowing is limited to the flattest areas (Photo 3), the others being mainly used for cattle or horse grazing (*Cynosurion cristati*) with resting areas that are sometimes very eutrophic (*Rumicion alpini*), where *Rumex alpinus*, *Veratrum album*, *Chenopodium bonus-henricus*, *Dactylis glomerata*, etc., predominate.

Photo 2 - *Tractema lilio-hyacinthus* in the Atlantic beech forest (*Adoxo-Fagetum = Fagetum sylvaticae* Luquet 1926), Chaudefour valley.

Photo 3 - Hay meadows downstream of the Chaudefour valley: *Agrostietum capillaris* Luquet 1926 (*Violo luteae-Trisetetum flavescentis*, *Triseto-Polygonion*).

Grazed woodlands with *Salix caprea*, *Betula pubescens*, *Sorbus aucuparia*, and *Corylus avellana* were established, preparing the way for the arrival of the neutrophilous beech forest (*Adoxo moschatellinae-Fagetum sylvaticae = Fagetum sylvaticae* Luquet 1926, *Fagion sylvaticae* Luquet 1926), which constitutes the series head, on deep, well-mineralized mull andosol. There is a group of neutromesophilous species, including *Lilium martagon*, *Paris quadrifolia*, *Milium effusum*, and *Galium odoratum*, species of Atlantic distribution, such as *Euphorbia hyberna* and *Tractema lilio-hyacinthus*, vernal geophytes such as *Adoxa moschatellina*, as well as some tall mesotrophic grasses, including *Lactuca plumieri*, *Doronicum austriacum*, and *Senecio ovatus*.

On the steep valley slopes, mainly facing north, lies a subatlantic, mesomontane, meso-acidiphilous climatophilous holoseries that leads to beech forest dominated by *Luzula sylvatica* (H2). It mainly occupies the steep north-facing slopes on trachyandesitic lava.

A few dynamic stages of meadows and grasslands within this series are visible in the area visited: one can observe shrubby thickets of *Salix caprea*, *Betula pendula*, *B. pubescens*, *Sorbus* (*Betula pendulae-Salicetum capreae sorbetosum ariae*, *Sambuco-Salicion capreae*), and a few patches of montane heathland (*Galio saxatilis-Vaccinietum myrtilli*, *Diantho hyssopifolii-Vaccinion myrtilli*), tall grasses of clearings or windthrow areas (*Lactuco plumieri-Epilobietum angustifolii* or *Senecioni fuchsii-Digitalietum purpureae*, *Epilobion angustifolii*) and shaded edges of *Melampyro sylvatici-Poion chaixii*, mesophilous (*Prenantho purpurae-Avenelletum flexuosae*), or on weter soils (*Agrostio capillaris-Lactucetum plumieri*). A similar series was described in detail in the Chaîne des puys by Roux (2017).

We especially observe the predominance of the series head, the *Luzula sylvatica* beech forest (*Luzulo sylvaticae-Fagetum*, *Fagion sylvaticae* Luquet 1926). It is a forest which is dominated by acidiphilous species, *Vaccinium myrtillus*, *Avenella flexuosa*, *Prenanthes purpurea*, *Luzula sylvatica*, and *L. nivea*, and includes a group of neutromesophilous species, *Galium odoratum* and *Phyteuma spicatum*, as well as mesotrophilous, such as *Poa chaixii*, *Senecio cacaliaster*, and *Festuca altissima*.

On sunny and convex slopes with drier soils, and more sporadically, a mesomontane, acidophilous, climatophilous holoseries is found, leading to a species-poor beech forest with *Solidago virgaurea* (H3). This series includes acidophilous montane heaths (*Galio saxatilis-Vaccinietum*, *Diantho hyssopifolii-Vaccinion myrtilli*) and grasslands (*Nardo-Agrostion tenuis*). *Avenella flexuosa*, *Vaccinium myrtillus*, *Teucrium scorodonia*, *Luzula nivea*, *L. sylvatica*, *Hieracium murorum*, *Melampyrum pratense*, and *Maianthemum bifolium* are abundant.

The beech forest (*Solidago virgaureae-Fagetum*, *Luzulo-Fagion*) constitutes the most represented community.

Above 1,400 m altitude, the uppermontane neutrophilous and chionophilous climatophilous holoseries of the beech forest with *Doronicum austriacum* (H4, Photos 4 and 5) is observed, forming a regular belt at the upper edge of the beech forest with several communities in dynamic contact.

The grazed grassland *Diantho pseudocollini-Scorzoneroidetum pyrenaicae* (*Nardo-Agrostion tenuis*, Photo 6) is a widespread community in the Auvergne mountains, acidiphilous, on oligotrophic soils, species-rich (>30 per 20 m²). It is maintained by extensive cattle grazing. It includes numerous species of the class *Nardetea*, including *Arnica montana*, *Galium saxatile*, *Gentiana lutea*, *Viola lutea* subsp. *lutea*, *Meum athamanticum*, and *Nardus stricta*, as well as a small group of subalpine species (*Nardion*), such as *Epikeros pyrenaeus*, *Potentilla aurea*, and *Scorzoneroides pyrenaica*.

The low cranberry heath *Allio victorialis-Vaccinietum myrtilli vaccinietosum uliginosi* (*Genisto pilosae-Vaccinion*) is acidiphilous,

Photo 4 and 5 - *Doronicum austriacum* and chionophilous uppermontane beech forest on the upper slope of Chaudefour (*Doronico austriaci-Fagetum*, *Aceri-Fagion*).

Photo 6 - In the foreground, pastures with *Nardus* (*Diantho pseudocollini-Scorzoneroidetum pyrenaicae*, *Nardo-Agrostion tenuis*) in series H4 in the uppermontane belt above the Sarrevielle wood.

typical of the upper edge of the beech forest, enriched in mesotrophic species such as *Stellaria holostea*, *Polygonatum verticillatum*, and *Calamagrostis arundinacea*. It is dominated by cranberries, *Vaccinium gaultherioides*, *V. uliginosum*, *V. myrtillus*, and includes *Calluna vulgaris* and *Genista pilosa*.

This series also includes a tall heath with “purging broom” (*Cytision oromediterranei*), which corresponds to dynamic stages after abandonment of grazing (*Silene vulgaris-Cytisetum purgantis*) or occupies either rocky, dry and warm sites, where it constitutes a permaseries (*Teucrio scorodoniae-Cytisetum purgantis*).

Shrubby thickets of *Betula pubescens*, *Sorbus aucuparia*, and *Aria edulis* occupy extensive areas between the uppermontane and lower subalpine belts. In the area visited, they form grazed woodlands where herds find shelter. *Calamagrostis arundinacea*, a thermophilous subalpine species, forms significant populations at forest edges (cf. *Doronico austriaci-Calamagrostietum arundinaceae*), in these undergrowth and clearings where it is sheltered from the wind. These shrub communities interact with the beech forest or form patches above the upper edge of the forest (*Pruno petraeae-Sorbus aucupariae*).

The series head is the beech forest *Doronico austriaci-Fagetum* (*Aceri-Fagion*, Photo 5). This plant community, with *Acer platanoides* instead of *A. pseudoplatanus*, is in its typical aspects with trunks and shoots bent by the snow. It is species-rich with a group of neutromesophilous forest species, *Paris quadrifolia*, *Lamium galeobdolon*, *Galium odoratum*, *Phyteuma spicatum*, acidiphilous, *Prenanthes purpurea*, *Luzula sylvatica*, *Poa chaixii*, a group of tall mesotrophilous and chionophilous subalpine herbs, *Ranunculus platanifolius*, *Doronicum austriacum*, *Imperatoria ostruthium*, *Adenostyles alliariae*, *Lactuca plumieri*, *Allium victorialis*, and also has an Atlantic character with *Tractema lilio-hyacinthus* and *Euphorbia hyberna*.

It appears that the current altitudinal range of this series is shifting due to climate change. The active expansion of *Betula* and *Sorbus* shrubby thickets is noteworthy.

Several tall-herb permaseries can be observed in the visited area.

Along the streams on the forested slope of Sarrevielle, in the mesomontane belt, we observe an edaphohygrophilous permaseries of sylvatic tall forbs, (*Crepido paludosae-Adenostyletum alliariae*, *Adenostylion alliariae*) (P1). It includes a group of sciophilous species *Lamium galeobdolon*, *Chrysosplenium alternifolium*, *Epilobium montanum*, a group of rheophilous species, *Chaerophyllum hirsutum*, *Ranunculus aconitifolius*, *Geum rivale*, *Chrysosplenium oppositifolium*, and tall herbs descended from the subalpine belt, *Lactuca alpina*, *Rumex arifolius*, *R. alpinus*, *Adenostyles alliariae*. This tall forb riparian community of the montane belt exists throughout the north of the Massif central where it replaces the southern *Arabidopsio cebennensis-Adenostyletum* Braun-Blanq. 1950.

An edapho-aerohygrophilous permaseries of tall-forb forest, non-riparian, on eutrophic soils, the *Doronico austriaci-Campanuletum latifoliae* (*Adenostylion alliariae*) (P2), exists in a few rare locations (Chaudefour only), notably near the Pérouse waterfall. This community is primarily known in the Cantal mountains where it also occupies bottoms of glacial valleys.

The climatophilous thermomesophilous, on mesotrophic soils, subalpine tall-herb meadow *Calamagrostietum arundinaceae* Luquet 1926 (*Calamagrostion arundinaceae*) (P3, Photo 7) constitutes subalpine enclaves in the uppermontane belt, benefiting from snowy, sheltered climates. It occupies steep east-facing slopes, sheltered from the prevailing winds, where snow accumulates and supplies the soil with water in spring. It is very species-rich community with *Cirsium erisithales* (Photo 8), *Laserpitium latifolium*, *Crepis conyzifolia*, *Campanula scheuchzeri*, *Lactuca plumieri*, *Patzkea paniculata*, *Rosa spinosissima*, *Gentiana lutea*, and *Serratula tinctoria* subsp. *macrocephala*. This is an impoverished grouping compared to the *Calamagrostis* communities located and widespread higher up in the subalpine belt, where we also find *Bupleurum longifolium*, *Cyanus montanus*, *Allium victorialis*, *Pedicularis foliosa*, *Chaerophyllum villarsii*, *Vicia orobus* (Photo 9) and *Sorbus chamaemespilus*.

Photo 7 - Enclave of subalpine vegetation on the upper slopes of Chaudefour valley, upstream from the Sarrevielle woods: *Calamagrostietum arundinaceae* Luquet 1926.

Photo 8 - *Cirsium erisithales*.

Photo 9 - *Vicia orobus*, Atlantic-montane common species in *Calamagrostietum arundinaceae* Luquet 1926.

Pavin lake (group 1, afternoon)

The first group will hike around lake Pavin (2.5 km), ascend to the viewpoint (70 m elevation gain). We will then make our way across the *Nardus* mountain pastures located above, heading to the small, natural Estivadoux lake, which is subject to temporary flooding (Fig. 7).

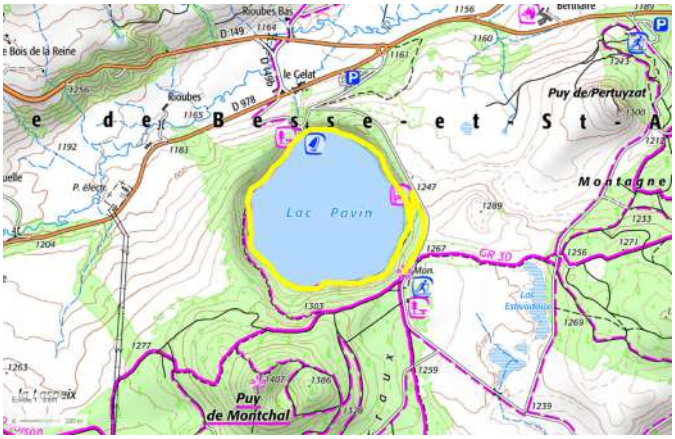


Figure 7 - Itinerary of group 1 around lake Pavin. Map source: IGN.

Pavin lake (Photo 10) lies in a maar crater created due to phreatomagmatic explosions. It is an oligotrophic lake with a depth of 91.8 m and a surface area of 0.44 km². It is overlooked by the puy de Montchal at 1,407 m, a Strombolian cinder cone. The age of this volcanism, estimated between 6,700 and 3,450 BP, makes it the youngest in the Auvergne region. The emerged slopes of the Pavin crater are covered with pyroclastic rocks ejected from the maar. It is surrounded by trachyandesite lava (Renault *et al*., 2009).

Photo 10 - Pavin lake with the snow-capped Dore mountains in the background.

Due to its great depth, Pavin lake is a meromictic lake, whose waters from a depth of 60 m are not mixed and are therefore anoxic and rich in toxic gases (CH4, H2S and CO2).

Vegetation series and plant communities visited:

The lake's flora is very poor, due to its great depth and steep banks. The aquatic flora includes two oligotrophic freshwater pondweeds: *Potamogeton alpinus* and *P. praelongus*; the latter species, found in the Jura and the Alps, is very rare in France and is specific to deep waters.

The crater slopes are entirely forested, covered by a beech forest (Photo 11) or a beech-fir forest, an ancient part of which already existed at the beginning of the 19th century on the slopes exposed to the north, as shown in Delécluze's drawing of 1821 (Fig. 8). The majority of these forests are meso-acidophilous and fall within the holoseries of *Luzulo sylvaticae-Fagetum* (H2). They include an inner shaded fringe belonging to mesophilic *Melampyro sylvatici-Poion chaixii* (*Prenantho purpureae-Avenelletum flexuosae*).

Photo 11 -Beech forest with *Luzula sylvatica* on the slopes of Pavin Lake (*Luzulo-Fagetum*).

Figure 7 - Drawing of Pavin lake by Étienne-Jean Delécluze (1821, MARQ Art Museum). Only half of the slopes were wooded at that time, unlike in 2026 when they were all wooded.

There is also a more neutrophilous holoseries (H5), reflecting an Atlantic influence, particularly well expressed south of the lake on the steep north-facing slopes which includes as a head series the beech forest with *Euphorbia hyberna* (*Euphorbio hybernae-Fagetum*, *Fagion*, *Eu-Fagenion*) (Photo 12): it shelters *Cardamine heptaphylla*, *Actaea spicata*, *Festuca altissima*, *Lilium martagon*, and *Galium odoratum*, while the acidophilous species disappear. The ravines of this sector shelter a cold shrub group from the uppermontane belt, coming from avalanche flows from the northern slope of the puy de Montchal, with *Ribes petraeum*, *Lonicera nigra*, *Sambucus racemosa*, *Sorbus aucuparia*, *Aria edulis*, and *Rosa pendulina* (*Sorbo aucupariae-Loniceretum nigrae*, *Pruno petraeae-Sorbion*).

Photo 12 - *Euphorbia hyberna*.

On this wetter slope, around small rivulets, we can see *Chrysosplenium oppositifolium*, *C. alternifolium*, *Cardamine amara*, *Impatiens noli-tangere* (cf. *Cardamino amarae-Chrysosplenietum alternifolii*, *Caricion remotae*) as well as tall grass (*Saxifrago rotundifolii-Petasitetum albi*, *Arunco-Petasition*).

Higher on the plateau, around 1,270 m, we find large areas of *Nardus* grassland, rich in species, mesomontane, in the context of extensive cattle grazing (*Diantho pseudocollini-Scorzoneroidetum pyrenaicae galietosum veri*, *Nardo-Agrostion tenuis*) (Photo 13). There are abundant species of *Nardetea*, *Festuca nigrescens*, *Arnica montana*, *Nardus stricta*, *Meum athamanticum*, *Hyperichum maculatum*, *Rhinanthus minor*, *Gentiana lutea*, *Scorzoneroides pyrenaica*, *Viola lutea* subsp. *lutea*, as well as *Platanthera chlorantha* (Photo 14), *Narcissus poeticus*, and *Dianthus seguieri* subsp. *pseudocollinus* (Photo 15). A more thermophilous group with *Genista sagittalis*, *G. tinctoria* subsp. *delarbrei* (Photo 16), *Galium verum*, and *Jacobea adonidifolia* completes this flora.

These pastures coexist with hay meadows (*Violo luteae-Trisetetum = Agrostietum capillaris* Luquet 1926, *Triseto-Polygonion*) with more mesotrophic species, *Trisetum flavescens*, *Dactylis glomerata*, *Geranium sylvaticum*, *Festuca nigrescens*, *Achillea millefolium*, *Narcissus poeticus*, *Phyteuma spicatum*, *Lotus corniculatus*, *Ranunculus acris*, and *Poa chaixii*.

All sorts of intermediate forms exist between these communities, depending on pastoral practices. In the case of liquid manure spreading, one also find particularly eutrophic and species-poor meadows, dominated by *Dactylis glomerata*, *Rumex longifolius*, *Taraxacum officinale*, etc. These highly productive meadows increase forage quantities, but are not very favorable to biodiversity, and unfortunately, are compatible with the protected geographical designation (IGP) of Saint-Nectaire cheese.

Photo 13 - *Nardetea* pastures around Pavin lake in the territory of the protected geographical designation of origin of Saint-Nectaire cheese.

Photos 14, 15 and 16 - *Platanthera chlorantha*, *Dianthus seguieri* subsp. *pseudocollinus* (P.Fourn.) Jauzein, *Genista tinctoria* subsp. *delarbrei* (Lecoq et Lamotte) Nyman, species of *Diantho-Scorzoneroidetum pyrenaicae*, the latter two endemic to the Massif central.

Capucin – vallée des Bains (group 2, afternoon)

The participants in group 2 will follow the route from the Salon du Capucin on the basalt plateau to the northeast slope of the Capucin (round trip distance 1.5 km, Fig. 9, Photo 17). Not far from the starting point, there is an old funicular built nearly 130 years ago, which was used to transport walkers from the town of Mont-Dore. The vallée des Bains is the largest and longest valley in the Dore mountains. It has numerous mineral springs captured in thermal establishments. Upstream, it ends in a very large glacial cirque overlooked by the highest peak of the Massif central, the puy de Sancy, which rises to 1,885 m (Photo 18). Downstream, after the town of Mont-Dore, the valley curves westward to La Bourboule, thus fully exposed to oceanic influences.

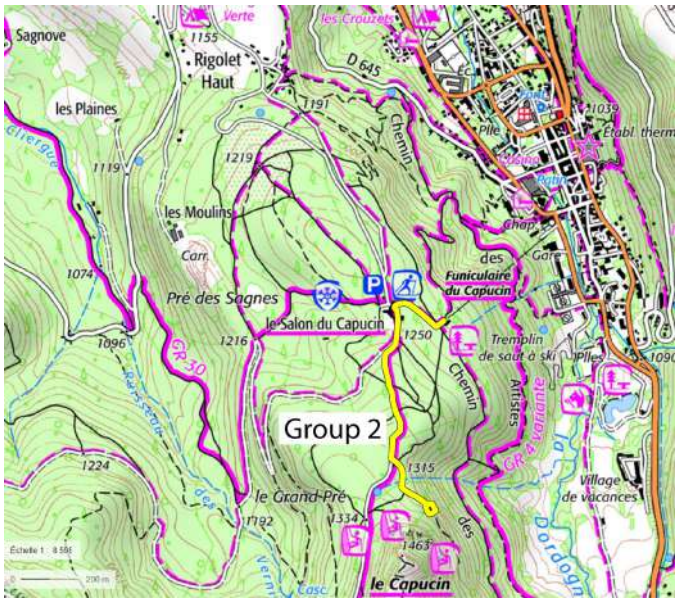


Figure 9 - Itinerary for group 2 north of the Capucin above the town of Mont-Dore. Map source IGN.

Photo 17 - Capucin summit in the Vallée des Bains at 1,463 m.

The peaks surrounding the valley are composed of various types of trachyandesite, a hard volcanic rock that accentuates their distinctive appearance. Volcanic-sedimentary deposits and a variety of pyroclastic rocks cover the slopes, often interspersed with intercalated lava. Rare outcrops of basaltic lava are also found, such as at the Capucin lounge.

Photo 18 - Sancy summit in the Vallée des Bains at 1,886 m.

The summit of Capucin at 1,463 m (Photo 17), which overlooks the town of Mont-Dore, takes its name from its hood-like shape, similar to those worn by the friars of the mendicant orders. It is a trachyandesite rock with a covering of welded tuffs on its northern slope below.

Located furthest north, the vallée des Bains is also the coldest. *Abies alba*, a native species, is particularly abundant here, unlike in the other, more eastern or southern valleys of the Dore Massif, which also receive less rainfall. These fir forests, always mixed with beech, are not recent; they were already well established at the beginning of the 19th century, as evidenced by the drawing of the Vallée des Bains made by Delécluze in 1821. (Fig. 10).

Vegetation series and plant communities visited:

The vegetation observed during the excursion will be exclusively fir forests and their edges, in the mid-montane zone, corresponding to the "*Abietetum albae*" of Luquet and placed in the *Piceion excelsae* sensu Luquet 1926. Our visit will be located in a place close to a site of one of the 9 relevés of the table of Luquet.

Figure 10 - The vallée des Bains and the old spa village of Mont-Dore in 1821, drawing by Étienne-Jean Delécluze (1821, MARQ art museum).

The first forest visited is at the Salon du Capucin. This forest is managed as an uneven-age forest-selection stand of *Abies alba* (Photo 19). This type of silviculture promotes the natural regeneration of the fir, a shade-loving species, as saplings can germinate and develop in the shade of the larger trees. It avoids clear-cutting and gives the stand a structure where all age classes are represented. *Fagus sylvatica* is present and consistent in this type of forest.

Photo 19 - Acidiphilous fir forest from the Salon du Capucin (*Solidago virgaureae-Fagetum*, sylvofacies to *Abies alba* = *Abietetum albae* Luquet 1926, *Luzulo-Fagion*).

Acidophilous species are abundant and dominant in the herbaceous layer, including *Dryopteris dilatata*, *Luzula sylvatica*, *L. nivea* (Photo 20), *Vaccinium myrtillus*, *Prenanthes purpurea*, and *Avenella flexuosa*. The flora includes a few rare mesotrophic species: *Festuca altissima* and *Senecio cacaliaster*; neutromesophilous species are also rare, with only *Stellaria nemorum*.

The moss layer is abundant, which is characteristic of the structure of these evergreen coniferous forests. It is dominated by *Rhytidiadelphus loreus*.

This plant community has not any notable qualitative floristic differences with the acidophilous beech forest observed in the region, under the name *Solidago virgaureae-Fagetum* (*Luzulo-Fagion*), in which it can be classified as well as in the mesomontane acidophilous climatophilous holoseries H3b.

Along the path, we can observe shaded mesophilous *shaded* edges (cf. *Agrostio capillaris-Lactucetum plumieri*, *Melampyro-Poion chaixii*) with *Euphorbia hyberna*, an Atlantic species, reflecting significant atmospheric humidity.

Photo 20 - *Luzula nivea*, an acidiphilous species from the mountains of southern Europe.

A second fir forest is observed at the end of the via ferrata, on a steep northern slope (Photo 21): it is a fir-beech species-rich forest with *Acer platanoides* and a group of neutromesophilous species, including *Festuca altissima*, *Lamium galeobdolon*, *Galium odoratum*, *Paris quadrifolia*, *Milium effusum*, *Tractema lilio-hyacinthus*, nitrophilous species, *Impatiens noli-tangere*, *Geranium robertianum*, *Galeopsis tetrahit*, mesotrophilous species of higher altitude, *Polygonatum verticillatum*, *Lactuca alpina*, *Adenostyles alliariae*, *Ribes petreum*. Acidophilous species are present but not abundant: *Prenanthes purpurea*, *Dryopteris dilatata*, *D. carthusiana*, *Oxalis acetosella*. Bryophytes include *Plagiomnium affine*, *Plagiochila asplenioides*, and *Plagiomnium undulatum*, moderately acidophilous mosses.

This type of Abies forest shows very few floristic differences from the neutral Atlantic beech forests in the Chaudefour valley, *Adoxo moschatellinae-Fagetum* (*Eu-Fagenion*) and belongs to the Atlantic climatophilous mesomontane holoseries H1b.

Photo 21 - Neutrophilous Atlantic beech-fir forest on the north-facing slope below the Capucin (*Adoxo-Fagetum*, *Eu-Fagenion*).

We observe in thinnings and internal clearings fringe vegetation with *Calamagrostis arundinacea* belonging to *Knaution dipsacifoliae* (cf *Doronico austriaci-Calamagrostietum*).

In the intra-forest embankments and ditches of the more humid sectors, exposed to the north, a wet fringe develops, dominated by montane and aerohygrophilous species (Photos 22 and 23) of the tall-forb plant community *Saxifrago rotundifolii-Petasitetum albi* (*Arunco dioici-Petasition albi*).

Syntaxonomic and nomenclatural discussion:

In these fir forests observed at Capucin, only a few species are noted as characteristic of coniferous forests, such as *Abies alba*, *Dryopteris dilatata*, *Festuca altissima*, *Struthiopteris spicant*, *Rhytidiadelphus loreus*, and they are not exclusive to this, also being found under beech forests.

However, more specialized species from the class *Vaccinio-Piceetea* or the order *Piceetalia* are absent or rare in the forests of the Dore mountains, such as *Listera cordata*, *Orthilia secunda*, *Moneses uniflora*, *Vaccinium vitis-idaea*, *Lycopodium annotinum*, *Huperzia selago*, *Luzula luzuloides*, and, among the mosses, *Plagiothecium undulatum*, *Bazzania trilobata*, *Sphagnum quinquefarium*, and *S. capillifolium*.

In some relevés, Luquet had found the first two, but this characteristic assemblage is quite small, and we are here outside the natural range of *Picea abies*, a non-native species in the Massif central, as well as in a fully oceanic climate. So it seems inappropriate, according to the criteria that prevail today, to link these fir forests to the more eastern class *Vaccinio-Piceetea* and order *Piceion*. But they should rather be classified in the *Carpino-Fagetea*.

In the Forez mountains, east of the Massif central, the characteristic species are more numerous, the Atlantic influence is less pronounced, and several fir stands attributed to these class and order have been described (Thébaud *et al*. 2014).

From a nomenclatural point of view as shown by Thébaud and Bernard (2018) the *Piceion excelsae* Luquet 1926 is validly published and has priority over the *Piceion excelsae* Pawł, Sokołowski et Wallisch 1928 that consequently is an illegitime name (Art. 31 de l'ICPN). However, this latter name has been used much more in literature unlike the first. For this reason, Roux *et al*. (2026) propose the name *Piceion abietis* Pawł., Sokołowski et Wallisch 1928 as a conserved name and the name *Piceion abietis* Luquet 1926 as a rejected name (Art. 52).

Photo 22 and 23 - Two aerohygrophilous species present in the Capucin site: *Papaver cambricum*, an Atlantic montane species, and the lichen *Lobaria pulmonaria*.

The puy de Dôme (social dinner 10th September)

The participants of the 34th European Vegetation Survey conference will be invited to a social dinner at the summit of the puy de Dôme (Photos 24 and 25) and will be able to observe the landscapes and vegetation of the puy de Dôme and the entire Chaîne des puys by going up on the panoramic train and more especially the summit vegetation by moving freely around the top of the puy de Dôme.

Photos 24 and 25 - The puy de Dôme, summit of the "Chaîne des puys", 1,465 m (photo by Joël Damase).

The puy de Dôme is a recent volcano, formed 11,000 years ago, the highest in the Chaîne des puys, reaching an altitude of 1,465 m and rising more than 500 m above the plateau below. It is a Pelean-type volcano, characterized by a violent eruption that built a cumulo-dome, a flat-topped peak, resulting from eruptions of viscous, silica-rich trachyte lava. This type of volcanism led to the ejection of acidic trachytic material, ash, and lapilli over long distances. Its slopes, composed of scree and ejected material, reveal trachytic rocks and ridges in situ to the west and north.

Vegetation series and plant communities:

The vegetation of the puy de Dôme varies according to an altitudinal gradient. Over a short distance, several belts overlap, transitioning from submontane to subalpine. The summit vegetation forms an isolated subalpine island, the only one of its kind in the Chaîne des puys, beginning at an unusually low altitude of approximately 1,300 m. This is due to its isolated location, lacking the protection of any other mountain, and its generally convex shape, making it exposed to all winds. These winds sweep across most of its slopes. Only the eastern slope is somewhat sheltered from the prevailing westerly winds. The puy de Dôme is thus fully subjected to the influence of the oceanic climate.

According to Roux (2017), several series of vegetation develop from bottom to top on the puy de Dôme, according to an altitudinal gradient and exposure (Fig. 11).

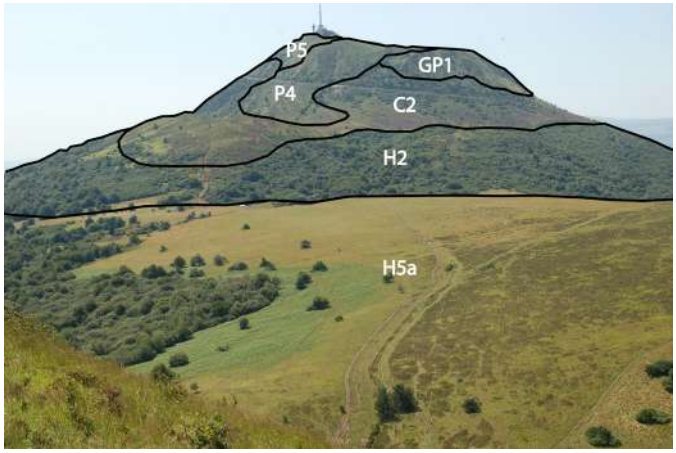


Figure 11 - Vegetation series on the north slope of puy de Dôme. **GP1**: geopermaseries of trachytic rocks. **P4**: cryophilic subalpine permaseries (*Allio-Vaccinietum uliginosi*). **P5**: shelter permaseries (*Heracleo-Calamagrostietum*). **C2**: Ubac curtaseries with *Sorbus* and *Salix*. **H2**: climatophilous meso-acidiphilous holoseries of the beech forest with *Luzula sylvatica* on trachytic rocks. **H5a**: climatophilous neutrophilous holoseries of the beech forest with *Euphorbia hyberna* on basaltic or trachy-andesitic rocks.

On the basaltic plateau below, between 860 and 1,080 m, we find the submontane, neutrophilous, climatophilous holoseries of the beech forest with *Euphorbia hyberna* and *Corylus avellana* (*Euphorbio hybernae-Fagetum coryletosum avellanae*, *Eu-Fagenion*) (H5b). This series is located on recent lava flows, characterized by an irregular cover, formed of holes and bumps, called "cheires". It includes a grazed grassland, *Ranunculo bulbosi-Brachypodietum pinnati* (*Bromion erecti*), which, after abundance, is invaded by *Pteridium aquilinum* (*Holco-Pteridetum*, *Epilobion angustifolii*), then by a willow-birch grove with *Aria edulis* (*Betulo pendulae-Salicetum capreae sorbetosum*, *Sambuco-Salicion*), and then by hazel stands with *Daphne mezereum* (*Daphno-Coryletum typicum*, *Astrantio-Corylion*).

On the lower trachytic slopes of the puy de Dôme, up to approximately 1,260 m, we find the climatophilous, meso-acidophilous montane holoseries (H2) of the beech forest with *Luzula sylvatica* (*Luzula sylvaticae-Fagetum*, *Fagion sylvaticae*). Most of this area is covered by forest, except for some coniferous plantations and a few patches of pastures. It is differentiated into a typical sub-series with the heathland *Galio saxatilis-Vaccinietum typicum* (*Diantho-Vaccinion*) and a south-facing sub-series with the grassland of *Brachypodio-Dianthetum monspessulani typicum* (*Bromion erecti*), followed by the *Corylus* scrub (*Daphno mezerei-Coryletum typicum*, *Astrantio-Corylion*) (Photo 26).

Photo 26 - Community with *Corylus avellana* and *Daphne mezereum* in the Chaîne des puys (*Daphno-Coryletum*, *Astrantio-Corylion*).

This *Corylus* community forms a dense thicket, very widespread throughout the Chaîne des puys. It can be very stable and very species-rich, combining several groups: vernal, neutromesophilous beech forest species, hemiheliophilous forest edge species, species from herbaceous communities, etc. It is well differentiated by *Daphne mezereum* (Photo 27), and we find more Atlantic species, such as *Euphorbia hyberna* and *Vicia orobus* (Photo 28). The flora is differentiated with more thermophilous species on sunny slopes, such as *Geranium sanguineum*, *Brachypodium rupestre*, *Cotoneaster integerrima*, *Laserpitium latifolium*, and *Dianthus hyssopifolius*.

Photos 27 and 28 - *Daphne mezereum and Vicia orobus.*

Higher up the slopes, we see the widespread presence of shrublands, representing a subalpine, chionophilous climatophilous curtaseries dominated by *Sorbus* and *Salix caprea* (C2). This variety exhibits north-facing variant up to 1,320 m and a south-facing variant up to 1,400 m. At this altitude, the wind is a major constraint for the development of beech trees, which survive as separated gnarled individuals in sheltered positions. *Sorbus aucuparia*, *Aria edulis*, *Salix caprea*, and *S. x capreola* are the dominant shrubs that are spreading as scrub and hedge, *Stellario-Rubetum idaei* (*Epilobion angustifolii*) on north-facing slopes or *Cirsio erisithales-Teucrietum* (*Knaution dipsacifoliae*) on south-facing ones.

Non-forest vegetation extends across the summit and highest slopes of the puy de Dôme, corresponding to several permaseries according to the geomorphology and exposure.

The summit subalpine climatophilous permaseries of the *Allium victorialis* and *Vaccinium uliginosum* heath (*Allio victorialis-Vaccinietum uliginosi vaccinietosum uliginosi*, *Genisto pilosae-Vaccinion*) (P4) is found on the summit and part of the highest northern slopes. Unfortunately, due to overuse, this heath has almost completely disappeared from the summit that now supports trampled, eroded, and/or nitrophilous replacement grasslands that are difficult to classify. The endemic *Alchemilla basaltica* (included in *A. transiens*) (Photo 29) is found there.

The subalpine, sheltered, chionophilous permaseries of the *Calamagrostis arundinacea* and *Heracleum sphondylium* tall-herb vegetation (*Heracleo sphondylii-Calamagrostietum*, *Calamagrostion arundinaceae*) (P5) is confined to sheltered eastern slopes or well-exposed gullies between trachytic ridges. *Cirsium erisithales*, *Lilium martagon*, *Lactuca plumieri*, *Aconitum lycoctonum*, and *Cyanus montanus* are found there.

Photo 29 - *Alchemilla basaltica* Buser, an endemic species of the Massif central.

The subalpine geopermaseries of high trachytic rocky slopes (GP1) brings together specialized communities which coexist in the ridges and rocky corridors below the summit (Photos 30 and 31): in particular, xerophilous and cryophilous heath of the convex land forms (*Alchemillo saxatilis-Vaccinietum uliginosi*, *Genisto pilosae-Vaccinion*), with cryophilous species such as *Alchemilla basaltica*, *Vaccinium gaultherioides*; *Calamagrostion* communities in snowier, more humid corridors (*Luzulo sylvaticae-Calamagrostietum*) or mesophilous types on deep soils (*Heracleo sphondylii-Calamagrostietum*), or drier types (community with *Libanotis pyrenaica* and *Calamagrostis arundinacea*).

Photos 30 and 31 - Alternating sheltered ravines with *Calamagrostis* tall-herb community (*Heracleo-Calamagrostietum*) and cold, windy trachytic rocky ridges covered by heathland (*Alchemillo saxatilis-Vaccinietum uliginosi*, *Genisto-Vaccinion*) in the GP1 geopermaseries of the summit of puy de Dôme.

The Cantal mountains (post-conference excursion 11th-13th September)

The post-conference excursion following the 34th European Vegetation Survey conference will take place from Friday, September 11th, to Sunday, September 13th, 2026.

On the morning of September 12th, participants will visit the Plomb du Cantal Chain. In the afternoon, they will go to the Saint-Antoine chapel in the Murat region and the town of Murat.

On September 13th, they will visit the Impradine cirque near puy Mary.

The first three sections provide general information on the sites visited and the routes. The fourth section presents a detailed characteristic of plant communities and associated flora in the supra-forest landscape.

A table of relevés published by J. Braun-Blanquet (1926) is presented on pages 33 and 34 (Tab. 1).

Chain of the Plomb du Cantal: 12th September (morning)

The Plomb du Cantal, reaching an altitude of 1,855 m, is the highest point of the massif. It forms a small basaltic outcrop, reduced to a volcanic chimney 80 m in diameter. This is the result of the most recent volcanic event in the Cantal region, which occurred approximately 3 million years ago.

To the north, the ridges from puy du Rocher to Aiguillon are composed of hard, acidic trachyandesites. On the slopes, layers of lava alternate with deposits of breccia (agglomerated blocks of rock resulting from pyroclastic flows). These breccias line the bottom of the valleys of the Gouyère stream, the destination of our route.

All the peaks except the ridges are covered with moraines from the Würmian glaciation of the Cantal massif, which ended more than 10,000 years ago. On the eastern slope of the ridge, two spectacular glacial cirques can be seen, including the Cirque de Chamalière to the north.

The chain of Plomb, located in the southeast of the Cantal mountains, enjoys a relatively sheltered climate compared to the other ranges of the Massif, especially that of puy Mary, which is colder and wetter (Loos 2024).

Participants will be taken by a cable car to the Plomb du Cantal mountain range. The group will follow the ridge trail on foot (6 km round trip, 250 m elevation gain, with rocky sections equipped with ladders), and return via the Plomb du Cantal cable car (Fig. 12). The non-forested peaks of the Plomb range drawn by Delécluze (1821) (Fig. 13), were not very different from those of today. Figures 14 and 15 show the landscape units that participants will encounter on the east and west slopes of the puy du Rocher, north of the chain of Plomb du Cantal. On these summits and their high slopes, we witness the maximum expression of the vegetation of the subalpine belt, between (1,450) 1,500 and 1,855 m.

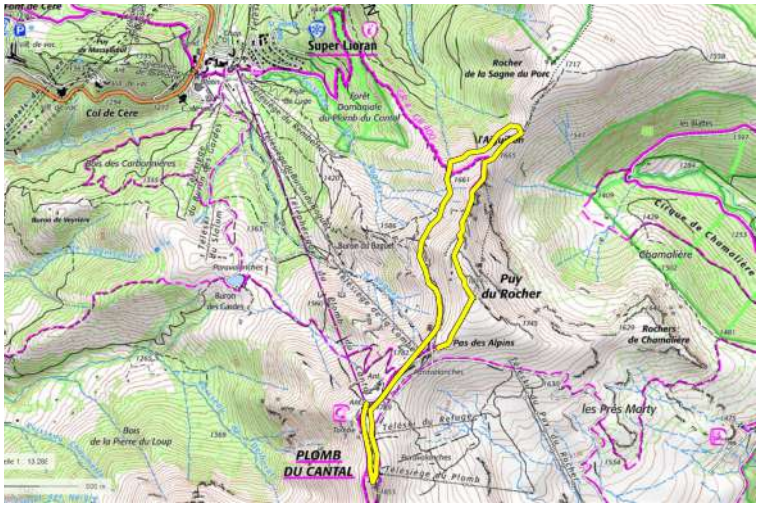
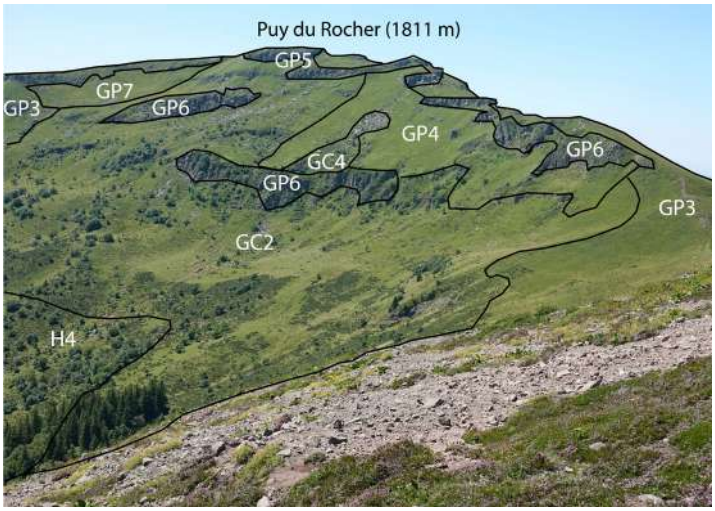
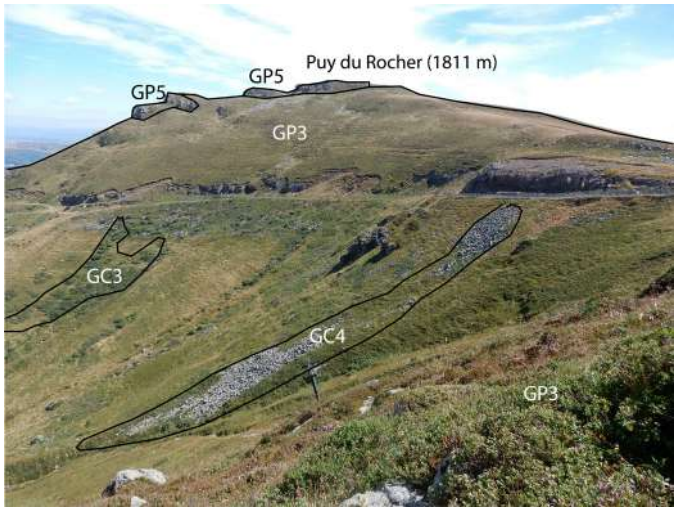


Figure 12 - Itineraries of the September 12 excursion to Plomb du Cantal and Aiguillon (*Nardion*, *Genisto-Vaccinion*, *Cardamino-Montion*, *Festucion variae*), map source: IGN.

Figure 13 - The Plomb du Cantal chain drawn in 1821 by Étienne-Jean Delècluze, (1821, MARQ Art Museum, City of Clermont-Ferrand). In the foreground, a "buron", summer pasture dwelling.





Figures 14 and 15 - Sketch of subalpine vegetation series north of the Plomb range. At the left, the eastern slope of the Chamalière cirque under puy du Rocher. At the right, the western slope of the puy du Rocher. **H4**: uppermontane climatophilous holoseries of the beech forest. **GP3**: climatophilous geopermaseries of cold summits and slopes. **GP4**: climatophilous geopermaseries of snow-covered shelter slopes. **GP5**: edaphoxerophilous geopermaseries of cold rocks. **GP6**: edaphoxerophilous geopermaseries of warm rocks. **GP7**: edaphochionophilous geopermaseries with a short growing season. **GC2**: climatophilous geocurtaseries of warm, dry slopes. **GC3**: peaty edaphohygrophilous geocurtaseries at the head of the valley. **GC4**: edaphoxerophilous geocurtaseries of scree slopes with large boulders.

We will be able to observe, south of the cable car, on the plateau located north of the Plomb du Cantal, the site of a relevé of the "association à *Genista pilosa* et *Calluna*" of Braun-Blanquet (= *Pulsatillo vernalis-Cytisetum decumbentis typicum*), short grassy heath, anemocryophilous and xerophilous of the upper subalpine belt (geopermaseries GP3).

Next, we will go to the summit of Plomb for a panoramic view of the Cantal mountains, the largest volcano in Europe. We will be able to observe a thermophilous, acidoneutrophilous grassland with *Festuca arvernensis* subsp. *costei* on basalt on the sunny side of the summit (cf. *Bupleuro ranunculoidis-Festucetum costei*), while the northern slope of Plomb is home to very cryophilous vegetation.

From Le Plomb, we will take the ridge path northwards, from where we can see numerous subalpine habitats surrounding puy du Rocher (1,811 m). The view will encompass the eastern slope with the Chamalière cirque and the western slope above the Lioran ski resort. Several subalpine geopermaseries can be observed, featuring vegetation of the *Genisto-Vaccinion*, *Calamagrostion*, *Galio-Patzkeion*, *Nardion*, *Festucion airoidis*, *Salicion herbaceae*, and *Dianthion gratianopolitani*. In particular, we will note the north-facing nivation niches (geopermaseries GP7) with the very rare pioneer and open community of *Plantagini alpinae-Agrostietum rupestris*, linked to a long duration and overabundance of snow.

Further north, south of the Aiguillon (1,665 m), we will have a view of the north of the Plomb chain and will be able to observe the diverse vegetation of the Chamalière cirque, with the thermoxerophilous open grassland *Leucanthemo delarbrei-Patzkeetum paniculatae*, type association of *Festucion variae* Braun-Blanq. 1926 (geopermaseries GP6).

To the northwest, we will visit the valleys of the small rivulets that give rise to the Gouyère stream, where the locus classicus of the *Nardion* Braun-Blanq. 1926 (geopermaserie GP7) is located, as well as the locus classicus of the "association à *Vaccinium uliginosum* et *V. myrtillus*" of Braun-Blanquet (*Vaccinietum myrtillo-uliginosi*), and the locus classicus of the "association à *Bryum schleicheri* et *Montia rivularis*" of Braun-Blanquet (*Montio fontanae-Bryetum schleicheri*). This area constitutes an extensive grazing range for one of the few sheep/goat flocks in the Cantal mountains, within the *Vaccinietum myrtillo-uliginosi* heath.

The return to Le Lioran will allow us to observe, by cable car, the landscapes of the western slope of the Plomb, from the upper subalpine geopermaseries to the lower subalpine ones (GC1), uppermontane ones (H4), and mesomontane forests of beech and fir trees. The Alagnon valley, north of Le Lioran, is one of the few valleys where *Abies alba* is dominant in the forest canopy.

Region of Murat: 12th September (afternoon)

The town of Murat is located east of the main ridge of the Cantal mountain, in the valley of the Alagnon River (Fig. 16). It lies within a basin bordered to the north and south by large basalt plateaus, known as "planèzes," which correspond to a more recent and peripheral phase of Cantal basaltic volcanism. Quaternary glaciations sculpted several valleys, the confluence of which is located upstream from the town. Among these, the Alagnon valley is the widest and most representative, particularly at the village of Laveissières, upstream from Murat, with its U-shaped relief, flat bottom, and significan drop in elevation. The basin is covered with moraines and fluvioglacial deposits.

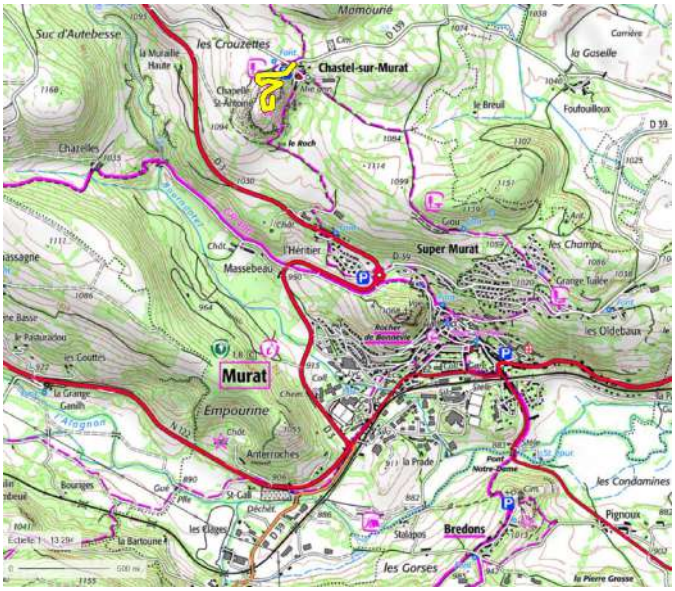


Figure 16 - Itineraries on the basaltic hill of the Saint-Antoine chapel northwest of Murat. Map source: IGN.

Several volcanic peaks overlook the town and its surroundings: Bonnevie rock, just above the old town; Bredons, to the south; and Saint-Antoine chapel rock, to the north (Fig. 17 and 18). These three outcrops of basanite, a very dark rock rich in olivine, correspond to volcanic necks or dikes originating from the same eruptive fissure, which occurred approximately 3 to 4 million years ago. Prismic cliffs can be observed at Bonnevie and Bredons.

Figure 17 - The town of Murat in its Cantal volcanic landscape setting. Drawing from 1821 by Étienne-Jean Delécluze, (1821, MARQ Art Museum).

Figure 18 - The town of Murat with the Bonnevie rock and basalt columns above. Drawing from 1821 by Étienne-Jean Delécluze, (1821, MARQ Art Museum).

Murat enjoys a sheltered climate, less subject to oceanic influences, significantly drier at the same altitude (400 mm less), and warmer than that of the western slope of the Cantal mountain.

This more continental climate explains the abundance of *Pinus sylvestris* on the eastern lawns (Pinatelle forest). There is also an upward trend of thermoxerophilic vegetation in the eastern part of Cantal, particularly at favorable exposures on the edges of valleys. This is the case of the vegetation that will be visited at the Saint-Antoine Chapel.

Vegetation series and plant communities visited:

At these two sites we will see the xerothermophilous vegetation on basaltic volcanic rock, very widespread in the region between Saint-Flour, Murat, Neussargues and Allanche. This is vegetation of the *Koelerio-Phleion* alliance at its upper altitudinal limit in this area. They are part of a larger complex on volcanic rock that includes the sheltering slopes of Cézallier and Dore mountains (Roux & Brocard 2023). They had been studied by Luquet (1937) as part of research along an altitudinal gradient from the plain of Limagne near Clermont-Ferrand.

The vegetation of these rocky areas in a sheltered climate can be described as two typical landscape units:

A submontane to montane edaphoxerophilous saxicolous geopermaseries (GP2) in which several mosaic plant communities can be distinguished.

Cliff chasmophytic vegetation with *Sempervivum tectorum* subsp. *arvernense* and *Saxifraga fragosoi* (*Sempervivo arvernensis-Saxifragetum continentalis*, *Asplenion septentrionalis*). In addition to the eponymous species, we find *Sedum dasyphyllum*, *Asplenium septentrionale*, *A. trichomanes*, and *Hylotelephium maximum*.

An open pioneer grassland dominated by perennial species, on lithosols of subhorizontal rock slabs and basaltic prism heads, with *Sempervivum arvernense* (Photo 32), *S. arachnoideum*, and *Festuca arvernensis* (*Sempervivo arvernensis-Festucetum arvernensis sempervivetosum arachnoidei*, *Sedo-Scleranthion*). *Sedum acre*, *S. album*, *Petrosedum rupestre*, *P. forsterianum*, *Allium*

sphaerocephalon, *Poa bulbosa*, *Scleranthus perennis*, *S. annuus*, and *Jasione montana* are also found here. In the surrounding area, these vegetation types also support *Gagea bohemica*.

Annual vegetation with a mixture of acidophilous and neutrophilous species is differentiated with *Ornithopus perpusillus*, *Teesdalia nudicaulis*, *Vulpia myuros*, *Myosotis stricta*, *Trifolium striatum*, *T. glomeratum*, *Alyssum alyssoides*, *Saxifraga tridactylites* (Photo 33), *Arenaria serpyllifolia*, *Petrorhagia prolifera*, *Teucrium botrys*, *Veronica verna* (cf. *Spergulo pentandrae-Veronicetum dillenii*, *Thero-Airion*).

Among the flora, we note *Sempervivum* x *pomeli* Lamotte, a hybrid between *S. tectorum* subsp. *arvernense* and *S. arachnoideum*.

A submontane to montane edaphoxerophilous curtaserie on rocky south-facing slopes (C3). On dry slopes with shallow soils and exposed rocks, a fairly widespread silicicolous grassland is present, dominated by *Festuca* gr. *ovina*, which was studied by Luquet (1937) in his work "Les colonies xérothermiques de l'Auvergne" and compared with those of the Limagne hillsides in the Clermont-Ferrand region.

Luquet highlighted a progressive decrease in Mediterranean and thermophilous species along an altitudinal gradient of nearly 900 m. He had differentiated the highest-altitude basalt grasslands under the name "Festuca ovina dry grassland group." Roux & Brocard (2023) showed that this community now corresponds to a more montane, original plant association with *Carlina acanthifolia* and *Phleum phleoides* (*Carlino acanthifoliae-Phleetum phleoidis*, *Koelerio-Phleion*, Photo 34).

The *Carlino-Phleetum* is dominated by *Festuca arvernensis*, *F. lemanii*, and the more frequent species are *Poterium verrucosum*, *Phleum phleoides*, *Potentilla verna*, *P. fagineicola*, *Scabiosa columbaria*, *Genista sagittalis*, *Eryngium campestre*, *Helianthemum nummularium*, *Trifolium incarnatum* var. *molinierii*, *Tordylium maximum*, *Lathyrus sphaericus*. Pioneer species such as *Scleranthus perennis*, *Sedum acre*, *Arabidopsis thaliana* also differentiate this lawn, including rather basiphilous annuals, such as *Alyssum alyssoides*, *Arenaria serpyllifolia*, and *Saxifraga tridactylites*. Rarer species can be found here, such as *Veronica scheererii* or *Cruciata pedemontana* (Photo 35), a thermophilic southern species with its only locality in Cantal here (Roux *et al.* 2022).

Thermophilic herbaceous fringes of *Oreoselinum nigrum* surround these lawns (cf. *Cervario rivini-Oreoselinetum nigri*, *Geranion sanguinei*), with *Hypericum perforatum*, *Vicia lutea*, *Brachypodium rupestre*, and the rare *Gasparrinia peucedanoides* present in the nearby region.

These grasslands and edges appear to be dynamic with a thicket of *Juniperus communis*, *Prunus spinosa*, and *Rosa* sp. (cf. *Juniperus communis-Amelanchieretum ovalis*, *Amelanchiero-Buxion*). *Rhamnus alpina*, a basiphilous species, rare for the Auvergne, can also be found there.

Photo 32 and 33 - Xerophilous saxicolous vegetation on basalt with *Sempervivum tectorum* subsp. *arvernense* (Lecoq & Lamotte) Rouy & E.G.Camus; *Saxifraga tridactylites*.

Photo 34 and 35 - Xeric grassland *Carlino acanthifoliae-Phleetum* on the basalt hill of the Saint-Antoine Chapel; *Cruciata pedemontana*.

The Impradine cirque and the Brèche de Rolland: 13th September (morning)

The slopes of the Impradine valley are covered in lahars, debris flows formed from volcanic pyroclastic rocks reworked by meltwater runoff. Upstream in the valley lies one of the most beautiful glacial cirques in the Massif central, facing northeast. Here, trachyandesitic ridges rise above stacks of scoriaceous potassic trachybasalt flows, forming the cirque's cliffs. Below, a scree slope forms the base, before the trachyandesitic rock reappears. The bottom of the cirque is scattered with erratic boulders. The cliffs alternate with deep, dark gullies, the widest of which is the Brèche de Rolland, a gash visible from afar that cuts the ridge.

The cirque is dominated by the puy Mary at 1,783m. This giant was originally a cumulo-dome of viscous lava, trachyte, built up more than 6 million years ago, which was subsequently reshaped by four glaciers during the Quaternary period, flowing into the adjacent valleys. To the east, the ridge extends to the puy de Peyre Arse at 1,806 m (Fig. 19). These areas are regularly grazed by a herd of "Salers" breed cows.

This site, given its pronounced relief, supports a great diversity of environments and vegetation types. We gradually move from the highland level to the lower subalpine level, then to the upper subalpine level, above 1,600 m. All these ecological landscape units are shown in figure 20.

The excursion will begin at the Eylac pass at around 1,440 m. We are here in the upper montane belt in the climatophilous holoseries H4, where oligotrophic, species-rich *Nardus* pastures (*Diantho pseudocollini-Scorzoneroidetum pyrenaicae*, *Nardo-Agrostion tenuis* Sillinger 1933) are very widespread. The locus classicus of the montane subassociation "*festucetosum rubrae*" of the *Nardetum* of Braun-Blanquet (1926), "created by grazing", is located not far from here, probably a little further north at 1,350 m altitude. The *typicum* sub-association, seen on September 12, is located in the chaine of Plomb du Cantal at the Gouyère ravine. The series head is the *Doronicum austriacum* beech forest (*Doronico austriaci-Fagetum*, *Aceri-Fagion*).

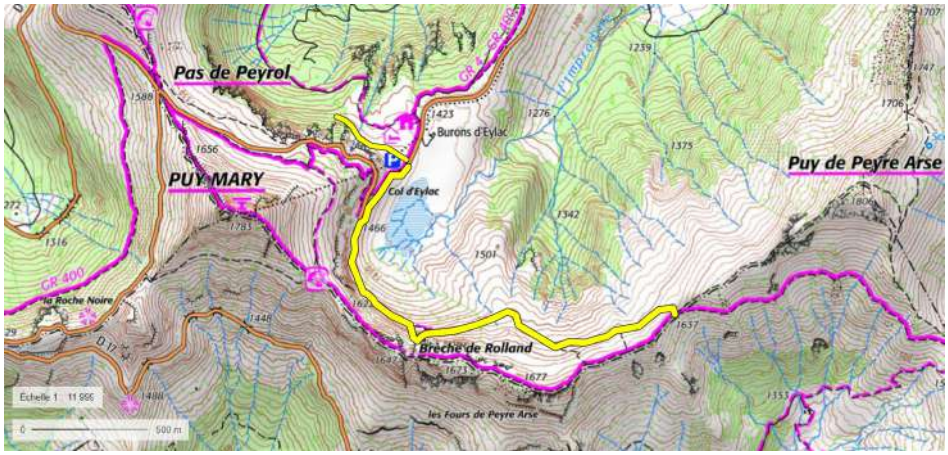


Figure 19 - Walking itinerary on September 13 in the upper Impradine valley and to the Brèche de Rolland. Map source: IGN.

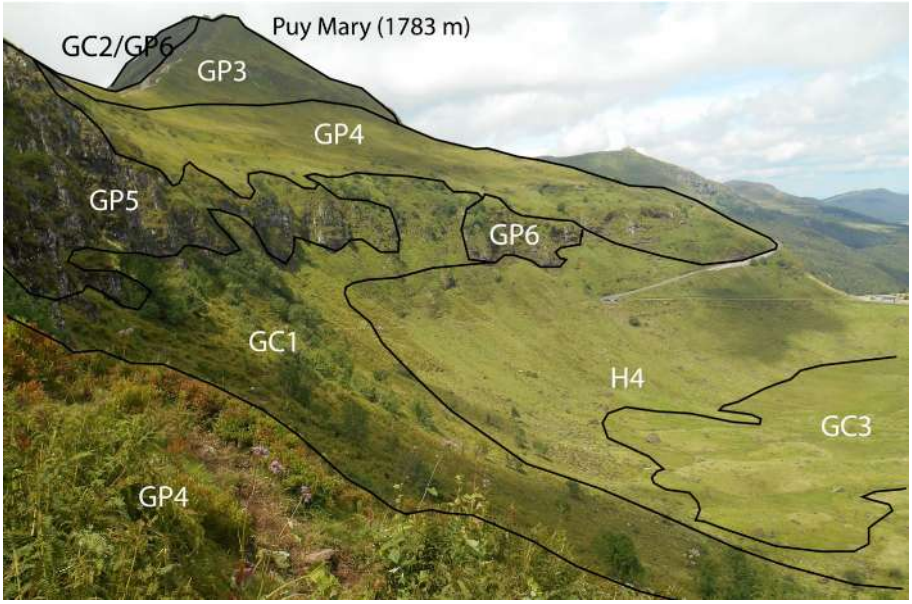


Figure 20 - Sketch of vegetation series and geoseries in the Impradine-puy Mary cirque. **H4**: Climatophilous holoseries of the beech forest *Doronico austriaci-Fagetum*; **GP3**, climatophilous geopermaseries on cold subalpine summits and slopes; **GP4**, climatophilous geopermaseries on sheltered subalpine slopes; **GP5**, subalpine edaphoxerophilous geopermaseries on cold, shaded rocks; **GP6**, subalpine edaphoxerophilous geopermaseries on warm, sunny rocks; **GC1**, climatophilous geocurtaseries of lower subalpine slopes and snowy timberline; **GC2**, subalpine climatophilic geocurtaseries on warm, dry south-facing slopes; **GC3**, edaphohygrophilic peaty geocurtaseries of the heads of valleys.

Participants will follow the mid-slope hiking trail to gradually reach the subalpine belt. Initially, the trail will cross shrubby edges which are the site of a late snowpack in the lower part of the subalpine zone (geocurtaseries GC1), with shrub communities of *Pruno petraeae-Sorbion aucupariae* and rich-species heaths (*Euphorbio hybernae-Vaccinietum myrtilli*) and fern communities.

Towards the Brèche de Rolland, participants will reach north-east-facing, snow-covered shelter slopes on deep soils characterizing the geopermaseries GP4, where we find a rich natural meadow (*Pediculario foliosae-Geranietum sylvatici*) and a tall-forb community (*Imperatorio ostruthii-Adenostyletum alliariae*). The latter takes full expression in the Brèche of Rolland, where the locus classicus of the *Adenostyletum alliariae* Braun-Blanquet 1926 and the *Adenostylion* Braun-Blanquet 1926 is located. It takes place on a steep slope and very humid soils with unstable blocks.

Near this site, participants will be able to observe the shaded and damp base of the cliffs, which represent accessible fragments of geopermaseries GP5.

Then they will reach the ridge where we can enjoy a panoramic view of the southwestern part of the Cantal mountains. This ridge is occupied by the heaths of *Genisto pilosae-Vaccinion*, mesophilous *Vaccinietum myrtillo-uliginosi* or xerophilous *Pulsatillo vernalis-Cytisetum decumbentis* on the cold slopes and summits of the upper subalpine belt (geopermaseries GP3).

On the drier and warmer slopes on the other side of the ridge, it will be possible to see the "association with *Festuca spadicea* and *Chrysanthemum delarbrei*", the type of the alliance of *Festucion variae* Braun-Blanquet 1926 (*Leucanthemo delarbrei-Patzkeetum paniculatae* Braun-Blanquet 1926, *Galio saxatilis-Patzkeion paniculatae*) whose locus classicus is found on the southern slope of puy Mary around 1,750 m. These xerophilous slopes correspond to the geopermaseries GP6.

On the return journey to the col d'Eylac, which follows the same pass, there will be a view of the flat bottom of the Impradine valley, covered in wetlands (geocurtaseries GC3). This wet ecological compartment shelters the locus classicus of the "*Caricetum fuscae*" and the *Caricion fuscae* of Braun-Blanquet (1926).

These landscape compartments are delineated in figure 20. Figure 21 shows the whole of the Cantal mountains.

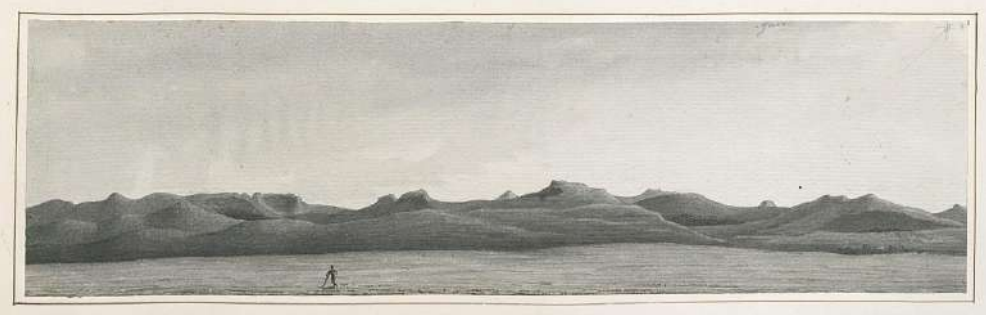


Figure 21 - The Cantal mountains seen from the northwest, with the puy Mary, roughly in the center, appearing as a small cone in the distance. Drawing from 1821 by Étienne-Jean Delécluze (1821, MARQ Art Museum).

Landscape units, plant communities, and flora of the supra-forest areas of the Cantal mountains

The summits of the Cantal mountains, transitioning from the upper montane to the upper subalpine belts, host a rich diversity of environments. They harbor numerous specialized, restricted, and contrasting plant communities due to the combination of different topographic conditions, varied volcanic soils, and a generally humid climate with an oceanic character. These communities are organized within vegetation complexes, linked by dynamic ecological and geomorphological characteristics that shape the landscape. The traditional and current use of these areas for cattle grazing, from late spring to early autumn, for five months of the year, is also an essential element of the Cantal landscapes.

We present below an outline of the landscape units of the summit areas of the Cantal mountains, with the plant communities and flora that characterize them. We will begin with the climatophilous units, linked to climate and altitudinal gradient, generally quite extensive, followed by the edaphophilous units, more specialized and covering smaller areas. Examples are given in sites of Cantal mountains of their distribution: north of the Plomb chain (Fig. 14), Impradine and puy Mary (Fig. 20).

Climatophilous holoseries of the beech forest *Doronico austriaci-Fagetum* in the snowy edges of the uppermontane belt (H4). Several communities make up this series.

Nardus grassland (*Diantho pseudocollini-Scorzoneroidetum pyrenaicae*, *Nardo-Agrostion tenuis*) is a mesoacidiphilous species-rich community on oligotrophic soil. It is linked to extensive cattle grazing.

Grassy *Vaccinium* heaths, belonging to the alliance of *Genisto pilosae-Vaccinion*: *Euphorbio hybernae-Vaccinietum myrtilli*, species-rich with subalpine optimum; *Allio victorialis-Vaccinietum myrtilli vaccinietosum*, altimontane and impoverished (Photo 36).

Photo 36 - *Allium victorialis*.

High heath with *Cytisus oromediterraneus*, "purging broom" (*Silene vulgaris-Cytisetum oromediterranei*, *Cytision oromediterranei*). In this zone, this community corresponds to dynamic stages on warm slopes after grazing has ceased (Photo 37).

Photo 37 - *Cytisus oromediterraneus* dominated community grazed by "Salers" cows in the uppermontane belt of Cantal.

Various herbaceous fringes, including the *Doronico austriaci-Calamagrostietum arundinaceae* (*Knaution dipsacifoliae*), which is a *Calamagrostis* meadow forming clearings in beech forests or in stages of forest recolonization.

Shrub groves with *Betula pubescens*, *Sorbus aucuparia*, *Aria edulis*, *Lonicera nigra* (*Sorbo aucupariae-Loniceretum nigrae*, *Pruno petraeae-Sorbion*). In the visited area, they mainly consist of open woodlands where herds graze and take shelter.

Timberline beech forest (*Doronico austriaci-Fagetum*, *Aceri-Fagion*). This community is present in its typical form with trunks and shoots of *Fagus*, *Acer*, or *Sorbus* bent by the snow, and herbaceous layer rich in tall herbs (Photo 38). It appears that the distribution range of this series is currently undergoing an altitudinal shift due to global warming, as evidenced by the active expansion of shrub thickets.

Photo 38 - Snow-twisted beeches in the *Doronico austriaci-Fagetum* at the Eylac pass, series head of the uppermontane belt climatophilous holoseries H4.

This landscape unit is characterized by numerous tree or shrub forest species, *Fagus sylvatica*, *Abies alba*, *Acer platanoides*, *Corylus avellana*, *Salix caprea*, *Lonicera nigra*, *Betula pubescens*, *Sorbus aucuparia*, *Aria edulis*, as well as, herbaceous species, such as *Phyteuma spicatum*, *Prenanthes purpurea*, *Luzula sylvatica*, *Euphorbia hyberna*, *Stellaria holostea*, *Teucrium scorodonia*, tall herbs *Allium victorialis*, *Polygonatum verticillatum*, *Epilobium angustifolium*, *Doronicum austriacum*, *Lactuca plumieri*, *Senecio cacaliaster*, *Senecio ovatus* subsp. *ovatus*, *Calamagrostis arundinacea*, and acidophilous species of lawns or heaths, including *Arnica montana*, *Galium saxatile*, *Poa chaixii*, *Vaccinium myrtillus*.

Climatophilous geocurtaseries of the shrub edge above the snowy timberline in the lower part of the subalpine belt (GC1). The upper forest edge offers a sheltered climate from prevailing winds and snow accumulation. It also supports shrub growth, particularly in wind-sheltered concave landforms. The deeper colluvial soils support the development of mesophilous communities with high species richness. It is difficult to clearly differentiate the communities of this geocurtaseries from some communities of the upper montane holoseries (H4) based on their floristic characteristics. Four permaseries and one curtaseries comprise its composition.

Calamagrostis arundinacea tall-herb community of the *Calamagrostion arundinaceae* alliance: *Luzulo sylvaticae-Calamagrostietum arundinaceae*, mesohygrosciophilous, at the bottom of slope, often north-facing; *Calamagrostietum arundinaceae* in warmer conditions.

Photo 39 - *Lonicera alpigena* in the timberline.

Photo 40 - *Rosa pendulina* (GC1).

Grassy heaths dominated by *Vaccinium myrtillus*, belonging to the *Genisto pilosae-Vaccinion* alliance: *Euphorbio hybernae-Vaccinietum myrtilli typicum*, species-rich, and *Allio victorialis-Vaccinietum myrtilli*. These heaths may be in a dynamic relationship with shrubby formations.

Shrubby formations and low woodlands dominated by *Sorbus aucuparia*, *Aria edulis*, and *Betula pubescens*, with occurrence of *Ribes petraeum*, *Sorbus chamaemespilus*, *Lonicera alpigena* (cf. *Roso pendulinae-Sorbetum chamaemespili*, *Pruno petraeae-Sorbion*). These formations have herbaceous layer dominated by tall herbs of *Mulgedio-Aconitetea*. They have been little studied in the Cantal mountain, unlike in the Dore mountains (Seytre 2008).

Various herbaceous fringes that were not studied.

This lanscape unit is characterized by numerous shrub species that are also present in meadows and heaths, including *Sorbus chamaemespilus*, *Lonicera alpigena* (Photo 39), *Rosa pendulina* (Photo 40), *Ribes petraeum*, *Prunus padus* and by subalpine tall forbs *Polygonatum verticillatum*, *Senecio cacaliaster* (Photo 41), *Doronicum austriacum*, *Ranunculus platanifolius*, *Chaerophyllum villarsii*, *Allium victorialis*, *Trollius europaeus*, *Rumex arifolius*, *Streptopus amplexifolius*, *Cirsium erisithales*, *Aconitum lycoctonum*, and *Knautia basaltica*.

Photo 41 - *Senecio cacaliaster*.

Climatophilous geocurtaseries of warm and dry south-facing slopes (GC2). These slopes can experience some summer drying. Several herbaceous or heathland communities are found here, forming two characteristic permaseries and one curtaseries.

Tall-grass meadow with *Betonica officinalis* and *Patzkea paniculata* (*Betonico officinalis-Patzkeetum paniculatae*, *Galio saxatilis-Patzkeion*). The floristic composition of this mesophilous/mesoxerophilous, species-rich southern community makes it intermediate with *Calamagrostion arundinaceae*. It falls into the South European order of *Festucetalia spadiceae* (Photo 42).

Bilberry dominated heath with *Patzkea paniculata* (*Patzkeo paniculatae-Vaccinietum myrtilli*, *Genisto pilosae-Vaccinion*). It comes into contact and dynamics with the previous community.

Cytisus oromediterraneus dominated formation from the lower subalpine belt (*Silene vulgaris-Cytisetum oromediterranei*, *Cytision oromediterranei*). It represents dynamic stages after pasture abandonment. Once settled and mature, it can be fairly stable or give way to *Vaccinium myrtillus* heath or *Nardus* grasslands and does not constitute climax groups as those on rocks.

This landscape unit is differentiated by thermoxerophilous orophytes such as *Patzkea paniculata*, *Cytisus oromediterraneus*, *Jacobea adonidifolia* (Photo 43), *Dianthus hyssopifolius*, *Serratula tinctoria* subsp. *monticola*, *Crepis conyzifolia*, *Senecio doronicum*, *Libanotis pyrenaica* subsp. *pyrenaica*, *Festuca arvernensis* subsp. *costei*, *Campanula scheuchzeri* subsp. *lanceolota*, *Genista tinctoria* subsp. *delarbrei*, *Leucanthemum delarbrei*, *Festuca microphylla*, *Thymus pulegioides* subsp. *chamaedrys* (= subsp. *similialpestris* Debray).

Photo 42 - *Betonico-Patzkeetum tall/grass community* (GC2).

Photo 43 - *Jacobea adonidifolia*

Climatophilous geopermaseries of heaths on the cold summits of the upper subalpine belt (GP3). It corresponds to the ridges, the summit plateaus, and the slopes surrounding them, subject to strong and cold winds, at altitudes above 1,600 m. It includes four permaseries.

Xerophytic *Calluna* dominated dwarf heath with *Pulsatilla vernalis* and *Cytisus decumbens* (*Pulsatillo vernalis-Cytisetum decumbentis typicum*, *Genisto pilosae-Vaccinion*). This fairly rich xerophytic heathland is especially well represented in the Plomb chain compared to other Cantal ridges (Photos 44 and 45).

Photo 44 - Dwarf cryoxerophilous heath *Pulsatillo vernalis-Cytisetum* (GP3).

Photo 45 - *Pulsatilla vernalis*.

Xerophytic *Calluna* heath with *Jasione laevis* (*Jasiono laevis-Callunetum vulgaris*, *Genisto pilosae-Vaccinion*). This dwarf heath is more common in the Dore mountains; in the Cantal region, it is well represented on acidic lava, phonolites or trachytes of the puy Griou and puy Mary.

Heath codominated by *Vaccinium myrtillus* and *V. gaultherioides* (*Vaccinietum myrtillo-uliginosi*, *Genisto pilosae-Vaccinion*). It comprises several subassociations depending on the exposure and is located around the summits on the higher, slightly snowier slopes.

Semi-cryptogamic dwarf heath, featuring *Empetrum nigrum* and *Huperzia selago* (*Racomitrio lanuginosi-Empetretum nigri huperzietosum selaginis*, *Genisto pilosae-Empetrion hermaphroditi*), grows on the north-facing slopes below the ridge. It is particularly exposed to northerly winds (Photo 46). Unlike the previous heathlands, it belongs to the alpine class *Loiseleurio-Vaccinietea*.

This landscape unit is rich in cryophilous species of alpine lawns (class *Juncetea trifidi*), *Phyteuma hemisphaericum*, *Agrostis rupestris*, *Luzula spicata*, *Avenula versicolor*, *Pedicularis comosa*, *Festuca airoides*, *Pulsatilla vernalis*, *Silene ciliata* (Photo 47), *Euphrasia minima*, and it also includes *Alchemilla saxatilis*, *Antennaria dioica*, *Solidago virgaurea* subsp. *alpestris*, *Huperzia selago*, *Gentiana verna*, *Sabulina verna*, and *Androsace halleri*.

Photo 46 - Cryosciophilous heath *Racomitrio lanuginosi-Empetretum* (GP3).

Photo 47 - *Silene ciliata*.

Climatophilous geopermaseries of sheltered, snow-covered slopes on deep soils (GP4). This landscape unit is common on steep eastern slopes, sheltered from the winds, in cirques and corridors between cliffs. Snow accumulates there and melts in the spring. The soils are mesotrophic or eutrophic, due to active mineralization. The following characteristic plant communities and permaseries are found there:

Briza media and *Agrostis capillaris* grassland (*Brizo mediae-Agrostietum capillaris*, *Nardo-Agrostion tenuis*). These are rich, mesoacidophilous and mesophilous, well-watered grasslands, associated with snowdrifts or diffuse runoff. They may be linked to grazing and have dynamic connections with subalpine *Vaccinium* heaths.

Tall-herb meadows with *Calamagrostis arundinacea* of the *Calamagrostion arundinaceae*: *Heracleo sphondylii-Calamagrostietum arundinaceae*, meso-eutrophic, in corridors or under cliffs (Photo 48) and *Calamagrostietum arundinaceae*, mesophilous and mesotrophic, on rock talus slopes.

Photo 48 - *Heracleo-Calamagrostietum* on shelter slope (GP4).

Heath of *Euphorbia hyberna*, *Vaccinium myrtillus* (*Euphorbio hybernae-Vaccinietum myrtilli*), already seen in the previous unit (GC2).

Tall herb community with *Pedicularis foliosa* and *Geranium sylvaticum* (*Pediculario foliosae-Geranietum sylvatici*, *Calamagrostion arundinaceae*), linked to long periods of snow cover and a warm microclimate, often found in small, sheltered cirques. It is rare in the Cantal, but more common in the Dore mountains.

Tall forb with *Imperatoria ostruthium* and *Adenostyles alliariae* (*Imperatorio ostruthii-Adenostyletum alliariae*, *Adenostylion alliariae*), the association originally described for the alliance of *Adenostylion* Braun-Blanq. 1926 (Photo 49).

This landscape unit is differentiated by small shrubs such as *Sorbus chamaemespilus*, *Rosa pendulina*, tall mesophilic and orophilous grasses and meadow species, *Adenostyles alliariae*, *Imperatoria ostruthium*, *Rumex arifolius*, *Epilobium trigonum*, *Pedicularis foliosa*, *Crepis lampsanoides*, *Cirsium erisithales*, *Allium*

victorialis, *Hieracium prenanthoides*, *Pimpinella major*, *Aconitum lycoctonum*, *Trollius europaeus*, *Chaerophyllum villarsii* (Photo 50), *Bupleurum longifolium* (Photo 51) *Geranium sylvaticum*, *Vicia orobus*, *Gentiana lutea*, *Alchemilla glabra*, *Anemone alpina* subsp. *apiifolia*.

Photo 49 - *Imperatorio-Adenostyletum* in Brèche de Rolland, *locus classicus* of *Adenostylion* (GP4).

Photo 50 - *Chaerophyllum villarsii*.

Photo 51 - *Bupleurum longifolium*.

Edaphohygrophilous upper montane to subalpine geocurtaseries of wetlands at the emergence of the hydrographic network (GC3). This unit corresponds to a mosaic of communities in topogenous and soligenous basins, springs, fens, and wet grasslands. The ombrogenous peat bogs are reduced there due to prolonged snow cover. It comprises four permaseries and one curtaseries.

Spring moss-rich community (*Montio fontanae-Bryetum schleicheri*, *Cardamino-Montion*), of flowing cold whitewater, rheophilous and meso-acidiphilous, stenothermal.

Small-sedge fens (*Bartsio alpinae-Caricetum nigrae*, *Caricion nigrae*), slightly acidic, in snowy hollows around springs, rivulets and seeps (Photo 52).

Photo 52 - *Bartsio-Caricetum* (GC3).

Small-sedge fens, often dominated by *Carex nigra* or *Juncus filiformis* (*Junco filiformis-Caricetum nigrae*, *Caricion nigrae*), in stagnant water of flat areas and small basins, on peaty acidic soils.

Low hummocks and carpets dominated by *Sphagnum* (*Carici nigrae-Sphagnetum magellanici*, *Sphagnion medii*). This community corresponds to an early stage of ombrotrophic peatland. The significant snow cover at this altitude and the short growing season limit the development of raised bogs.

Low hygrophilous thicket with *Salix bicolor* and *S. lapponum* (*Salicetum bicolori-lapponum*, *Salicion helveticae*), well-differentiated especially in the Plomb chain (Photo 53).

Photo 53 - *Salicetum bicolori-lapponum* (GC3).

This landscape unit is differentiated by hygrophilous orophytes, including *Salix lapponum*, *S. bicolor*, *S. repens*, *S. aurita*, *Montia fontana*, *Micranthes stellaris* (Photo 54), *Myosotis martini* (Photo 55) = *M. scorpioides* subsp. *lamottiana* Braun-Blanq. 1926), *Stellaria alsine*, *Epilobium anagallidifolium*, *E. alsinifolium*, *Juncus filiformis*, *Bartsia alpina*, *Trichophorum cespitosum*, *T. alpinum*, *Eriophorum angustifolium*, *E. vaginatum*, *Carex* spp., *Viola palustris*, *Pinguicula vulgaris*, *Parnassia palustris*, *Festuca rivularis*, *Sarmentypnum exannulatum*, *Bryum schleicheri*, *Blindia acuta*, *Philonotis seriata*, *Campylium stellatum*, and *Amphidium mougeotii*.

Photo 54 - *Micrantes stellaris*.

Photo 55 - *Myosotis martini* = *M. scorpioides* subsp. *lamottiana* Braun-Blanq. 1926.

Edaphoxerophilous geocurtaseries of silicate large boulders screes (GC4). These formations resulting from post-glacial gelifraction and gelifluction are frequent. They consist of thickly stacked trachy-andesitic blocks, more or less fixed, and often sparsely vegetated, mainly supporting species-poor vegetation, with three permaseries and one curtaseries.

Dryopteris oreades formation (*Dryopteridion oreadis*) forming margins of dense vegetation dominated by *Dryopteris*, taking place on the fixed and humified part at the edge of the scree (Photo 56).

Photo 56 - *Dryopteris oreades* boulders fields (GC4).

Pioneer species-poor vegetation dominated by *Cryptogramma crispa* (*Cryptogrammetum crispae*, *Androsacion alpinae*) on bare boulder screes.

Chionophilous communities dominated by *Athyrium distentifolium* (*Senecioni cacaliastri-Athyrietum distentifolii*, *Dryopterido-Athyrion*) on stabilized and long snow-covered boulder screes, rich in fine fraction, often facing east below the ridges.

Formation dominated by *Cytisus oromediterraneus* (*Teucrio scorodoniae-Cytisetum purgantis senecionetosum cacaliastri*, *Cytision oromediterranei*). These are mature, primary broom stands located on scree slopes with large, fixed and humus-rich boulder fields, on adrets (Photo 57).

Photo 57 - *Teucrio-Cytisetum oromediterranei* (GC4).

This ferns-rich landscape unit includes specialized orophilous species such as *Cryptogramma crispa*, *Dryopteris oreades*, *D. expansa*, *Gymnocarpium dryopteris*, *Phegopteris connectilis*, *Valeriana tripteris*, *Cytisus oromediterraneus*, with some tall grasses and tall forbs, such as *Athyrium filix-femina*, *A. distentifolium*, *Calamagrostis arundinacea*, *Senecio cacaliaster*, *Epilobium angustifolium*, *Jacobea adonidifolia* and acidophilous heath species, including *Gentiana lutea*, *Vaccinium myrtillus*, and *Festuca nigrescens*.

Edaphoxerophilous geopermaseries of cold summit rocks and walls (GP5). These are the highest rocky peaks of the massif and the north-facing walls and cliffs (Photo 58). They are subject to both edaphic drought, in a context of high atmospheric humidity, and cold temperatures during the growing season. The characteristic rupicolous or saxicolous permaseries are as follows:

Photo 58 - Roches taillades under puy Mary (GP5).

Outcrop community with *Silene ciliata* and *Festuca airoidis* (*Sileno ciliatae-Festucetum airoidis*, *Festucion airoidis*). This open, anemophilous grassland is confined to small areas of a few square meters on the humus deposits of summit rocks above 1,700 m. It is a true alpine enclave in the subalpine belt, particularly rich in orophytes (Le Gloanec & Le Hénaff 2024). Floristically, it is very similar to the low-lying heathland of *Pulsatillo vernalis-Cytisetum decumbentis*, which is more frequent.

Photo 59 - *Biscutello arvernensis-Festucetum airoidis* (GP5).

Semi-chasmophytic lawn (*Biscutello arvernensis-Festucetum airoidis*, *Festucion airoidis* Braun-Blanq. 1948) (Photo 59).

Cryptogam-rich *Empetrum nigrum* dwarf heath (*Racomitrio lanuginosi-Empetretum typicum*, *Genisto pilosae-Empetrion hermaphroditi*). It occupies steep, north-facing rocky slopes.

Chasmophytic moderately insolated community on dry rock walls (*Valeriano tripteridis-Phyteumetum hemisphaerici*, *Dianthion gratianopolitani*) it is quite widespread from the upper montane to subalpine belt.

Chasmophytic community on cold and shady rock walls (*Saxifragetum lamottei*, *Dianthion gratianopolitani*), strictly subalpine.

Chasmophytic community on cold, wet and shaded north-facing rock walls (*Micranthetum hieraciifoliae*, *Dianthion gratianopolitani* Focquet 1982), neutrophilous on trachy-basaltes, very rare; it only exists in Impradine and Rhue cirques.

Rheophilic spring community of subalpine seeping walls on volcanic tuffs (*Sagino procumbentis-Pedicularietum verticillatae*, *Arabidion soyeri*), meso-acidophilous/neutrophilous community resulting from permanent flows on the walls (Photo 60).

Photo 60 - *Sagino-Pedicularietum verticillatae* (GP5).

This landscape unit is distinguished by numerous subalpine to alpine orophytes: *Salix hastata*, *Silene ciliata*, *Agrostis rupestris*, *Festuca airoides*, *Biscutella arvernensis*, *Cerastium alpinum*, *Dryas octopetala* (rare), *Ligularia sibirica*, *Sabulina verna*, *Pedicularis verticillata* (Photo 61), *Gentiana verna*, *Androsace halleri*, *Cochlearia pyrenaica*, *Phyteuma hemisphaericum*, *Empetrum nigrum* subsp. *hermaphroditum*, *Arabis alpina*, *Saxifraga bryoides*, *S. lamottei* (rare), *S. oppositifolia* (Photo 62, rare), *S. androsacea*, *S. paniculata*, *S. fragosoi*, *Micranthes stellaris*, *M. hieraciifolia* (Photo 63, rare), *Dianthus gratianopolitanus*, *Alchemilla amphisericea*, *A. alpigena*, *A. saxatilis*, *Thymus callitrichefolius* Sennen, *Asplenium viride*, *Polystichum lonchitis*, and *Hieracium piliferum*.

Photo 61 - *Pedicularis verticillata.*

Photo 62 - *Saxifraga oppositifolia.*

Photo 63 - *Saxifraga hieraciifolia* (source Flora danica).

Edaphoxerophilous geopermaséries of warm and sunny rocks (GP6). This unit brings together four xerophilous, saxicolous, heliothermophilous plant communities, which constitute characteristic permaseries.

Stripped grassland, mainly dominated by *Festuca arvernensis* subsp. *costei* (*Bupleuro ranunculoidis-Festucetum costei*, *Galio saxatilis-Patzkeion paniculatae*), neutrophilous, on humic soil and steep basaltic rocky south-facing slopes, on small areas, forming bare steps.

Stripped grassland mainly dominated *by Patzkea paniculata* (*Leucanthemo delarbrei-Patzkeetum paniculatae* Braun-Blanq. 1926), often on rocky slopes just below the ridges, on trachy-andesitic skeletal soils (Photo 64).

Open and rocky grasslands on pavements on lithosol with *Sedum* (*Sileno rupestris-Sedetum annui*, *Sedo-Scleranthion*).

Photo 64 - *Leucanthemo delarbrei-Patzkeetum paniculatae* Braun-Blanq. 1926 (GP6).

Dwarf heath on convex, rocky landforms with *Arctostaphyllos uva-ursi* (*Pulsatillo vernalis-Cytisetum decumbentis scabiosetosum columbariae*, *Genisto pilosae-Vaccinion*), in the sheltered parts of the sites, more heliothermophilous than other communities.

This landscape unit is characterized by saxicolous or xerothermophilous orophytes: *Cotoneaster integerrima*, *Rosa spinosissima*, *Arctostaphyllos uva-ursi*, *Bupleurum ranunculoides* subsp. *ranunculoides* (Photo 65), *Dianthus gratianopolitanus* (Photo 66), *Epilobium angustifolium*, *Festuca arvernensis* subsp. *costei*, *F. billyi*, *Hylotelephium maximum*, *Laserpitium latifolium*, *Leucanthemum delarbrei*, *Patzkea paniculata*, *Pilosella peleteriana*, *Scabiosa columbaria* var. *spreta* Jord., *Sempervivum tectorum* subsp. *arvernense*, *S. arachnoideum*, *Sedum annuum*, *S. dasyphyllum*, *S. hirsutum*, *S. forsterianum*, *Silene saxifraga*, and *Thymus pulegioides* var. *vestitus*.

Photo 65 and 66 - *Bupleurum ranunculoides* subsp. *ranunculoides*; *Dianthus gratianopolitanus*.

Edaphochionophilous geopermaseries (GP7). This unit brings together four communities in diverse concave landforms, basins, adapted to a prolonged snow cover and a short growing season, corresponding to four characteristic permaseries:

Mat-grass sward community of wet snowmelt ravine *Plantagini alpinae-Nardetum strictae* Braun-Blanq. 1926, *Nardion strictae* Braun-Blanq. 1926).

Mat-grass sward mesophilous community of snowy depressions under the ridge (*Euphrasio minimae-Nardetum strictae*, *Nardion strictae*, *Eu-Nardenion strictae*) (Photo 67).

Snow-patch, moss-rich, open community (*Plantagini alpinae-Agrostietum rupestris*, *Salicion herbaceae*), linked to an erosive snow overload, below plateaus acting as feeding surfaces.

Species-poor formations dominated by *Luzula desvauxii* (*Veratro albi-Luzuletum desvauxii*, *Mutellino adonidifoliae-Luzulion desvauxii*) in the snowy, eroded, and damp ravines, on steep slopes, which represent the latest snowdrift areas of the massif (Photo 68).

This landscape unit is differentiated by chionophilous species such as *Trifolium alpinum*, *Mutellina adonidifolia*, *Luzula desvauxii*, *Plantago alpina*, *Poa alpina*, *Sedum alpestre* (Photo 69), *Murbeckiella pinnatifida*, *Geum montanum* (Photo 70), *Scorzoneroides pyrenaica*, *Potentilla aurea*, *Pseudorchis albida*, *Festuca heteromalla* (= *F. rubra* subsp. *fallax*), *Athyrium distentifolium*, *Micranthes stellaris*, *Alchemilla alpina*, *Kiaeria starkei*, *Oligotrichum hercynicum*, *Lophozia sudetica*, *Marsupella sparsifolii*, *Racomitrium macounii*, *R. heterostichum*, *R. fasciculare*...

Photo 67 - *Euphrasio minimae-Nardetum* (GP7), in small basins in heathlands of Peyre Arse.

Photo 68 - *Veratro-Luzuletum desvauxii* in snowy ravines of puy Mary (GP7).

Photo 69 - *Sedum alpestre*.

Photo 70 - *Geum montanum*.

Table 1 - Correspondence between the relevé numbers in Table 1 and the Braun-Blanquet numbers from the 1926 publication, including original and current syntaxon names (for author names, refer to the synsystem in this booklet). **1** (1 p. 32/33): Association à *Nardus* et *Plantago alpina* (*Plantagini alpinae-Nardetum strictae*); ravin de la Goulière. **2** (2 p. 34): *Nardetum festucetosum rubrae* (= *Diantho pseudocollini-Scorzoneroidetum pyrenaicae*); cirque d'Impradine. **3** (1 p. 36/37): Association à *Festuca spadicea* et *Chrysanthemum Delarbrei* (*Leucanthemo delarbrei-Patzkeetum paniculatae*); puy Mary. **4** (1 tab. 2 p. 44): Association à *Genista pilosa* et *Calluna* (= *Pulsatillo vernalis-Cytisetum decumbentis*); Plomb du Cantal. **5** (3 tab. 2 p. 44): Association à *Genista pilosa* et *Calluna* (= *Pulsatillo vernalis-Cytisetum decumbentis*); Between Brèche de Rolland and puy Mary. **6** (4 tab. 2 p. 44): Association à *Vaccinium uliginosum* et *V. myrtillus* (*Vaccinietum myrtillo-uliginosi*); ravin de la Goulière. **7** (5 tab. 2 p. 44): Association à *Vaccinium uliginosum* et *V. myrtillus* (*Vaccinietum myrtillo-uliginosi*); Plomb du Cantal. **8** (7 tab. 2 p. 44): Association à *Vaccinium uliginosum* et *V. myrtillus* (*Vaccinietum myrtillo-uliginosi*); Roc de Mandailles. **9** (1 p. 38): Association à *Adenostyles alliariae* et *Cicerbita alpina* (*Imperatorio osthrutii-Adenostyletum alliariae*); Brèche de Roland. **10** (1 p. 39/41): *Cardaminetum amarae subatlanticum*; vallon de l'Impradine. **11** (1 tab. 1 p. 40): Association à *Bryum schleicheri* et *Montia rivularis* (*Montio fontanae-Bryetum schleicheri*); cirque d'Impradine. **12** (2 tab. 1 p. 40): Association à *Bryum schleicheri* et *Montia rivularis* (*Montio fontanae-Bryetum schleicheri*); Col des Rombières. **13** (3 tab. 1 p. 40): Association à *Bryum schleicheri* et *Montia rivularis* (*Montio fontanae-Bryetum schleicheri*); Peyre Arse. **14** (4 tab. 1 p. 40): Association à *Bryum schleicheri* et *Montia rivularis* (*Montio fontanae-Bryetum schleicheri*); ravin de la Goulière. **15** (1 p. 43): Association à *Carex fusca* (*Junco filiformis-Caricetum nigrae*); cirque de l'Impradine.

Relevés of J. Braun-Blanquet (1924) Names of alliances of J. Braun-Blanquet (1926)	*Nardion*		*Festucion variae*	*Genisteto-Vaccinion*					*Adenostylion*	*Cardamineto-Montion*				*Caricion fuscae*
Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Relevé area (m2)	50	500	100								20	20	20	20	100
Altitude	1620	1350	1750	1800	1660	1600	1800	1680	1600	1350	1350	1540	1600	1610	
Exposure (°)	N	N	S		S	NNE		NE	N		E	NE	S	NE	
Slope (°)		15	40		10	30		10	35	5	5	5	25	25	
Accidental species	0	0	0	4	6	7	0	4	0	0	0	0	1	0	0
Number of species	23	55	38	21	24	26	26	23	24	6	19	22	16	14	11
Herb layer															
Geum montanum L.	+					+									
Luzula desvauxii Kunth	+								1						
Poa alpina L.	p														
Plantago alpina L.	2														
Agrostis rupestris All.	2			+											
Trifolium alpinum L.	2	+		1			+	r							
Nardus stricta L.	3	4													
Galium saxatile L.	+	+				+									
Ranunculus serpens Schrank		1													
Achillea millefolium L.		+													
Ajuga reptans L.		+													
Alchemilla glabra Neygenf.		+													
Anemone nemorosa L.		+													
Carex caryophyllea Latourr.		+													
Carex leporina L.		+													
Carex pallescens L.		+													
Carex pilulifera L.		+													
Conopodium majus (Gouan) Loret		+													
Euphrasia micrantha Rchb.		+													
Genista sagittalis L.		+													
Omalotheca sylvatica (L.) Sch.Bip. & F.W.Schultz		+													
Luzula sudetica (Willd.) Schult.		+													
Bistorta vivipara (L.) Delarbre		+													
Phleum alpinum L.		+													
Plantago lanceolata L.		+													
Prunella vulgaris L.		+													
Rhinanthus minor L.		+													
Scorzoneroides autumnalis (L.) Moench		+													
Silene nutans L.		+													
Stellaria graminea L.		+													
Trifolium pratense L.		+													
Trifolium repens L.		+													
Veronica officinalis L.		+													
Polygala serpyllifolia Hose		+													
Centaurea nigra L.		+													
Cerastium fontanum s. *vulgare* (Hartm.) Greuter & Burdet		+													
Pilosella lactucella (Wallr.) P.D.Sell & C.West		+													
Pilosella officinarum F.W.Schultz & Sch.Bip.		+													
Thymus pulegioides L.		+	+												
Viola lutea s. *lutea* Huds.		+	+												
Jasione laevis Lam.		+	+			+									
Patzkea paniculata (L.) G.H.Loos			3												
Leucanthemum delarbrei Timb.-Lagr. ex Lamotte			1												
Cytisus oromediterraneus Rivas Mart. et al.			1												
Thymus pulegioides v. *vestitus* (Lange) Jalas			1												
Biscutella arvernensis Jord.			+												
Crepis conyzifolia (Gouan) A.Kern.			+												
Jacobaea adonidifolia (Loisel.) M.Fr.-rat			+												
Linaria repens (L.) Mill.			+												
Phyteuma betonicifolium Vill.			+												
Polygala vulgaris L.			+												
Scabiosa columbaria L.			+												
Sedum annuum L.			+												
Senecio doronicum (L.) L.			+												
Euphrasia officinalis s. rostkoviana (Hayne) F.Towns.			+												
Pilosella peleteriana (M.Fr.-rat) F.W.Schultz & Sch.Bip.			+												
Laserpitium latifolium s. *latifolium* L.			+												
Sempervivum tectorum s. *arvernense* L. Lecoq & Lamotte			+												
Silene vulgaris s. *vulgaris* (Moench) Garcke			+												
Hieracium juranum Rapin			+												
Atocion rupestre (L.) Oxelman			+												
Thesium alpinum L.			+												
Cytisus decumbens (Durande) Spach				+											
Pedicularis comosa L.				+											
Carex umbrosa var. *umbrosa* Host				+											
Pulsatilla vernalis (L.) Mill.				+											
Phyteuma hemisphaericum L.	+		+	+			+								
Genista pilosa L.			+	+	3										
Serratula tinctoria L.				+	1										
Luzula spicata (L.) DC.					+										
Hieracium lanceolatum Vill.					+										
Knautia godetii Reut.					+										
Hypericum maculatum Crantz					+	+									
Dianthus seguieri s. *pseudocollinus* (P.Fourn.) Jauzein		+			+	+									
Pulsatilla alpina (L.) Delarbre	r			+		1	+								
Poa chaixii Vill.		+				+	+								

Relevés of J. Braun-Blanquet (1924) Names of alliances of J. Braun-Blanquet (1926)	*Nardion*		*Festucion variae*	*Genisteto-Vaccinion*					*Adenostylion*	*Cardamineto-Montion*					*Caricion fuscae*
Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Relevé area (m2)	50	500	100								20	20	20	20	100
Altitude	1620	1350	1750	1800	1660	1600	1800	1680	1600	1350	1350	1540	1600	1610	
Exposure (°)	N	N	S		S	NNE		NE	N		E	NE	S	NE	
Slope (°)		15	40		10	30		10	35	5	5	5	25	25	
Accidental species	0	0	0	4	6	7	0	4	0	0	0	0	1	0	0
Number of species	23	55	38	21	24	26	26	23	24	6	19	22	16	14	11
Epikeros pyrenaeus (L.) Raf.	p	+				r		r							
Melampyrum pratense L.					+	+	+	+							
Arnica montana L.					+	+	+	+							
Campanula scheuchzeri s. *lanceolata* (Lapeyr.) J.-M.Tison		+			+	+	+	+							
Hieracium prenanthoides Vill.					+		+	+							
Helictochloa versicolor s. *versicolor* (Vill.) Romero Zarco							+	+							
Mutellina adonidifolia (J.Gay) Gutermann						+	+	+	+						
Trollius europaeus L.							+	1	+						
Rumex alpinus L.									3						
Adenostyles alliariae (Gouan) A.Kern.									2						
Ranunculus aconitifolius L.									2						
Lactuca alpina (L.) Benth. & Hook.f.									1						
Rumex arifolius All.									1						
Saxifraga rotundifolia L.									1						
Tozzia alpina L.									1						
Athyrium distentifolium Tausch ex Opiz									+						
Athyrium filix-femina (L.) Roth									+						
Chaerophyllum hirsutum L.									+						
Crepis lampsanoides (Gouan) Tausch									+						
Geranium sylvaticum L.									+						
Imperatoria ostruthium L.									+						
Streptopus amplexifolius (L.) DC.									+						
Silene dioica v. *dioica* (L.) Clairv.									+						
Gentiana lutea L.	+	1	+	+	+	1	+	+							
Calluna vulgaris (L.) Hull	r	+		5	2	+	+	+							
Meum athamanticum Jacq.	+	1	+		+	+	+	+							
Anthoxanthum odoratum L.		+	+		+	+	+	+	+						
Scorzoneroides pyrenaica (Gouan) Holub	1	+		+		+	+	+							
Festuca rubra L.	+	1	2		+	+	+	+			+				
Potentilla aurea L.	+	1				+	+	+							
Vaccinium myrtillus L.		+	1	1	2	2	2	3							
Avenella flexuosa (L.) Drejer			1	2	+	2	2	2							
Solidago virgaurea L.			+	+	+	+	+								
Vaccinium uliginosum L.	+			+	+	3	4	2							
Bistorta officinalis Delarbre				+	+	+	1	1	+						
Luzula multiflora (Ehrh.) Lej.		+			+	+	+	+							
Potentilla erecta (L.) Raeusch.		+			+			+							
Calamagrostis arundinacea (L.) Roth			+		+		+								
Chrysosplenium oppositifolium L.										1					
Veronica beccabunga L.										1					
Cardamine amara L.										2	+				
Epilobium alsinifolium Vill.										1	+	+			
Myosotis martini Sennen											+	+			
Veronica serpyllifolia L.		r									+	+	+	+	
Alchemilla coriacea Buser											1		+	1	
Sagina saginoides (L.) H.Karst.											+	+	+	+	
Sedum villosum L.											+	+	+	+	
Stellaria alsine Grimm											1	+	+	1	
Trifolium spadiceum L.											+	+	+		
Montia fontana s. *fontana* L.											+	+	1	+	
Micranthes stellaris (L.) Galasso & Soldano											1	+	2	+	
Viola palustris L.	+										+	+	+	+	+
Cardamine pratensis L.												+	+	+	+
Carex nigra (L.) Reichard											+	+		+	3
Carex echinata Murray												+			1
Carex canescens L.															2
Carex rostrata Stokes															1
Juncus filiformis L.												+			2
Comarum palustre L.															+
Lotus corniculatus L.	+	+													
Alchemilla L.		+							+						
Poa nemoralis L.			+						+						
Sorbus aucuparia L.						+		+							
Caltha palustris L.												+	+		
Epilobium nutans F.W.Schmidt												+	+		
Agrostis capillaris L.												+		+	
Caltha palustris L.										+					+
Blitum bonus-henricus (L.) Rchb.	r														
Agrostis L.		+													
Rumex acetosella L.		r													
Galium pumilum Murray			+												
Hieracium pallidulum Jord. ex Boreau			+												
Hieracium acuminatum Jord.			+												
Equisetum palustre L.											+				
Glyceria notata Chevall.												+			
Epilobium palustre L.													+		
Pinguicula vulgaris L.													+		
Agrostis stolonifera L.															+
Moss Layer															
Polytrichum juniperinum Hedw.	1														
Cladonia rangiferina (L.) Weber				+											
Flavocetraria cucullata (Bellardi) Kŝrnefelt & A.Thell				+											
Cetraria islandica (L.) Ach.				+			1								
Brachythecium rivulare Schimp.										+	+				
Ptychostomum pseudotriquetrum J.R.Spence & H.P.Ramsay											+	+			
Ptychostomum schleicheri (DC.) J.R.Spence ex Bell & Holyoak											4	4	4	4	
Philonotis seriata Mitt.											2	1	1	1	
Rhizomnium punctatum (Hedw.) T.J.Kop.									+			+		+	
Sanionia uncinata (Hedw.) Loeske	+														2
Brachythecium Schimp.									+						

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Position of the plant communities visited, within the phytosociological system

Potametea Klika in Klika et V.Novák 1941
Potametalia W.Koch 1926
Potamion pectinati (W.Koch 1926) Libbert 1931
Eu-Potamenion pectinati

Cf ***Elodeo canadensis-Potametum alpini*** Krausch *ex* H.Passarge 1994

Montio fontanae-Cardaminetea amarae Braun-Blanq. et Tüxen *ex* Klika et Hadač 1944
Montio fontanae-Cardaminetalia amarae Pawł. in Pawł., Sokołowski et Wallisch 1928
Cardamino amarae-Montion fontanae Braun-Blanq. 1925

Montio fontanae-Bryetum schleicheri Braun-Blanq. 1925

Cardamino amarae-Chrysosplenietalia alternifolii Hinterlang *ex* B.Foucault 2018
Caricion remotae M.Kästner1942

Cardamino amarae-Chrysosplenietum alternifolii F.M.Maas 1959

Arabidion soyeri Julve *ex* B.Foucault 2018 (= *Cochlearion pyrenaicae* Bardat in Bardat *et al.* 2004 *nom. inval.*)

Sagino procumbentis-Pedicularietum verticillatae Thébaud 2025

Oxycocco palustris-Sphagnetea magellanici Braun-Blanq. et Tüxen *ex* V.Westh., J.Dijk, Passchier et G.Sissingh 1946
Sphagnetalia magellanici M.Kästner et Flössner 1933
Sphagnion magellanici M.Kästner et Flössner 1933
Polytricho communis-Eriophorenion vaginati Thébaud et Pétel 2008

Carici nigrae-Sphagnetum magellanici Bick 1985

Scheuchzerio palustris-Caricetea fuscae Tüxen 1937
Caricetalia fuscae W.Koch 1926
Caricion fuscae W.Koch 1926

Bartsio alpinae-Caricetum nigrae J. et M.Bartsch 1940

Junco filiformis-Caricetum nigrae (Oberd.1957) Rivaz-Mart. et Géhu 1978 (= *Caricetum fuscae subalpinum* Oberdorfer 1957)

Asplenietea trichomanis (Braun-Blanq. in H.Meier & Braun-Blanq. 1934) Oberd. 1977
Asplenietalia septentrionalo-cuneifolii Mucina et Theurillat 2015
Asplenion septentrionalis Gams ex Oberd.1938

Sempervivo arvernensis-Saxifragetum continentalis Billy *ex* Thébaud, C.Roux, C.-E. Bernard et Delcoigne 2014

Androsacetalia vandellii Braun-Blanq. in H.Meier et Braun-Blanq. 1934
Dianthion gratianopolitani Focquet 1982 *nom. inval.* (Art. 5)

Valeriano trypteridis-Phyteumetum hemisphaerici Billy *ex* Thébaud, C.Roux, C.-E. Bernard et Delcoigne 2014

Micranthetum hieraciifoliae Quézel et Rioux 1954 *mut.* Thébaud 2025

Saxifragetum lamottei Quézel et Rioux 1954

Thlaspietea rotundifolii Braun-Blanq. 1948
Galeopsietalia segetum Oberd. et Seibert in Oberd. 1977
Galeopsion segetum Oberd. 1957

Biscutello lamottei-Galeopsietum segeti Coquillard, Geugnot et R.Michalet *ex* Thébaud, C.Roux, C.-E. Bernard et Delcoigne 2014

Androsacetalia alpinae Braun-Blanq. in Braun-Blanq. et H.Jenny 1926
Androsacion alpinae Braun-Blanq. in Braun.-Blanq. et H.Jenny 1926

Cryptogrammetum crispae Jenny-Lips 1930

Dryopteridion oreadis Rivas-Mart. 1977 *corr.* Rivas-Mart. *et al.* 1984

Community with *Dryopteris oreades*

Epilobietea angustifolii Tüxen et Preising *ex* von Rochow 1951
Epilobietalia angustifolii Tüxen *ex* von Rochow 1951
Epilobion angustifolii Oberd. 1957

Lactuco plumieri-Epilobietum angustifolii (Billy 1997) B.Foucault in B.Foucault & Catteau 2015

Senecioni fuchsii-Digitalietum purpureae Pfeiffer 1936

Stellario holosteae-Rubetum idaei H.Passarge 1982

Holco mollis-Pteridetum aquilini H.Passarge 1994

Filipendulo ulmariae-Convolvuletea sepium Géhu et Géhu-Franck 1987
Loto pedunculati-Filipenduletalia ulmariae H.Passarge (1975) 1978
Filipendulo ulmariae-Chaerophyllion hirsuti B.Foucault 2011

Ranunculo aconitifolii-Filipenduletum ulmariae Bal.-Tul. et Hübl 1979

Mulgedio alpini-aconitetea variegati Hadač et Klika *ex* Klika 1948
Adenostyletalia alliariae Braun-Blanq. 1930
Adenostylion alliariae Braun-Blanq. 1926

Crepido paludosae-Adenostyletum alliariae Loos et Thébaud 2024

Doronico austriaci-Campanuletum latifoliae Quézel et Rioux 1954

Imperatorio osthrutii-Adenostyletum alliariae (Braun-Blanq. 1926) B.Foucault in B.Foucault et Corriol 2013 (= association à *Adenostyles alliariae* et *Cicerbita alpina* Braun-Blanq. 1926)

Mutellino adonidifoliae-Luzulion desvauxii R.Michalet et T.Philippe *ex* Le Hénaff *et al.* 2021

Veratro albi-Luzuletum desvauxii R.Michalet et T.Philippe *ex* Thébaud, C.Roux, C.-E. Bernard et Delcoigne 2014

Dryopterido filicis-maris-Athyrion distentifolii (Holub *ex* Sýkora et Štursa 1973) Jeník *et al.* 1980)

Senecioni cacaliastri-Athyrietum distentifolii Thébaud in Loos et Thébaud 2024

Calamagrostietalia villosae Pawłowski *et al.* 1928
Calamagrostion arundinaceae (Luquet 1926) Oberd. 1957

Calamagrostietum arundinaceae Luquet 1926

Luzulo sylvaticae-Calamagrostietum arundinaceae R.Michalet et T.Philippe *ex* Thébaud, C.Roux, C.-E. Bernard et Delcoigne 2014

Heracleo sphondylii-Calamagrostietum arundinaceae R.Michalet et T.Philippe *ex* Thébaud, C.Roux, C.-E. Bernard et Delcoigne 2014

Pediculario foliosae-Geranietum sylvatici Michalet et Philippe *ex* Thébaud, C.Roux, C.-E. Bernard et Delcoigne 2014

Community with *Libanotis pyrenaica* and *Calamagrostis arundinacea*

Petasito-Chaerophylletalia Morariu 1967
Arunco-Petasition albi Braun-Blanq. et Sutter 1977

Saxifrago rotundifolii-Petasitetum albi (Choisnet et Mulot 2008) Loos 2024 *prov.*

Senecioni rupestris-Rumicetalia alpini Mucina et Karner in Mucina *et al.* 2016
Rumicion alpini Scharfetter 1938

Rumicetum alpini Beger 1922

Melampyro pratensis-Holcetea mollis H.Passarge 1994
Melampyro pratensis-Holcetalia mollis H.Passarge 1979
Melampyro sylvatici-Poion chaixii Julve *ex* Boullet et Rameau in Bardat *et al.* 2004

Poo chaixii-Euphorbietum hybernae Bignon 1986 *ex* Thébaud, C.Roux, C.-E. Bernard et Delcoigne 2014

Prenantho purpureae-Avenelletum flexuosae (Bignon 1986) Loos 2024 *prov.*

Agrostio capillaris-Lactucetum plumieri Loos 2024 *prov.*

Trifolio medii-Geranietea sanguinei T.Müll. 1962
Antherico ramosi-Geranietalia sanguinei Julve ex Dengler in Dengler et J.Krebs 2003
Geranion sanguinei Tüxen in T.Müll. 1962
Antherico ramosi-Geranienion sanguinei J.-M.Royer 2015

Cf ***Cervario rivini-Oreoselinetum nigri*** Billy *ex* J.-M. Royer 2014

Origanetalia vulgaris T.Müller 1962

Knaution dipsacifoliae Julve *ex* Dengler et Boch 2008
Laserpitio latifolii-Teucrienion scorodoniae J.-M.Royer 2016

Doronico austriaci-Calamagrostietum arundinaceae (Coquillard 1993) Loos 2024 *prov.*

Cirsio erisithalis-Teucrietum scorodoniae Billy *ex* J.-M.Royer 2016

Juncetea trifidi Hadač in Klika et Hadač 1944 (= *Caricetea curvulae* Braun-Blanq. 1948)
Caricetalia curvulae Braun-Blanq. in Braun-Blanq. et H.Jenny 1926
Festucion airoidis Braun-Blanq. 1948 *mut.* Mucina *et al.* 2016

Jasiono arvernensis-Agrostietum rupestris R.Michalet et T. Philippe *ex* Thébaud, C.Roux, C.-E. Bernard et Delcoigne 2014, ***silenetosum ciliatae*** Loos 2024 *prov.* (= *Sileno ciliatae-Agrostietum rupestris* Le Gloanec et Le Hénaff 2024 *nom. inval.*)

Biscutello arvernensis-Festucetum airoidis Billy *ex* Thébaud, C.Roux, C.-E. Bernard et Delcoigne 2014

Festucetalia spadiceae Barbero 1970
Nardion strictae Braun-Blanq. 1926 (= *Galio saxatilis-Potentillion aureae* B.Foucault 1994 *p.p.*, = *Euphrasio minimae-Nardion strictae* Le Hénaff, Hostein, M.Dumont et Pradinas 2021 *nom superfl.*)

Plantagini alpinae-Nardetum strictae Braun-Blanq. 1926

Euphrasio minimae-Nardetum strictae R.Michalet et T.Philippe *ex* Thébaud, C.Roux, C.-E. Bernard et Delcoigne 2014

Galio saxatilis-Patzkeion paniculatae B.Foucault 2016

Arnico montanae-Patzkeetum paniculatae R.Michalet et T.Philippe *ex* Thébaud, C.Roux, C.E.Bernard et Delcoigne 2014

Betonico officinalis-Patzkeetum paniculatae Loos in Loos et Thébaud 2024

Leucanthemo delarbrei-Patzkeetum paniculatae Braun-Blanq. 1926 (= association à *Festuca spadicea* et *Chrysanthemum delarbrei* Braun-Blanq. 1926)

Bupleuro ranunculoidis-Festucetum costei Thébaud in Loos et Thébaud 2014

Salicetea herbaceae Braun-Blanq. 1948
Salicetalia herbaceae Braun-Blanq. in Braun-Blanq. et H.Jenny 1926
Salicion herbaceae Braun-Blanq. in Braun-Blanq. et H.Jenny 1926

Plantagini alpinae-Agrostietum rupestris R.Michalet et T.Philippe *ex* Thébaud, C.Roux, C.-E. Bernard et Delcoigne 2014

Loiseleurio procumbentis-Vaccinietea Eggler *ex* Schubert 1960
Rhododendro ferruginei-Vaccinietalia microphylli Braun-Blanq. in Braun-Blanq. et H.Jenny 1926
Genisto pilosae-Empetrion hermaphroditi Thébaud, Choisnet et C.Roux 2021

Racomitrio lanuginosi-Empetretum nigri Luquet 1926

Helianthemetea guttati Rivas Goday et Rivas Mart. 1963
Helianthemetalia guttati Braun-Blanq. in Braun-Blanq., Molin. et H.Wagner 1940
Thero-Airion Tüxen *ex* Oberd. 1957

Spergulo pentandrae-Veronicetum dillenii Korneck 1975

Festuco-Brometea Braun-Blanq. et Tüxen *ex* Klika et Hadač 1944
Brometalia erecti W.Koch 1926
Bromion erecti W.Koch 1926
Chamaespartio sagittalis-Agrostienion capillaris Vigo *ex* J.-M.Royer et Ferrez 2020

Brachypodio pinnati-Dianthetum monspessulani Lemée et Carbiener 1956

Ranunculo bulbosi-Brachypodietum pinnati R.Michalet, Coquillard et Gueugnot *ex* Thébaud, C.Roux, C.-E.Bernard et Delcoigne 2014

Koelerio-Phleion phleoidis Korneck 1974

Carlino acanthifoliae-Phleetum phleoidis C.Roux et Brocard 2023

Nardetea strictae Rivas Goday et Borja Carbonell in Rivas Goday et Mayor López 1966 *nom. conserv. propos.* Mucina *et al.* 2016
Nardetalia strictae Oberd. *ex* Preising 1950
Nardo-Agrostion tenuis Sillinger 1933 (inclus *Galio saxatilis-Potentillion aureae* B.Foucault 1994 *p.p.*)

Brizo mediae-Agrostietum capillaris Thébaud 2008

Diantho pseudocollini-Scorzoneroidetum pyrenaicae Billy *ex* Thébaud, C.Roux, C.-E.Bernard et Delcoigne 2014 *mut.* Ragache 2021, ***typicum*** et ***galietosum veri***

Carici piluliferae-Nardetum stictae R.Michalet et T.Philippe *ex* Thébaud, C.Roux, C.-E.Bernard et Delcoigne 2014

Sedo albi-Scleranthetea biennis Braun-Blanq. 1955
Sedo albi-Scleranthetalia biennis Braun-Blanq. 1955
Sedo albi-Scleranthion biennis Braun-Blanq. 1955

Sempervivo arvernensis-Festucetum arvernensis B.Foucault 1987 ***sempervivetosum arachnoidei*** *J.-M.*Royer et Ferrez 2018

Sileno rupestris-Sedetum annui Oberdorfer 1957

Arrhenatheretea elatioris Braun-Blanq. *ex* Braun-Blanq., Roussine et Nègre 1952
Arrhenatheretalia elatioris Tüxen 1931
Triseto flavescentis-Polygonion bistortae Braun-Blanq. et Tüxen *ex* Marschall 1947
Rhinantho pumili-Trisetenion flavescentis B.Foucault 2016

Violo luteae-Trisetetum flavescentis (Luquet 1926) B.Foucault 1986

Trifolio repentis-Phleetalia pratensis H.Passarge 1969
Cynosurion cristati Tüxen 1947

Festuco commutatae-Cynosuretum cristati Tüxen in Büker 1942

Cyano montani-Cynosuretum cristati (Lachapelle 1964) B.Foucault 2016

Calluno vulgaris-Ulicetea minoris Braun-Blanq. et Tüxen *ex* Klika in Klika et Hadač 1944
Vaccinio myrtilli-Genistetalia pilosae Schubert *ex* H.Passarge 1964
Diantho hyssopifolii-Vaccinion myrtilli Boullet *et al.* in Thébaud, Choisnet et C.Roux 2021 *ad interim*.

Galio saxatilis-Vaccinium myrtillus R.Michalet, Coquillard et Gueugnot 1989

Genisto pilosae-Vaccinion Braun-Blanq. 1926
Vaccinienion myrtillo-uliginosi Thébaud, Choisnet et C.Roux 2021

Vaccinietum myrtillo-uliginosi Braun-Blanq. 1926

Euphorbio hybernae-Vaccinietum myrtilli Coquillard *ex* Thébaud, C.Roux, C.-E.Bernard et Delcoigne 2014

Patzkeo paniculatae-Vaccinium myrtilli Thébaud, Choisnet et C.Roux 2021

Carici piluliferae-Vaccinienion Schaminée Hennekens et Thébaud 1993

Allio victorialis-Vaccinietum uliginosi Shaminée et Hennekens 1992

Alchemillo saxatilis-Vaccinietum uliginosi Thébaud *ex* Schaminée, Hennekens et Thébaud 1993

Eu-Genisto pilosae-Vaccinienion (= *Phyteumo hemisphaerici-Vaccinienion* Schaminée et Hennekens in Schaminée Hennekens et Thébaud 1993 *p.p.)*

Pulsatillo vernalis-Cytisetum decumbentis Quézel & Rioux 1954 *mut*. Thébaud, Choisnet et C.Roux 2021 (= *Pulsatillo vernalis-Genistetum* Quézel et Rioux 1954, = association à *Genista pilosa* et *Calluna* Braun-Blanq. 1926 *p.p.*)

Jasiono laevis-Callunetum vulgaris Michalet et Philippe *ex* Thébaud, C.Roux, C.-E.Bernard et Delcoigne 2014 (= association à *Calluna vulgaris* et *Genista pilosa* Luquet 1926 *p.p.*)

Cytisetea scopario-striati Rivas Mart. 1975
Cytisetalia scopario-striati Rivas Mart. 1975
Cytision oromediterranei Tüxen in Tüxen et Oberd. 1958

Silene vulgaris-Cytisetum oromediteranei (Billy *ex* Thébaud, C.Roux, Bernard et Delcoigne 2014) Loos 2024 *nom. inval.* (Art. 1, 2a)

Teucrio scorodoniae-Cytisetum purgantis Coquillard *ex* Thébaud, C.Roux, C.-E.Bernard et Delcoigne 2014

Franguletea alni Doing *ex* V.Westh. in V.Westh. et den Held 1969
Salicetalia auritae Doing 1962
Salicion cinereae T.Müll. et Görs *ex* H.Passarge 1961

Salicetum pentandro-atrocinereae Thébaud, C.Roux, C.-E.Bernard et Delcoigne 2014

Rhamno catharticae-Prunetea spinosae Rivas Goday et Borja *ex* Tüxen 1952
Prunetalia spinosae Tüxen 1952
Amelanchiero ovalis-Buxion sempervirentis O.Bolòs et Romo 1989

Junipero communis-Amelanchieretum ovalis Billy *ex* B.Foucault et J.-M.Royer 2016

Sambucetalia racemosae Oberd. *ex* H.Passarge in Scamoni 1963
Sambuco nigrae-Salicion capreae Tüxen et A.Neumann *ex* Oberd. 1957

Betulo pendulae-Salicetum capreae Billy *ex* B.Foucault in B.Foucault et J.-M.Royer 2016, ***sorbetosum ariae***

Betulo carpaticae-alnetea viridis Rejmánek *ex* Boeuf, Theurillat, Willner, Mucina et Simler in Boeuf *et al.* 2014
Alnetalia viridis Rübel *ex* Karner et Willner in Willner et Grabherr 2007
Pruno petraeae-Sorbion aucupariae Rameau *ex* Seytre et Boeuf in Boeuf 2011

Sorbo aucupariae-Loniceretum nigrae B.Foucault 1987

Roso pendulinae-Sorbetum chamaemespili Billy *ex* Thébaud, C.Roux, C.-E.Bernard et Delcoigne 2014

Salicion helveticae Rübel *ex* Theurillat in Theurillat *et al.* 1995 (= *Salicion lapponum-glaucae* Gams 1936)

Salicetum bicolori-lapponum (Lachapelle in Cusset et Lachapelle 1962) Julve 1993 *nom. inval.* (Art. 2b, 3b, 7)
Carpino-Fagetea sylvaticae Jakucs *ex* H.Passarge 1968
Fagetalia sylvaticae Tüxen in Barner 19
Fagion sylvaticae Luquet 1926
Eu-Fagenion sylvaticae

Adoxo moschatellinae-Fagetum sylvaticae (Luquet 1926) Rivas Mart., Báscones, T.E.Diáz, Fern.Gonz. et Loidi 1991 (= *Fagetum sylvaticae* Luquet 1926, *Fageto-Scilletum Lilio-Hyacinthii* (Lemée 1956) Cusset 1963 *nom. illeg.*)

Euphorbio hybernae-Fagetum sylvaticae Billy *ex* Thébaud, C.Roux, C.-E.Bernard et Delcoigne 2014

Luzulo sylvaticae-Fagetum sylvaticae Cusset 1964

Aceri pseudoplatani-Fagion sylvaticae (Oberd. 1957) Moor 1976

Doronico austriaci-Fagetum sylvaticae Seytre in Renaux, Timbal, Gauberville, Thébaud, Bardat, Lalanne, J.-M.Royer et Seytre 2019

Astrantio-Corylion avellanae H.Passarge 1978

Daphno mezerei-Coryletum avellanae C.Roux in Thébaud, C.Roux, C.-E.Bernard et Delcoigne 2014

Luzulo luzuloidis-Fagetalia sylvaticae Scamoni et H.Passarge 1959
Luzulo luzuloidis-Fagion sylvaticae W.Lohmeyer et Tüxen in Tüxen 1954

Solidago virgaureae-Fagetum sylvaticae (Cusset 1964) Renaux, Timbal, Gauberville, Thébaud, Bardat, Lalanne, J.-M.Royer et Seytre 2019 (= *Deschampsio flexuosae-Fagetum* Lemée *ex* Cusset in Cusset et Lachapelle 1961 *nom. illeg* (Art. 31)

Vegetation series seen during the excursions

H1: climatophilous, neutrophilous, mesomontane, atlantic beech forest holoseries of *Adoxo moschatellinae-Fagetum* (Chaudefour, Monneaux). H1b: the same series with matured forest dominated by *Abies alba* (Capucin).

H2 : climatophilous, meso-acidiphilous, mesomontane, subatlantic beech forest holoseries of *Luzulo sylvaticae-Fagetum* (Chaudefour, Monneaux, Pavin, puy de Dôme).

H3: climatophilous, acidophilous, mesomontane, species-poor beech forest holoseries of *Solidago virgaureae-Fagetum* (Chaudefour, Monneaux, Capucin). H3b: the same series with mature forest dominated by *Abies alba* (Capucin).

H4 : climatophilous, neutrophilous and chionophilous, upper montane, beech forest holoseries of *Doronico austriaci-Fagetum* (Chaudefour, Monneaux, Plomb, Impradine).

H5 : climatophilous, meso-acidiphilous/neutrophilous, mesomontane, atlantic beech forest holoseries of *Euphorbio hybernae-Fagetum* (Pavin, puy de Dôme). H5b : climatophilous, subneutrophilous, submontane, atlantic beech forest holoseries of *Euphorbio hybernae-Fagetum coryletosum* (puy de Dôme).

C1 : edaphohygrophilous, mesomontane, mesotrophic/eutrophic willow grove curtaseries of the *Salicetum pentandro-atrocinereae* (Chaudefour, Monneaux).

C2 : climatophilous, lower subalpine, mountain ash and goat willow wood curtaseries of *Pruno petraeae-Sorbion* dominated by *Sorbus* aucuparia, *Aria edulis* and *Salix caprea* (puy de Dôme).

C3 : edaphoxerophilous, of basaltic south-facing slopes, sheltered climate, submontane to montane, thicket curtaseries of *Amelanchiero-Buxion* (Murat).

P1 : edaphohygrophilous, montane, subject to rivular flooding, tall-forb permaseries of *Crepido paludosae-Adenostyletum alliariae* (Monneaux).

P2 : edapho-aerohygrophilous, montane, eutrophic, tall-forb permaseries of *Doronico austriaci-Campanuletum latifoliae* (Chaudefour).

P3 : climatophilous, thermomesophilous, mesotrophic, subalpine tall-herb meadow permaseries of *Calamagrostietum arundinaceae* (Monneaux, Plomb, Impradine).

P4 : climatophilous, subalpine, heath permaseries of *Allio victorialis-Vaccinietum* (Monneaux, puy de Dôme).

P5 : climatophilous, chionophilous, of sheltered slopes, subalpine, tall-herb meadow permaseries of *Heracleo sphondylii-Calamagrostietum* (puy de Dôme).

GP1 : edaphoxerophilous subalpine geopermaseries of high trachytic rocky slopes (puy de Dôme).

GP2 : edaphoxerophilous, under sheltered climate, submontane to montane geopermaseries on basaltic rocks (Murat).

GP3 : climatophilous, upper subalpine, heath geopermaseries, on the cold summits (Plomb, Impradine).

GP4 : climatophilous, subalpine geopermaseries of sheltered, snow-covered slopes on deep soils (Plomb, Impradine).

GP5 : edaphoxerophilous, subalpine, geopermaseries of cold summit rocks and walls (Impradine).

GP6 : edaphoxerophilous, subalpine geopermaseries of warm and sunny rocks (Plomb).

GP7 : edaphochionophilous, subalpine geopermaseries of concave landforms, basins, ravines, with short growing season (Plomb).

GC1 : climatophilous, lower subalpine geocurtaseries of the snowy timberline (Impradine).

GC2 : climatophilous, subalpine geocurtaseries, on warm and dry south-facing slopes (Plomb).

GC3 : edaphohygrophilous, peaty and flooded, upper montane to subalpine geocurtaseries of wetlands at the emergence of the hydrographic network (Plomb, Impradine).

GC4 : edaphoxerophilous, upper montane to subalpine geocurtaseries of silicate large boulders screes (Plomb).