Eastern Alpine and Dinaric Society
for Vegetation Ecology

40th Meeting
Banja Luka, Bosnia and Herzegovina
June 19-22, 2024

Book of Abstracts

Banja Luka, 2024

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Banja Luka, Bosnia and Herzegovina, June 19-22, 2024

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PREFACE

Dear Colleagues and Friends,

On behalf of the University of Banja Luka, Faculty of Forestry, Society for the Protection of Natural Heritage – Arbor Magna and the Eastern Alpine and Dinaric Society for Vegetation Ecology (EADSVE), we are delighted to welcome you to the 40th EADSVE Meeting. This significant event is being held at the Faculty of Forestry in Banja Luka, in collaboration with Arbor Magna.

Banja Luka, the academic, financial, and administrative center of Republika Srpska, is proud to host this important symposium. The Faculty of Forestry has been a distinguished member of the University of Banja Luka for over 30 years. It is with great honor and excitement that we host the EADSVE meeting for only the second time in Bosnia and Herzegovina, the first being organized by Prof. Fukarek at the Faculty of Forestry in Sarajevo back in 1969.

This year's symposium has attracted 63 participants who will present 22 oral and 26 poster presentations, representing a total of 191 authors from 16 countries. Your attendance underscores a shared commitment to scientific exellence and the exchange of ideas that have defined the EADSVE meetings for the last more than 60 years. This meeting is not only an opportunity to share knowledge but also to explore the beautiful and culturally rich city of Banja Luka. We trust that you will enjoy discovering its historical landmarks, natural beauty, and warm hospitality.

We extend our thanks to the presenters, chairpersons, and the students whose contributions are vital to the success of this meeting.

We have strived to ensure that this conference is well-organized and meets your expectations. We hope it will be a fruitful and constructive platform for the exchange of ideas and scientific challenges, as well as straightening existing bonds and fostering new ones.

Once again – a warm welcome to Banja Luka. We wish you productive discussions and a rewarding experience at the 40th EADSVE Meeting.

Organizing Commity

PROGRAMME

Wednesday, June 19, 2024

Venue:	Faculty of Forestry, University of Banja Luka, Bulevar Vojvode Petra Bojovića 1A, 78000 Banja Luka, Bosnia and Herzegovina
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19:00-20:00	Welcome Reception

Thursday, June 20, 2024

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	Information about next meeting
	Excursions and social dinner info

20:00-2:00	SOCIAL DINNER (Restaurant Stara Ada)

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POSTERS

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3. Vladan Djordjević, Svetlana Krdžić, Elvedin Šabanović, Spyros Tsiftsis: First record of a natural hybrid × *Gymnigritella suaveolens* (Orchidaceae) in Serbia

4. Dragana Jenačković Gocić, Ivana Kostić Kokić, Danica Vukotić, Danijela Nikolić, Irena Raca, Tatjana Anđelković: Floristic and ecological differentiation of certain *Potamogeton* dominated communities: a case study of the central Balkan Peninsula

5. Danica Vukotić, Nevena Kuzmanović, Gordana Andrejić, Dragana Jenačković Gocić: *Cyperus glomeratus* dominated community: a case study of deserted sand-gravel pits in Southern Serbia

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8. Dmitar Lakušić, Nevena Kuzmanović: The communities of *Sesleria uliginosa* in the wetlands of the glacial lakes of Mt. Durmitor (Montenegro)

9. Elvedin Šabanović, Ćamil Omerhodžić, Šemso Šarić: Wild orchids (Orchidaceae) in the are of Lake Čapljak

10. Karlo Mikić, Željko Škvorc, Krunoslav Sever, Magdalena Brener, Daniel Krstonošić: Changes in floristic composition and biodiversity over a decade of succession in dry grasslands on Slavonian Mt. (Croatia)

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ORAL PRESENTATIONS

Diversity and classification of Pannonian sand-dune vegetation

Mirjana Ćuk[1,2], Andraž Čarni[3,4], Dariia Borovyk[1,5], Kryštof Chytrý[1,6], Dmytro Iakushenko[7,8], Zoltán Botta-Dukát[9], Anikó Csecserits[9], Renata Ćušterevska[10], Jiří Danihelka[1,11], Ružica Igić[2], Miloš Ilić[2], Svitlana Iemelianova[1,5], Monika Janišová[12], Ilona Knollová[1], Anna Kuzemko[5], Ankica Milovanović[2], Dragica Purger[13], Tamás Rédei[9], Tijana Šikuljak[2], Željko Škvorc[14], Rosen Tzonev[15], Iuliia Vasheniak[16], Dragana Vukov[2], Wolfgang Willner[6,17], Milan Chytrý[1]

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Continental sand dunes are covered by sparse vegetation and characterized by a relatively rapid succession of plant cover. Inland sand dune pioneer vegetation presents mostly species-poor grasslands dominated by perennial tussock grasses and herbs, with frequent occurrence of annuals and cryptogams. At the time scale of a few decades, pioneer vegetation on sand successively develops into different types of steppe or woodland. Although legally protected, inland sand dune vegetation is under strong anthropogenic influence, which has already resulted in massive habitat loss and qualitative deterioration of many of the remaining inland sand dunes. However, their value for biodiversity conservation is very high since various species of narrow distribution and specific affinities are related to these habitats.

The vegetation on inland sand dunes can change over time due to a variety of natural and human-induced factors. In the national classification systems of the Czech Republic, Hungary, Romania and Ukraine, the vegetation of inland sand

dunes is divided into two classes - *Koelerio-Corynephoretea canescentis* Klika in Klika et Novák 1941 and *Festucetea vaginatae Soó 1968*. The first class comprises vegetation of acidic sands (*Corynephoretalia canescentis* Klika 1934) and pioneer grasslands on shallow soils of rock outcrops (*Alysso-Sedetalia* Moravec 1967, *Sedo-Scleranthetalia* Br.-Bl. 1955, *Thero-Airetalia* Rivas Goday 1964). *Festucetea vaginatae* contains vegetation of sandy steppes distributed in the forest-steppe and steppe zones of the Pannonian region and Eastern Europe. In contrast to the suboceanic sand grasslands, the communities of this class usually occur on base-rich sands and are richer in species.

In this study, we analyzed 86,113 plots stored in the European Vegetation Archive and 6,123 additional (published and unpublished) plots collected from experts across Europe. Due to the absence of clear classification of the vegetation on inland sand dunes, particularly in the Pannonian-Pontic region, our study provides syntaxonomical classification of sandy vegetation of Europe. It revises existing classification and establishes formal definitions for high-rank syntaxa of vegetation on inland sand dunes.

Key words: inland sand dune, vegetation classification

Acknowledgements: This research was supported by the Visegrad Fund

Coenosystematic analysis of sandy grassland in the centre of Carpathian Basin

Károly Penksza[1], Szilárd Szentes[2], Zoltán Bajor[1], Eszter Saláta-Falusi[1], Zsuzsa Lisztes-Szabó[3], Dénes Saláta[4], Péter Csontos[5], Attila Fűrész[1], Gabriella Fintha[1], Dániel Balogh[1], Tünde Szabó-Szöllősi[1], Márta Fuchs[6], Erika Micheli[6]

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We examined the sandy grasslands in steppe-forest-steppe vegetation along the Danube in the central part of the Carpathian Basin. We studied the grasslands in terms of coenology, focusing on the dominant *Festuca* taxa. The survey was conducted on 4 different locations in the Carpathian Basin. Cover of dominant grass (*Festuca*) species was used as an indicator value. Pedological background was also examined. Coenosystematic analysis has shown *Festuca pseudovaginata* mainly in forest-shrub areas, and the samples also contained elements of *Quercetea pubescentis-petraeae* and steppe taxa. In *Festuca wagneri* grasslands, proportion of taxa of *Festucetalia valesiacae* and *Festuco-Brometea* was higher. In addition, all three vegetation types were less diverse at their northern and southern edges, and contained also forest, steppe and closed grassland species at greater proportion. The *Festuca pseudovaginata* has evolved on forest soils. The soil profile showed 1,5 m deep forest soil, and the amount of organic matter was higher. The dominant *Festuca* taxa of these vegetation types are good indicators of the changes in the vegetation and their ecological background. The central sandy grassland, forest-steppe areas of the Carpathian Basin have become mosaic-like, but the present survey affirmed that several patches of the original vegetation have remained.

Key words: *Festuca vaginata, Festuca p*seudovaginata, steppe, forest-steppe

Acknowledgement: The survey was supported by OTKA K-147342

Transferability of the Multiple Potential Natural Vegetation Model within the Pannonian biogeographic region

Imelda Somodi[1], Krisztina Dóra Konrád[2,3], Kriszta Szabadi[1], Andraž Čarni[4,5], Mirjana Ćuk[6], Zoran Galić[7], Adrienn Gyalus[3], Alen Kiš[8], Annamária Laborczi[9], Siniša Ozimec[10], László Pásztor[9], Ranko Perić[8], Ivan Pilaš[11], Klára Szabados[8], Gábor Szatmári[9], Tamás Vinkó[12], Ivana Vitasović-Kosić[13], Ákos Bede-Fazekas[1,14]

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Predictive Vegetation Models (PVMs) are often applied to estimate climate change's impact on vegetation. However, typically, these models are trained on the same area as applied to, while climate change will likely create conditions that are only present outside the focus area contemporarily. Therefore, performance of PVMs outside the focus area, particularly in areas closer to the expected climate, i.e. transferability, is a key indicator to assess their ability to estimate the impact of climate change.

In our study, we tested the transferability of multiple potential natural vegetation model (MPNV) of Hungary, a variant of PVMs. Transferability was measured by the performance on new areas with expectedly closer climate to that of the future in Hungary.

Therefore, we applied the models to areas within the Pannonian biogeographic region, but outside the training area, i.e. Hungary. The study area included Prekmurje from Slovenia, northern parts of Slavonia and Baranja from Croatia and the northern 2/3 of Vojvodina, Serbia. Model predictions were compared with vegetation data collected from existing sources and dedicated field sampling.

We identified that predictions of zonal and wooded vegetation types matched observations well. Differences between model predictions and observations emerged for certain herbaceous types and particularly in Vojvodina. Saline steppes were among these, which is particularly concerning as these habitats are expected to benefit from climate change. Furthermore, given that Vojvodina appears to harbor a climate similar to future Northeastern Hungary, our results warn that a prerequisite for successful climate change impact assessment is the training of models including a broader area than the focus area—in our case: Hungary.

Key words: predictive vegetation models, climate change, transferability

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Vegetation diversity of Bulgaria – existing knowledge and future perspectives

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The existing diversity in the climatic, soil and geological conditions on the territory of the country determine a significant variety of vegetation types. During the last 10-15 years, after the fast development of phytocoenological database, data about existing vegetation types in Bulgaria was digitized and easily accessible. Nowadays they are predominantly stored in 1 national (Bulgarian National Database) and 2 regional databases (Balkan Vegetation Database, Balkan Dry Grassland Database). Together with this the fast development of different numerical methods for analysis of vegetation data helped for more objective differencing of existing vegetation units on European and national scales. 30,151 phytosociological relevés were used in this analysis. The application of the ArcGIS 10.1 software was used for the analysis of vegetation data distribution range and mapping.

Vegetation diversity of Bulgaria is still not fully investigated and the established number of vegetation units depends on the investigation method and the different concepts for their range and division. A significant portion of the relevés were collected before 1990 and follow the Dominant approach. The majority of the relevés were collected after 2010 (72.3%). Currently, based on phytosociological data, the plant diversity of Bulgaria is represented by 50 classes, 74 orders, 103 alliances, and 136 associations.

The richest classes are *Festuco-Brometea, Carpino-Fagetea sylvaticae* and *Molinio-Arrhenatheretea*. Significant data were collected during the period 2017-2023 for the classes *Papaveretea rhoeadis, Phragmito-Magnocaricetea, Digitario sanguinalis-Eragrostietea minoris, Artemisietea vulgaris, Crataego-Prunetea, Helianthemetea guttati, Sisymbrietea, Epilobietea angustifolii, Lemnetea, Bidentetea* and *Potamogetonetea*.

The classes *Carici rupestris-Kobresietea bellardii, Thero-Salicornietea strictae, Charetea intermediae, Littorelletea uniflorae, Juncetea maritimi, Cakiletea maritimae, Adiantetea, Cymbalario-Parietarietea diffusae, Oxycocco-Sphagnetea* are still largely unexplored.

In recent years, as a result of targeted research, plant diversity has been well studied in the southern and western parts of the country, while in Northern and Eastern Bulgaria, studies are insufficient. Its investigation needs to continue and to cover all existing vegetation types systematically on the whole territory of the country.

Key words: Braun-Blanquet approach, syntaxonomy, vegetation units, vegetation database

Syntaxonomy and ecology of class *Bidentetea* Tx. et al. ex von Rochow1951 and class *Isoeto-Nanojuncetea* Br.-Bl. et Tx. in Br.-Bl. et al. 1952 in Bulgaria

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Till now there have been no consistent in-depth phytocenological studies of classes *Bidentetea* and *Isoeto-Nanojuncetea* in the country. This research focuses on hygrophytic and mesophytic plant communities near rivers, canals, and swamps, found in lowlands and semi-mountainous regions in Bulgaria.

During the period 2018-2023, 431 phytocoenological relevés following the Braun-Blanquet approach were collected. The plot size used was 8-16 m^2. In addition, we collected data for some abiotic factors such as slope, altitude, bedrock and inclination. All relevés were contributed to the Balkan Vegetation Database (EU-00-013). The nomenclature of species was standardized according to the Euro+Med PlantBase. The hierarchical clustering was performed by the PC-ORD software package using Bray-Curtis dissimilarity and flexible beta clustering algorithm. The species cover values were square root transformed and clusters were standardized to equal size. The diagnostic species were determined by calculating the Phi-coefficient and only the statistically significant values, evaluated by Fisher's exact test ($P<0.05$), were considered.

The syntaxonomical diversity of class Bidentetea was represented by 1 order (*Bidentetalia*), 2 alliances (*Bidention tripartitae* and *Chenopodion rubri*), 7 associations (*Bidentetum tripartitae, Polygonetum hydropiperis, Bidenti-Polygonetum mitis, Rumicetum palustris, Rumicetum maritime, Rumici crispi–Alopecuretum aequalis, Chenopodietum rubri* and 5 plant community types (*Pycreus longus*, *Persicaria minor*, *Persicaria maculata*, *Cyperus odoratus*, *Rorippa palustris*).

The syntaxonomical diversity of class *Isoeto-Nanojuncetea* was represented by 1 order (*Nanocyperitalia*), 1 alliance (*Nanocyperion*), 2 associations (*Dichostylido michelianae-Gnaphalietum uliginosi*, *Cyperetum flavescentis*) and 3 plant communities types (*Cyperus fuscus, Juncus articulatus, Juncus tenageia*).

Key words: classification, phytosociology, syntaxonomy, wetlands, saline and disturbed habitats, vegetation

Syntaxonomy and ecology of class *Lemnetea* O. de Bolós et Masclans 1955 in Bulgaria

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This study focuses on the syntaxonomy and ecology of the aquatic vegetation of the class *Lemnetea*. It comprises the stands of free-floating macrophytes. Up to this moment, it has not been studied comprehensively for the territory of Bulgaria. Three alliances and 9 associations have been recorded for this vegetation type inthe country so far.

We selected a total of 307 relevés, stored in the Balkan vegetation database (EU-00-013). They were collected between 2000-2023, following the Braun-Blanquet approach. 44 of them are published while 263 are not. The plot size is mostly in the range 5-10 m^2. Data for relevant ecological factors was collected. The nomenclature of species was standardized according to the Euro+Med PlantBase. The hierarchical clustering was performed by the PC-ORD software package using the Bray-Curtis dissimilarity and the flexible beta clustering algorithm. The species' cover values were square root transformed and clusters were standardized to equal size. The diagnostic species were determined by calculating the Phi-coefficient and only the statistically significant values evaluated by Fisher's exact test ($P<0.05$) were considered. Detrended Correspondence Analysis was used to reveal the major environmental gradients.

We classified the vegetation of this class to 1 order (*Lemnetalia minoris*), 3 alliances (*Lemnion minoris*, *Utricularion vulgaris*, *Stratiotion*) and 11 associations and 1 community type (*Lemnetum minoris*, *Lemno-Spirodeletum polyrhizae*, *Potamo-Ceratophylletum submersi*, *Lemno-Azolletum filiculoidis*, *Lemnetum gibbae*, *Marsileaetum quadrifoliae* (natantis), *Ceratophylletum demersi*, *Lemno-Hydrocharitetum*, *Lemno-Utricularietum*, *Spirodelo-Salvinietum natantis*, *Lemnetum trisulcae* and a community of *Lemna minor* and *Ceratophyllum demersum*).Two associatons (*Potamo-Ceratophylletum submerse* and *Marsileaetum quadrifoliae* (natantis) are recorded for the first time for the territory of the country.

Key words: classification, wetland vegetation, syntaxonomy, ecology, Lemnetea, Bulgaria, associations

Response of forests ecosystems to varying fire severities in northern Dinaric karst mountains (Slovenia)

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This study deals with forest fires in marginal areas of Mediterranean climatic and biogeographical regions (Northern Mediterranean), where fires were not common. The aim of the research was to detect differences in floristic composition and characteristics at different intensities of fire damage and to analyse changes in forest ecosystems during forest fires that occurred in the summer of 2022. The study included both zonal forests and non-native black pine (Pinus nigra) forests.

The study showed that satellite data, orthophoto interpretation and in-situ vegetation sampling (during the 2023 growing season) provide equivalent information on fire severity, allowing future assessments without field sampling. TWINSPAN classification analysis identified clusters of plots based on species composition and fire severity, with the first DCA axis correlating with fire severity. Post-fire areas became warmer, drier and lighter, which favoured the growth of ruderal and other post-fire emergent species.

The results suggest that post-fire recovery can be left to natural processes without human intervention, except in the case of non-native pine stands where planting or seeding may be necessary. Otherwise, it is necessary to control the possible occurrence of invasive species. Isolated adaptations of species to fire, such as heat-stimulated germination, have also been observed, which may have evolved in regions exposed to frequent fire and where fire acts as an evolutionary factor.

Key words: ecology, remote sensing, trait, vegetation, wildfire

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Signals of global environmental change in the understory vegetation of *Quercus*-dominated forests in Slovenia over the past three decades

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Vegetation resurvey studies utilising data from permanent plots are of great importance for detecting the effects of global environmental drivers on temperate forests. We analysed long-term vegetation changes in Slovenian oak forests, encompassing five sites dominated by *Quercus robur* (QR; 25 plots) and four sites dominated by *Quercus petraea* (QP; 20 plots). The initial survey was conducted in 1992/93, with a resurvey of selected plots in 2023. Vegetation records of vascular plants in the understory (herb and shrub layer) and overstory layers were carried out following the standard Braun-Blanquet method.

Since the early 1990s, the tree layer cover decreased on average for 42% in QR and for 19% in QP plots. This resulted in a denser understory vegetation and a significant increase in plot-level species richness in QR, but its slight decrease in QP forests. The extensive loss of tree layer and intensified management-related disturbances in QR forests caused significant changes in understory species composition. Species turnover in QR was mainly driven by the colonization of disturbance-tolerant taxa, whereas the compositional shift in QP was more due to species losses. Using plant ecological indicator values, we detected a process of vegetation thermophilization in both forest types, indicating an effect of rapid climatic warming. The understory communities are now more similar to each other than they were 30 years ago, suggesting a decline in beta diversity and a process of floristic homogenization.

Despite some common temporal trends, the vegetation responses during the 1992/93-2023 period exhibited forest type-specific patterns. The study presents evidence of understory vegetation dynamics triggered by increased oak canopy mortality (a strong local driver particularly in QR plots). The results have also revealed the signals of global change symptoms (thermophilization and homogenization), which acted rather independently from the observed decline in tree layer cover.

Key words: vegetation resurvey, permanent plots, oak mortality, thermophilization, floristic homogenization, tree layer cover

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Invasion of non-native plant species in oak forests in Slovenia: A resurvey study after 30 years based on permanent vegetation plots

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The conservation status and ecological integrity of forests, particularly in lowland areas, are threatened by the spread of non-native plant species, also known as neophytes. Long-term resurvey studies are necessary for the assessment of the temporal dynamics of neophytes in forests, but such data are scarce.

In 2023, we resampled 45 permanent vegetation plots established in 1992/93 in two forest vegetation types: oak-hornbeam forests dominated by *Quercus robur* and colline oak-beech forests dominated by *Quercus petraea*. Over the past 30 years, oak forests have experienced severe oak mortality, with greater habitat degradation in *Q. robur*. In the early 1990s, only three neophytes with low abundance were recorded on all plots. By the 2023 resurvey, the number of neophyte species increased to 22, comprising 15 herbaceous and 7 woody species, representing 7% of the total understorey species pool. The plots dominated by *Q. robur* exhibited a significant increase in neophyte numbers and cover, whereas the plots dominated by *Q. petraea* did not. The most common neophytes found were *Impatiens parviflora*, *Solidago gigantea*, *Erigeron annuus* and *Erechtites hieraciifolia*. The richness and cover of neophytes decreased with the cover of the tree layer. All non-native species colonised disturbed areas, except for *Impatiens parviflora*, which was able to colonise less degraded and shaded understorey sites.

The expansion of neophytes has been attributed to habitat degradation, particularly the loss of oak stands through mortality, which has been identified as the main cause. This was compounded by the effects of management disturbances affecting both understorey and soil conditions. It is anticipated that the invasion of neophytes will continue or even increase in the future, as altered light conditions and disturbances further reduce the resilience of forest habitats to their spread.

Key words: long-term vegetation change, invasive non-native plants, oak mortality, *Quercus robur*, *Quercus petraea*, canopy openness, *Impatiens parviflora*, Slovenia

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Impact of scattered tree (*Fagus sylvatica*)on plant communities, soil resources, and fungal diversity

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Scattered trees are an easily discernible feature in landscapes around the world. They are integral components of a broader ecosystem characterized by grazed and/or mowed open areas, generically defined as "wooded grassland." These systems are highly dynamic, but particularly threatened in the Mediterranean basin and marginal areas due to the abandonment of traditional agro-pastoral management. Despite recognition of the ecological relevance of wooded grasslands in Europe and the acknowledged importance of scattered trees in supporting biodiversity, few holistic studies have been conducted that include multiple ecosystem components simultaneously, and no study has been done in the Apennine area. This study aims to investigate the ecological impact of large, scattered *Fagus sylvatica* trees in seminatural grasslands of the central Apennines. We established four positions identified on the basis of a distance gradient from the trunk to the open grassland. Here, we analyzed vegetation, grassland yield, soil chemistry, root density, hydrological properties, light availability, and soil fungal diversity. Species richness, aboveground live biomass, and ground light availability increased with increasing distance from the tree trunk towards the grassland. Conversely, litter and root biomass decreased. In the soil, soil pH and nitrogen content increased with increasing distance from the trunk. Finally, four distinct plant communities were identified as significantly associated with the four positions.

Key words: wooded grassland, vegetation, fungi, biodiversity, roots

Which grazing livestock is the best option for the conservation of wood pasture habitats in the Pannonian region?

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Wood-pastures have characteristic farming tradition in the Pannonian biogeographical region. In the current research, we investigated wood-pastures of typical geographic locations in Hungary. These sample areas were situated in the North Hungarian Mountain Range, which had similar environmental features, however, grazed by different animals. The sample area of Cserépfalu was grazed by Hungarian Grey Cattle, but the Erdőbénye was grazed by Hungarian Racka Sheep. Both sample areas had different grazing pressures by both livestock animals. We made coenological surveys in 2 x 2 m sampling quadrats between 2012 and 2021 based on the method of Braun-Blanquet, estimating the coverage in percentage. We used the distribution of the diversity and grassland management value to assess the vegetation condition. Results of the two studied livestock were different. The diversity values of woody-shrubby-grassland mosaics were high. The grazing by cattle produced a variable, mosaic, shrubby area with high diversity values. In contrast, the grazing by sheep produced an area with lower cover values, but better grassland management values. Consequently, according to our results, grazing by cattle provided appropriate solution to create and conserve wood-pasture habitats in the studied areas of Hungary. Nevertheless, grazing by sheep provided adequate example to form a valuable grassland for grassland management values.

Key words: grassland management value, grazing, Pignatti life form, ruminant, wood-pasture

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Ecological variations and their effect on plants, vegetation and diversity patterns in dolines in Illyrian floristic province

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Karst areas are characterized by specific geomorphological forms (dolines, karst poljes, karst caves, etc.), which have a significant impact on biodiversity. Due to the permeability of carbonate bedrock for water, lack of water(humidity) represents one of the ecological limitations for plants. The relief formations and topography enable diverse ecological conditions (soil depth, soil moisture, difference in north-facing and south-facing slopes etc.) and the development of specific habitats, e.g. humid microclimate conditions in the bottom of dolines which contribute to the formation of vegetation patterns in the landscape.

Our research is focused on medium-sized dolines (up to 20 m depth, up to 50 m radius). This type of dolines does not have such a profound impact on vegetation patterns as larger karstic depressions (e.g. collapse dolines, uvalas, poljes), although they are often densely distributed in the landscape and thus still present a wider network of habitats for plants, for certain plants possibly a distinct network of microrefugia.

Vegetation patterns in dolines differ among macroclimatic zones, e. g., in the sub-Mediterranean zone diversity is the highest at the bottom of dolines, in contrast in the montane zone the highest diversity is on the slopes. Nevertheless, there are some common features, e.g. increased humidity and ruderal conditions at the bottom. The effect of climate modulation on the bottom of doline is the strongest in the sub-Mediterranean region.

We sampled the vegetation of 60 dolines in six selected regions of the Illyrian floral province, using the transect method. To evaluate ecological conditions and the impact of micro-topography inside of dolines, we recorded dolines with hand-held terrestrial LiDAR. We created high-resolution 3D relief models with the help of which we obtained explanatory variables for vegetation patterns. The research regions were divided into three groups; sub-mediterranean, montane and sub-pannonian.

Key words: karst, terrestrial lidar, biodiversity, dolines, Illyrian floral province, vegetation

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The Genus *Galium* L. (Rubiaceae) in North Macedonia

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This paper will present the results of multi-year research on the genus Galium, within the Flora of North Macedonia project, which is being implemented in the Macedonian Academy of Sciences and Arts. All the literary data mentioned in the floristic literature for Macedonia were taken into account, starting from the oldest data of Grisebach (1843-44) ending with the latest data published in various publications. Rich herbarium material was processed deposited in the Herbarium of the Institute of Biology, Faculty of Natural Sciences and Mathematics, Skopje (MKNH). The genus Galium in the territory of North Macedonia is represented by 34 species, 4 subspecies, 2 varieties and 2 forms belonging to 9 different sections: Sect. Platygalium Koch (1 species), Sect. Hylaea (Griseb.) Ehrend. (1), Sect. Trachygalium K. Schum. (1), Sect. Aparinoides (Jordan) Gren. (3), Sect. Gallium (2), Sect. Leiogalium Lebed (15), Sect. Leptogalium Lange (1), Sect. Jubogalium Ehrend. (1) and Sect. Kolgyda Dumort (Sect. Aparine Koch) (9). The polymorphism is particularly present in the Sect. Kolgyda Dumort (Sect. Aparine Koch), with 9 species, dominated by annual plants as well as in the Sect Leiogalium Lebed, represented by 19 taxa, dominated by perennial plants. Most of the species of the Sect Leiogalium represent southern Balkan endemics (*Galium asparagifolium, G. breviramosum, G. helenicum, G. macedonicum, G. oreophilum, G. rhodopeum, G. rigidifolium, G. speciosum*, and others), of which two species are described from the territory of North Macedonia - *Galium macedonicum* Krendl (Locus classicus: Jakupica - Papradišta) and *Galium speciosum* Krendl (Locus classicus: Prilep - Pletvar).

Key words: classification, distribution, flora, Galium, North Macedonia

Acknowledgements: This research was supported within the research program of the Macedonian Academy of Sciences and Arts. Part of the herbarium material was revised by Franz Krendl (1926-2020), one of the best experts on the genus Galium in the Balkan Peninsula, curator at the Botanical Department of the Natural History Museum, Vienna.

Distribution, population size, ecology and variability of autumn flowering snowdrop (*Galanthus reginae-olgae* Orph.) along the northern limit of its Balkan distribution (Croatia, SE Europe)

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Galanthus reginae-olgae Orph. is an autumn- to early winter-flowering snowdrop species, with leaves absent or very short at the onset of flowering, first discovered in the Taigetos Mts. in southern Greece and described as by T. G. Orphanides in 1876. To date, it was found in Greece, Corfu, Ionian Islands, Albania, Montenegro, Bosnia and Herzegovina, Italy, Sicily and in Croatia. The field study in 2023 revealed as many as 35 populations in southern Croatia, some of them counting up to 100,000 specimens. Most of the populations exhibit semi-sciophyte behaviour within transitional habitats (ecotones) from insolated grassland to shaded eu- and sub-Mediterranean thickets and forests, and are found in the elevational range from the sea level to 664 m a.s.l., at the average distance of 5.44 km from the sea. Based on the bioclimatic CHELSA 2.1. model, the studied population prefer Mediterranean conditions with a mean annual air temperature of 14.61 °C and mild winters without frost events. The high average annual precipitation that exceeds 1.600 mm, although limited to the winter period, is beneficial for this invernal geophyte. The analyses of the temporal-thermic data gave us clear insight into environmental circumstances that could serve as triggers for the onset and duration of snowdrop anthesis. Finally, based on observed leaf length and flowering time (from December to February), the investigated population could be designated as *Galanthus reginae-olgae* subsp. *vernalis* Kamari. Considering that the Croatian populations are rare and scattered along the northern border of the species range, future monitoring would give us insight into the adaptability of the species to habitat changes and clarify in what way the species adapts its phenology (emerging, flowering, pollination, and fruiting) to evident climate changes in the Mediterranean region.

Key words: anthesis, bioclimatic model, Croatia, *Galanthus reginae-olgae* subsp. *vernalis*, invernal species, transitional habitats

Floristic composition of habitats and invasive plants along the floodplains of the Sava River in the area of the City of Zagreb (Croatia)

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The Sava River is an important landscape element that divides the city of Zagreb into northern and southern parts. In spatial planning documents, the Sava is emphasized as an integral part of the "green ring" of Zagreb, which underlines the importance of preserving its ecosystems. Anthropogenic influences such as canalization and changes in the course of the river, as well as the large-scale urbanization of the area, lead to the establishment of invasive plant species and endanger the autochthonous flora.

The aim of this study, which was carried out in the 2022-23 vegetation period, was to inventory the vascular flora of the habitats along the Sava floodplain, especially those belonging to the Natura 2000 ecological network. A total of 199 plant taxa, divided into 59 families and 150 genera, were recorded at 10 sites along the Sava floodplain within the administrative boundaries of the City of Zagreb. The most frequently represented families are

Asteraceae (12.7 %), Poaceae (9.2 %), Fabaceae and Rosaceae with 6.6 % each, Brassicaceae, Caryophyllaceae and Lamiaceae with 5.1 % each.

Of these, 21 are invasive species, the most numerous of which are *Erigeron annuus* (L.) Desf., *Ambrosia artemisiifolia* L., *Ailanthus altissima* (Mill.) Swingle and *Amaranthus retroflexus* L.

The spectrum of life forms is dominated by hemicryptophytes (41 %), therophytes (26 %) and phanerophytes (18 %), while geophytes are represented by 9 %. Of the geoelements, the most numerous species are elements of the Eurasian flora and naturalized species.

The Sava floodplain represents a key point of diversity and harbors many special and rare plant and animal species. The results of this study provide new insights into the importance of protecting these habitats in terms of their plant diversity. Therefore, understanding and conserving the Sava River ecosystem is key to preserving the natural heritage and biodiversity of the city of Zagreb.

Key words: antropogenic influence, flooding, invasive plants, plant diversity, urbanization

Invasive relatives in Croatian waters - a new insight into the distribution and ecology of *Elodea canadensis* Michx. and *Elodea nuttallii* (Planch.) H. St. John

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Canadian and Nuttall's waterweed (*Elodea canadensis* Michx. and *E. nuttallii* (Planch.) H. St. John), are two invasive aquatic plants from North America. The first records in Croatia date from 1894 and 2006, respectively. Since previous investigations on these species were sporadical and local, a more systematical approach was undertaken from 2016 to 2022 - new insights of both species' distribution and ecology were made during the annual Water Framework Directive monitoring that covered the entire Croatian territory. Since *E. canadensis* is historically present in Croatia for a much longer period than *E. nuttallii*, it is subsequently more widespread. *Elodea nuttallii* has only been found in the Pannonian ecoregion so far. *Elodea canadensis* was, however, discovered for the first time in the Continental-Dinaric and Mediterranean-Dinaric ecoregions. Nearly three quarters (72,5%) of all *Elodea* records are in the Pannonian ecoregion, while 15% are in the Continental-Dinaric region and 12,5% in the Mediterranean-Dinaric ecoregion. Descriptive statistics was performed for physico-chemical and chemical parameters, as well as habitat characteristics. Vegetation relevés showed the most common accompanying species. Fitting multivariate models (CCA and NPMR) to species abundance revealed the ecological reaction of *E. canadensis* and *E. nuttallii* to environmental descriptors. Biochemical oxygen demand (BOD), conductivity (EC) and total phosphorus (Ptot) were identified as the most contribution predictors of the distribution of both species. *Elodea nuttallii* showed a higher preference for the more eutrophic sites (higher BOD, EC and Ptot) mostly represented by shallow, slow-flowing canals and impoundments with finer sediment, alongside the free-floating macrophytes. *Elodea canadensis* was recorded in more turbulent waters and on substrate of more variable size. In some eutrophic sites, the replacement of *E. canadensis* by *E. nuttallii* was also noticed supporting the idea that *E. nuttallii* is the more competitive congeneric species.

Key words: macrophytes, Southeastern Europe, freshwater habitat, invasive plants, water monitoring

Contribution to the distribution and phylogeny of *Euphorbia glareosa Pall. ex M. Bieb.* in the Balkan Peninsula

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The Balkan Peninsula, known for its numerous of glacial refugia, has been the subject of numerous phylogeographic studies in recent decades due to its highly heterogeneous topography and diverse mosaic of habitats. In this study, we investigate the phylogenetic relations of populations of the species *Euphorbia glareosa* in the area of the Balkan Peninsula. Due to the phylogenetic complexity and the morphological and genomic variability observed in this species, it has become the subject of extensive research. A variety of complementary methods have been used to study the phylogeny of the species, including nuclear ITS sequences, amplified fragment length polymorphisms, relative genome size estimation combined with chromosome counting, and morphometry. The genome size values were found to be variable, and the presence of polyploidy was confirmed by the examination of metaphase chromosomes. The AFLP analyses revealed a clear separation of some populations, which we consider to belong to a new taxon. Further research is required to clarify the phylogenetic relationships between the remaining populations of *E. glareosa* and to determine the extent of morphometric and genomic variability.

Key words: Balkan Peninsula, morphometry, phylogeny, polyploidy

First data for the pioneer vegetation of the class *Sedo-Scleranthetea* Br.-Bl. 1955 in the Republic of North Macedonia

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The class *Sedo-Scleranthetea* Br.-Bl. 1955 includes pioneer vegetation on shallow soils on rocky siliceous outcrops on siliceous rocks of temperate and boreal Europe. This vegetation type is poorly researched in the Balkan Peninsula. Only few data are available from some countries, while in other countries, such as N. Macedonia, there is no data at all about the vegetation of this class. The field research conducted on the vegetation in the area of the Nature Monument "Markovi Kuli" (Prilep) resulted with the first data about this vegetation type for the territory of N. Macedonia. Using the TURBOVEG software package, a database with a total of 186 vegetation relevés was created, of which 41 vegetation relevés came from own field research, and the remaining 145 vegetation relevés came from literary sources from Serbia, Greece and Bulgaria. With a series of hierarchical cluster numerical analysis in the JUICE software package with the PC-ORD program, we determined that the vegetation relevés from the territory of NM "Markovi Kuli" do not belong to any of the already defined associations from the rest of the Balkan Peninsula. Based on the results of the analysis, a new association *Erodio-Sedetum stefco* ass. nova was described. Within the frame of this association, two new subassociations are described – subass. *parentucellietosum latifoliae* subass. nova and subass. *sedetosum hispanicae* subass. nova. The analysis carried out showed that the new described plant communities are the most similar to the defined communities within the alliance *Diantho pinifolii–Jasionion heldreichii* Bergmeier et al. 2009 from Greece which belongs to the order *Sedo-Scleranthetalia* Br.-Bl. 1955 and the class *Sedo-Scleranthetea* Br.-Bl. 1955.

Key words: N. Macedonia, phytosociology, vegetation classification

Vegetation of the Iž island (Zadar archipelago, Croatia)

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The island of Iž belongs to the group of islands within the Zadar archipelago in the Middle Adriatic. It has an area of 16.51 km² and a coastline of 35.22 km. The highest altitude is 168 m a.s.l. Until now, the flora and vegetation on the island have not been explored. Our aims were to determine and explore the natural and semi-natural vegetation and related habitat types. The study was conducted in 2023. Vegetation was studied in accordance with the principles of the Braun-Blanquet approach.

Our preliminary results showed that the stands of forest associations *Fraxino orni-Quercetum ilicis* (*Fraxino orni-Quercion ilicis*, *Quercetea ilicis*) and *Pistacio lentisci-Pinetum halepensis* (*Pistacio lentisci-Pinion halepensis*, *Pinetea halepensis*) are restricted to the small fragments, while maquis occupy the largest area of the island. In addition, stands of the *Pistacia lentiscus-Myrtus communis* community, and garrigue of the *Cisto cretici-Ericion manipuliflorae* (*Ononido-Rosmarinetea*) are also abundant. Dry grasslands were found in small patches, nevertheless they contain a high species pool, including some plants that are rare in Croatia. Additionally, grasslands with diverse species composition and some protected or rare plants are found on abandoned fields and olive groves with different management histories. The rupicolous herbaceous vegetation of the salt-sprayed rocky cliffs (*Crithmo-Staticetea*) and the pioneer halo-nitrophilous vegetation (*Cakiletea maritimae*) are restricted to the narrow coastal strip, mainly in small bays. The thermophilic chasmophyte vegetation of the walls (*Cymbalario-Parietarietea diffusae*) is also recorded at several sites on the island. Vegetation dominated by *Typha angustifolia* was found in two well-preserved small karstic pools. These ecosystems contribute to the overall biodiversity of the island.

Key words: garrigue, maquis, Middle Adriatic, phytosociology, syntaxonomy

Vegetation of the southernmost part of Croatian territory – the Oštra Peninsula (Prevlaka)

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The peninsula of Oštra (often called Prevlaka) is the southeasternmost mainland part of the Republic of Croatia. It extends in the southeast direction and, with the last cape of Ponta Oštro (Cape Oštro), it closes the western part of the entrance to Boka Bay. On the Adriatic and Boka Bay sides, there are two small inlets, separated by an isthmus, i.e., a narrow land passage towards the peninsula. The peninsula is 2.5 km long, widest in the middle (480 m), and narrowest (170 m) on the western part. The area of the peninsula is 0.933 km² with a maximum altitude of 65 m. The southern rocky coast consists of steep coastal cliffs (up to 30 m high), while the northern one is mostly low. The bedrock consists of highly permeable Cretaceous limestones, while the predominant soil type is calcaric cambisol. The climate is Mediterranean (Csa type of the Köppen-Geiger classification). The area belongs to the meso-Mediterranean vegetation of the *Fraxino orni-Quercion ilicis* allliance. A multitude of anthropogenic pressures has profound negative impacts on the natural vegetation, mostly due to a long period of military occupation (1941-1992). Today, the peninsula is a popular tourist destination in the summer season.

In 2023 and 2024, vegetation was studied in accordance with the principles of the Braun-Blanquet approach. The largest area of the peninsula is covered by the *Myrto-Quercetum ilicis* association. Maquis communities are not optimally developed, they have a significant proportion of non-native species, mainly horticultural plant species planted during the military occupation. Rocky coastal vegetation (*Crithmo-Staticetea*) between the northern and southern coasts differs at the level of subassociations. Open areas are very rare, so vegetation of dry grasslands is not presented. In places where tourists most commonly stay, ruderal communities are mostly of a fragmentarily developed and/or they are species poor. In conclusion, the suggestions by the authorities to protect the peninsula with the category of significant landscape are neither feasible nor appropriate.

Key words: Adriatic coast, NE Mediterranean, phytosociology, vascular flora, vegetation

Bridging gap of 70 years of phytosociological survey-Classification of riparian forests in Vojvodina (Serbia)

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Riparian forests belong to the azonal vegetation types of Europe. As a biosystem often disrupted by human factors, its area is significantly reduced due to the conversion into arable land or forest plantations, formation of a network of canals and exploitation of wood. The mosaic structure of the Pannonian biogeographic region has all the characteristics of the natural forest-steppe vegetation at its origin. It is constructed by grasslands interspersed with structures of forested formations. Riparian forests are azonal type of vegetation, specific forest communities with a particular species composition related to the habitat formed on an alluvial plain.

The study area for this survey was the Southern part of the Pannonian plain, including the Northern part of Serbia, a province named Vojvodina. We sampled softwood riparian forests found at sites with more frequent and prolonged flooding, mainly built of species such as *Salix alba*, *Populus alba* and *P. nigra*. Hardwood forests are found at sites with less frequent flooding and are composed of *Fraxinus angustifolia*, *Ulmus laevis*, *U. minor* and *Quercus robur*. The sampling method was according to the seven-degree Braun-Blanquet scale. We collected 294 relevés over the course of 4 years. We added these to the 262 relevés collected from the literature to perform revision of syntaxonomic classification and nomenclature of riparian forest communities. Based on the obtained results the riparian forests of Northern Serbia can be classified into four classes: *Alno glutinosae-Populetea albae* P.Fukarek et Fabijanić 1968, *Salicetea purpureae* Moor 1958, *Franguletea* Doing ex Westhoff in Westhoff et Den Held 1969 and *Alnetea glutinosae* Br.-Bl. et Tx. ex Westhoff et al. 1946.

Key words: Braun-Blanquet scale, riparian forests, Pannonian region, syntaxonomic revision

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Phytocoenological analysis of forest vegetation in Lijevče Polje (northern Bosnia and Herzegovina)

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Lijevče Polje is a flat area in northern Bosnia situated between rivers Sava and Vrbas and Kozara Mt. Most abundant soil type is pseudogley, followed by humofluvisol, fluvisol, and gley soils. Historically, Lijevče has been and still is under strong anthropogenic impact, primarily agricultural. Forest areas that used to be the dominant vegetation type in the mid-18th century have been reduced to only about 15% today, while most of the wetland habitats have disappeared. Phytocoenological research of this area, as well as other lowland parts of Bosnia, is sparse, which is especially true for lowland forests.

Phytosociological research in Lijevče Polje was conducted from spring 2017 to summer 2023 using the standard phytosociological method (Braun-Blanquet, 1964). This resulted in a dataset consisting of 73 relevés of forest vegetation that were compiled into the Turboveg database and exported to Juice software for further analyses. Each relevé had coordinates, soil type, geological substrate, distance from the nearest river, and altitude recorded, while Ellenberg indicator values were calculated based on the floristic composition. TWINSPAN was used to divide the dataset four times resulting in 15 clusters. Those clusters were combined into ecologically and floristically homogeneous groups corresponding to associations.

The results indicate the presence of eight forest associations in Lijevče Polje. Within the *Carpino-Fagetea* class, the associations *Stellario-Carpinetum* and *Convallario-Carpinetum* were recognised. Within the class *Alno glutinosae-Populetea albae* associations *Pseudostellario-Quercetum roboris*, *Stellario nemorum-Alnetum glutinosae*, and *Fraxino pannonicae-Ulmetum glabrae* were recognized for the first time in BiH, along with the previously recorded *Genisto elatae-Quercetum roboris*. In the class *Salicetea purpureae*, the association *Salicetum albae* was recognised while *Carici elongatae-Alnetum glutinosae* was the only recognised association from the class *Alnetea glutinosae*. These findings represent a significant step towards classifications of this vegetation type in Bosnia and Herzegovina on an association level.

Key words: lowland forests, Lijevče polje, forest vegetation, *Carpino-Fagetea*, *Alno-Populetea*, *Salicetea purpureae*, *Alnetea glutinosae*

POSTER PRESENTATIONS

Relationship between the vegetation indices and the species composition of the pastures investigated under extreme climatic conditions in Pannonian sandy grasslands

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The effects of global climate change can also be observed in Hungary's climate. The present study analyses an example of this in sensitive grassland areas over a 5-year period, comparing the spring aspects of two extreme climatic years in particular and assessing the impacts on grassland areas that determine landscape use. The rapid development of satellites allows the most accurate analysis and monitoring of changes.

Satellite imagery was used to obtain quantile information through various multi-purpose applications. NDVI (Normalized Difference Vegetation Index) was used to detect vegetation activity and MNDWI (Modified Normalized Difference Water Index) was used to detect water saturation in the near-surface layers.

Our research covered the period 2017-2022, of which we highlighted 2 extreme years, 2020 and 2021, and analysed their spring conditions in detail. The satellite data were complemented and combined with field recordings using the classical quadratic method.

Over the 5 years studied, precipitation varied significantly, with the lowest in 2021 and the highest in 2022. Satellite imagery showed the impact of extreme climatic situation on the sandy grasslands along the river Ipoly. There are differences between the NDVI and MNDWI data of the different vegetation units and sampling points in the years studied, which correlate with the change in vegetation. The indices used in this case were applicable to both natural sandy grasslands and restored grasslands. The deviations were discernible and traceable. At the same time, the changes in vegetation that can be inferred from the data in the cenological records, were also indicative of environmental changes, especially changes in humidity conditions.

Key words: Sentinel-2A, extreme climatic conditions, NDVI, habitat changes

Acknowledgement: The survey was supported by OTKA K-147342.

Seed germination and seedlings growth parameters of two sandy grassland *Festuca* species in various soil mixtures

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This study was linked to an OTKA project on the vegetation of sandy grasslands along the Danube. During this survey, two grass species (*Festuca wagneri* and *Festuca tomanii*) were identified which, based on preliminary research, are suitable for urban planting and turf establishment in urban environments. We wanted to determine how well the seeds of the aesthetically selected individuals germinate and on which soil type they germinate most effectively. This information may also be important for future cultivation. It was assumed that seeds of *Festuca* species germinate better on sandy soils. For this purpose, the seeds of ten *Festuca wagneri* individuals and five *Festuca tomanii* individuals, selected on the basis of aesthetic criteria, were sown in six different substrates: sand-peat mixture, sand, coconut fibre, peat, coconut fibre-sand mixture, and native sandy soil. The growth and germination rates of seeds sown in peat and coconut fiber substrates were higher than in the native sandy soil. This was contrary to the expected result.

The results obtained suggest that *Festuca* seeds germinate on dead plant debris similar to peat soil structure or on the surface of live mosses than on bare sand.

Key words: sandy grassland, Festuca, soil mixture, sand surface, peat

Acknowledgements: The research was supported by OTKA K-125423, OTKA K-147342 grant and the MATE Research Excellence Program.

First record of a natural hybrid *× Gymnigritella suaveolens* (Orchidaceae) in Serbia

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During a floristic and chorological survey the orchids at Mt. Kopaonik (Serbia) in July 2023, *× Gymnigritella suaveolens*, a natural hybrid between *Gymnadenia conopsea* and *Nigritella rhellicani*, was found at the locality of Treska. This is the first record of this hybrid in Serbia and its single known record in the Central Balkans. Detailed data on its morphology, flowering period, distribution, habitat, ecological preferences, and population size are presented. The morphology of the hybrid lies in almost all characteristics between those of the two parental species. The most important distinguishing features of the hybrid include the colour, position, and the structure of the labellum and its lobes. *× Gymnigritella suaveolens* is notably taller than *N. rhellicani*, with longer and more elongated cylindrical inflorescences. The resupination of the hybrid flowers usually occurs halfway through development. The flower colour of the hybrid ranges from bright magenta to dark magenta. In × *Gymnigritella suaveolens*, the labellum is clearly three-lobed, in contrast to *N. rhellicani*, where the labellum is entirely or only very slightly three-lobed.

The newly-recorded hybrid was found in the *Festuco-Deschampsietum flexuosae* grassland community, at an altitude of 1,552 m, on sericite schists, on moderately moist soil and under full light conditions. Two hybrid specimens were found in an area where the population size of *G. conopsea* was larger than that of *N. rhellicani*. Conservation efforts should prioritize protecting both the hybrid and sympatric zones, rather than solely focusing on hybrid specimens.

Key words: Balkan Peninsula, ecology, *Gymnadenia*, hybrid, *Nigritella*, orchids, Serbia

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Floristic and ecological differentiation of certain *Potamogeton*-dominated communities: a case study of the central Balkan Peninsula

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In order to establish a degree of differentiation of *Potamogeton*-dominated communities regarding to their floristic composition and ecological affinities in terms of water properties (depth, pH, electroconductivity, concentration of nitrite, nitrate, phosphate, sulphate, fluoride, bromide, and chloride anions), stands distributed in standing and running waters in Danube, Great, West and South Morava, and Nišava catachment areas have been examining during the 2022 year. UPGMA classification and Canonical correspondence analysis (CCA) have been conducted on a database composed of 32 species and 66 relevés. Based on the results of classification and diagnostic species composition, it has been established the existence of 7 associations -*Potametum denso-nodosi* de Bolós 1957, *Potametum natantis* Hild 1959, *Potametum crispi* von Soó 1927, *Potametum pectinati* Carstensen ex Hilbig 1971, *Potametum lucentis* Hueck 1931, *Potametum perfoliati* Miljan 1933 and *Potametum pusilli* von Soó 1927. All communities are monodominant and species-poor, composed of 1 to 6 species. *Myriophyllum spicatum* L., *Ceratophyllum demersum* L., *Lemna minor* L. and *Najas marina* L. are the most frequent species that have taken part in composing those communities. According to the results of CCA, the strongest influence on the differentiation of *Potamogeton*-dominated communities have water depth, pH and concentration of nitrates and sulphates, while electroconductivity, and concentration of phosphate, chloride and fluoride anions have the smallest contribution. The community *Potametum perfoliati* is clearly separated from the others due to its affinity to deep waters, rich in nitrogen. Similar ecological preferences own floating phytocoenoses – *Potametum denso-nodosi* and *Potametum natantis*. They mostly prefer waters with lower pH values and concentrations of bromide, sulphate and fluoride anions, and higher electroconductivity, and phosphate content, which is opposite to the community *Potametum pusilli*. The phytocoenoses *Potametum crispi* and *Potametum pectinati* are indifferent to the analyzed physico-chemical water properties. These data provide valuable insights into the ecological differentiation of particular phytoceonoses that, in syntaxonomical sence, belonging to the vegetation class *Potamogetonetea* Klika in Klika et Novák 1941.

Key words: *Potamogeton*, aquatic rooted vegetation, macrophytes, water properties, ecological differentiation.

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Cyperus glomeratus-dominated community: a case study of deserted sand-gravel pits in the Southern Serbia

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The exploitation of sand and gravel is a common activity in the river valleys of Southern Serbia. The South Morava River, the largest river in this area, is one of the most heavily exploited rivers in Serbia. The prolonged exploitation and deterioration of this region have resulted in significant alterations to the surrounding environment, particularly in plant cover that has been affected in the areas that have been left derelict. In some of these areas that had prolonged periods of abandonment, a specific thermophilous vegetation has emerged. This vegetation is dominated by *Cyperus glomeratus*, a pioneer plant species of lowland riverbanks. A total of 21 relevés of the *C. glomeratus* dominated community were recorded during the research conducted in late summer and autumn of 2022 and 2023. Stands of *C. glomeratus*-dominated communities were recorded in the vicinity of settlements Čečina, Pukovac, Lipovica, Gornje Međurovo, Donje Međurovo, Čokot, Ćićina, Aleksinac, Lalinac and Čapljinac. The average cover of the dominant species was 3 (number of individual covering 25-50% of the area) according to the Braun-Blanquet cover-abundance scale, the exception was Čečina, where the cover of the dominant species was higher. Constant species were *Cyperus flavescens*, *Rumex palustri*s and *Bidens tripartitus*. The species itself was recorded on more localities along the South Morava River, in communities with domination of the species *Scirpus tabernaemontani, Phalaris arundinacea, Sparganium erectum, Typha latifolia, T. laxmannii* and *T. domingensis*. Except for the localities Donje Međurovo and Pukovac, these represent the first data on the distribution of *C. glomeratus* in the valley of the South Morava River. Discovery of new populations of *C. glomeratus* has significant value in elucidating the species' distribution in Serbia and the Balkan Peninsula. The presence of this species in sand-gravel pits, often degraded habitats, provides insight into the vegetation that develops in such environments.

Key words: *Cyperus glomeratus*, send gravel-pits, South Morava River valley, pioneer vegetation

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Rock plant communities of Stara Planina Mt. in Serbia

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The plant communities thriving on the rocky terrains of Stara Planina Mt. have been poorly investigated within the borders of Serbia. Consequently, we initiated a study with the main goal of uncovering the diversity of phytocoenoses in these habitats and their delineation in terms of ecological affinities. During the summer season of 2023 year, 181 vegetation stands were phytocoenologically described in accordance with Braun-Blanquet approach. Based on the results of UPGMA classification and the composition of diagnostic species, the existence of 21 vegetation groups was established. Communities dominated by heliophilous and succulent species (*Sedum urvillei* DC., *S. annuum* L., *S. album* L., *S. hispanicum* L., *Sempervivum marmoreum* Griseb., and *Jovibarba heuffelii* (Schott) Á. Löve & D. Löve) prefer dry rocks with steep slopes. Cliffs usually support the development of phytocoenoses characterized by species: *Silene flavescens* Waldst. & Kit., *Asplenium ruta-muraria* L., *Campanula rotundifolia* L., developed in dry rock fissures; *Asplenium trichomanes* L., *A. septentrionale* (L.) Hoffm., *Campanula wanneri* Rochel, *Silene lerchenfeldiana* Baumg., *Aster alpinus* L., *Saxifraga paniculata* Mill. thriving in moderately moist fissures; and *Heliosperma pusillum* subsp. *albanicum* (K.Malý) Niketić & Stevan., *H. pusillum* (Waldst. & Kit.) Rchb. subsp. *pusillum*, *Sedum alpestre* Vill., *Saxifraga pedemontana* subsp. *cymosa* Engl., *Cystopteris fragilis* (L.) Bernh., and *Moehringia pendula* (Waldst. & Kit.) Fenzl inhabiting wet rock crevices. The highest species richness is recorded in communities dominated by *Saxifraga paniculata* (41 taxa) and *Heliosperma pusillum* subsp. *pusillum* (41 taxa). Conversely, phytocoenoses dominated by species *Asplenium ruta-muraria* (5 taxa), *A. septentrionale* (5 taxa), *Sedum hispanicum* (5 taxa), and *Moehringia pendula* (3 taxa) exhibit the lowest number of species. The data gathered in this study represent a significant contribution to science by offering preliminary insights into the diversity of floristically and ecologically specific ecosystems within one of the longest mountain ranges in the Balkans.

Key words: vegetation, ecology, chasmophytes, rock plant phytocoenoses

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Protected plant taxa of the *Orchideaceae* family in the ravine forests of Serbia

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Gorges and canyons are the most typical refuges for relict vegetation and for rare, protected, endemic and relict plant taxa. We conducted a taxonomic analysis of stands of thermophilous ravine forests dominated by *Carpinus orientalis* and *Ostrya carpinifolia* in 12 gorges and canyons in Serbia. After the analysis, we identified 10 taxa from the *Orhideaceae* family out of a total of 419 registered taxa: *Anacamptis pyramidalis*, *Cephalanthera rubra*, *Epipactis helleborine*, *Himantoglossum calcaratum* subsp. *calcaratum*, *Limodorum abortivum*, *Neotinea tridentata* subsp. *tridentata*, *Neottia nidus-avis*, *Orchis purpurea*, *O. simia* and *Platanthera bifolia*. A total of three taxa were recorded in stands dominated by *C. orientalis*, while eight taxa were recorded in stands dominated by *O. carpinifolia*. All orchid taxa were identified as important for conservation as they are either strictly protected or protected by national legislation, the IUCN Red List of Threatened Species and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Additionally, the species *A. pyramidalis* is included in the lists of the Habitats Directive and the Bern Convention. The orchid taxa were recorded in closed or open forest stands, on gentle to steep slopes (10-40°), on southern and eastern aspects, between 320 and 800 m a.s.l. The remarkable number of orchids in the investigated thermophilous ravine forests can be explained by the favorable ecological conditions in ravine habitats (carbonate substrates, light, temperature and humidity). Given the exceptional floristic diversity of the investigated ravine forests in Serbia and the considerable number of rare and protected plant species found there, it is important to emphasize the high conservation value of these forest types.

Key words: thermophilous forest vegetation, ravine habitat, protected plant taxa, orchids

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The communities of *Sesleria uliginosa* in the wetlands of the glacial lakes of Mt. Durmitor (Montenegro)

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The species *Sesleria uliginosa* Opiz is a European species with a relatively limited and highly disjunctive boreo-mountain distribution. In southern Scandinavia and the Baltic countries, this species displays a relatively continuous distribution, with higher abundance observed in these regions. It is found in scattered locations across the reaminder of the area, with the southernmost occurrences in Bulgaria, Croatia and Montenegro. In the majority of the countries where the species occurs, it is included on national red lists due to its rarity and the significant threats to its habitats. *Sesleria uliginosa* represents an ecological extreme that is quite singular within the whole genus. It is found in calcareous swamps, typically in rich fen communities of the *Caricetalia davallianae* order, as well as in wet meadows belonging to the *Molinietalia* order. Nevertheless, it can also be found in rare instances in dry xerothermic grassland of the *Festucetalia valesiacae* order.

Over the course of several years, a comprehensive study was conducted on the flora and vegetation in the National park Durmitor in Montenegro. Of particular interest were the wetlands surrounding the glacial lakes on Mt. Durmitor, where a total of 16 relevés with the presence of *S.uliginosa* were recorded during this period. *Sesleria uliginosa* was the dominant species in the following communities recorded in Ševarita lokva and Malo Crno jezero: *Molinio-Seslerietum uliginosae* and *Deschampsio-Seslerietum uliginosae*. Additionaly, the species was observed in the communities where *Galium boreale* and *Molinia caerulea* were the dominant species (ass. *Galio boreale-Molinietum caeruleae*), as well ass. *Deschampsia cespitosa* and *Frangula alnus* (ass. *Deschampsio-Franguletum alni*).

Key words: *Sesleria uliginosa*, Mt. Durmitor, glacial lakes, vegetation

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Wild orchids (Orchidaceae) in the area of Lake Čapljak

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During a floristic and chorological survey the orchids (Orchidaceae) at Plana/Čapljak Lake in the municipality of Visoko (Bosnia and Herzegovina) in the period 2022-2023 the total of 19 species and subspecies from 8 genera of this family were found. It is also the first group survey on the ecology and distribution of orchids in this area. The recorded taxa were found in grass and forest habitats at an altitude of 500-620 m. The most taxa – rich genera are *Ophrys* (4), *Anacamptis* (3), *Cephalanthera* (3), *Orchis* (3), *Neottia* (2), *Platanthera* (2), *Gymnadenia* (1) and *Neotinea* (1).

Key words: orchids, ecology, Bosnia and Herzegovina

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Changes in floristic composition and biodiversity over a decade of succession in dry grasslands on Slavonian Mt. (Croatia)

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Continental dry grasslands on carbonate bedrock of Slavonian Mountains (Croatia) are among the most biodiverse semi-natural habitat types created under anthropogenic influence. To deepen our understanding of floristic changes and to observe ecological shifts in such habitats, the research was conducted on the vascular flora of successional stages of dry grasslands on the eastern slopes of Psunj mountain during the 2023 growing season. To record changes in habitat composition over a 10-year period, we made phytosociological relevés in the same locations investigated by Krstonošić (2013).

A total of 170 plant species were recorded, with the most represented plant families being Fabaceae, Poaceae, Rosaceae, Asteraceae, and Lamiaceae. The dominance of hemicryptophytes and taxa of the Eurasian floral element was established. The greatest biodiversity was recorded in the first and second successional stages, represented by grassland and mosaic habitats. In the researched area, 4 endangered, 6 protected, and 3 invasive plant species were recorded.

Mutual comparison of old and new phytosociological relevés at the same localities indicated advanced successional processes, suggesting that in the last 10 years, adequate management measures for such habitats were not implemented. To preserve the exceptional biological and landscape diversity of the researched area, it is necessary to find acceptable measures for the management of grassland habitats. One possible solution could be the inclusion of grassland habitats covered by this research in the ecological network Natura 2000.

Key words: flora, vegetation, succession, dry continental grasslands, Psunj mountain

Lunularia cruciata (L.) Dumort. ex Lindb.: a common liverwort in urban landscapes?

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Urban areas, characterized by high levels of urbanization, create distinct ecological conditions that pose challenges for many plant species. However, certain "small" plants, such as bryophytes (bryophytes *sensu stricto* and liverworts), have adapted to thrive in these environments. Among these species, some rare and endangered ones can be found, including the liverwort *Lunularia cruciata*. *Lunularia cruciata*, a rare species, forms colonies of thalloid plants that grow in diverse urban habitats such as dump soils, paths, and roadsides. These colonies are easily recognizable by their distinctive half-moon shaped gemma receptacles. Despite limited data, only four records in Serbia exist, with observations in Belgrade (Sabovljević & Grdović, 2009; Soška, 1949; Pavletić, 1955), Valjevo (Sabovljević and Marka, 2009), and the Fruška Gora mountain (villages of Beočin and Jazak) (Ilić, 2019). However, there is a high possibility that this species is more widespread, as only two locations are known in Novi Sad currently. With this newfound record, *L. cruciata* is identified as a member of the spontaneous bryophyte flora within urban areas of Serbia. *L. cruciata* is commonly found in Western Europe, but natural habitat is the Atlantic-Mediterranean region. Considering its increasing success in urban environments, this species is often cited as evidence of climate change. The main reason is the warmer winters and the lack of snow cover. The increasing success of *L. cruciata* in urban environments highlights the potential impact of climatic changes on the spread of invasive bryophytes. Recognizing the significance of bryoflora in urban ecosystems, it warrants further attention within the realm of urban flora and vegetation studies. Bryoflora in urban areas represents a significant component of urban flora and vegetation and deserves attention.

Key words: moss, liverwort, Lunularia cruciata, urban, climate change

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Cryptobiotic crust and Floristic survey on the pasture grazed by domestic water buffaloes

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Grasslands are significant in many ways in conserving and sustaining species diversity and landscape diversity. Natural and semi-natural grassland preservation in the ecological sense is extremely important for the survival of nationally protected plant and animal species. Several grasslands have become degraded, weedy and shrubbed without nature conservation management, human interventions, so the elimination of nature conservation treatments often threatens the biological diversity of habitats, in addition, the cover growth of some cosmopolitan species may lead to a decrease in diversity. Grazing is used in several regions with different animals such as sheep, goat, cattle or buffalo. Different animals have different effects on the lawn as they graze in different ways and the species composition of vegetation is also affected by the intensity of grazing. In this research we examined, how does grazing by water buffalo affect the species composition of grassland in terms of ecological values and nature conservation.

Key words: coenological research, conservation, biodiversity

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Environmental DNA sequencing reveals differential responses of bryophillus, animal parasitic and plant pathogenic fungi to forestry treatments

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This research was started in 2014, led by the Pilis Forestry Systems Experiment (PFSE), a long-term ecological study established in the Pilis Mountains that investigaties the effects of the forestry treatments on forest site, regeneration and multi-taxon biodiversity. We carried out DNA metabarcoding of fungi from soil samples to study the effect of different forestry treatments on the richness and community composition.

Samples were collected in between 2020 and 2021, here we present the first insights regarding the compositional dynamics of bryophillus, plant pathogenic and animal parasitic fungi under the above forestry treatments.

In the case of animal pathogenic fungi, forest treatments do not affect species richness, but the species composition of fungi communities. There is a significant difference in the composition of fungi communities that patogenic species, forest treatments explain 21,59% of the difference in composition between samples. So, there is difference between each treatment in alpha diversity.

In the case of bryophillus fungi, forest treatments do not affect species richness, but the species composition of fungi communities. There is a significant difference in the composition of fungi communities that bryophillus species, forest treatments explain 19.43% of the difference in composition between samples. So, there is no difference between each treatment in alpha diversity, but it is in beta diversity.

Richness and proportional abundance of plant pathogens were highest in clear-cuts and gaps and correlated positively with herb cover and soil moisture. Community composition of plant pathogenic fungi correlated strongly with treatment type, with significant differences observed in all forestry treatments when compared to the control and to each other. These differences in habitat preference were already evident at genus level. Finally, the data presented here provide an unprecedented insight into the diversity and niche-based habitat partitioning of plant pathogenic fungi that is presumably driven in part by the altered abiotic conditions and changes in understory vegetation.

Key words: biodiversity, community composition, DNA metabarcoding

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Assessing plant species distribution in the Natural Monument ,,Lalinačka Slatina" for prioritizing fire protection zones

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The Natural Monument ,,Lalinačka slatina“ is the biggest salt marsh south of rivers Sava and Danube in Serbia, encompassing approximately 252 ha. This territory inhabits nearly 270 plant species, many of them being halophytic, endemic, relict, endangered or protected. Over the last decade, an increasing occurrence of fires caused by anthropogenic activities and climate changes was detected in this area. Therefore, this study aimed to determine fire protection zones in which thermovision cameras for early detection of fires would be installed, based on location, distribution area, and extinction risk for plant species important from the conservation aspect. The distribution maps of microhabitats of six species (*Camphorosma monspeliaca*, *Limonium gmelinii*, *Stachys milanii*, *Sternbergia colchiciflora*, *Adonis vernalis*, *Galatella linosyris*) were created using Geo Tracker – GPS tracker Ver. 5.2. Results indicated that most of the analyzed species can be found in the central part of the salt marsh, covering a small territory located near the arable areas, designating them as highly vulnerable due to the fires since these areas are the initial point for fire developing in most cases, according to a survey conducted among the local population. Of particular concern is *Galatella linosyris*, which occupies 2333 m^2 in the thermophilic, stepe-like types of vegetation, making it exceptionally susceptible to fire. Similarly, *Stachys milanii* forms a fragmented population (798 m^2) adjacent to arable areas in the central part of Lalinačka slatina. *Camphorosma monspeliaca* formed small, fragmented populations, extremely affected by fires due to their proximity to a large reed affected by fire multiple times. Based on the constructed maps of species distribution thermovison camera was instaled in the proximity of the central part of NM ,,Lalinačka slatina”.

Key words: species distribution, protected areas, fire, thermovision cameras

Acknowledgements: This research was part of the project "Implementation of measures for the early detection of fires in a high-risk area of exceptional biological value - the natural monument "Lalinačka Slatina" funded by "EU for the Green Agenda in Serbia".

Additions to the class *Mulgedio-Aconitetea* Hadač et Klika in Klika et Hadač 1944 of the Republic of North Macedonia

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The Mulgedio-Aconitetea class includes shrubby and tall-herbaceous vegetation, in wet mesophilic habitats, along forest edges, which are naturally deforested due to edaphic or mechanical factors. On the territory of North Macedonia, this type of vegetation has been researched more intensively in recent times (Čarni et al. 1997, 2000). During our research on Mount Galichica, forest edge vegetation of the order Senecioni rupestris-Rumicetalia alpini Mucina in Mucina et al. 2013 was registered, as well as the only one alliance Rumicion alpini Rubel ex Scharfetter 1938, which develop in places of former fields or pastures that are intensively grazed and enriched with nitrates.

On Mt. Galicica, this alliance was registered on Stara Galicica, along the edges of the *Calamintho grandiflorae-Fagetum* forest community. The own vegetation releves were compared with 40 others releves from the literature, wich included 9 associations from the nitrophilous "saum" vegetation from the territory of the Republic of North Macedonia (*Mulgedio-Aconitetea* and *Epilobietea angustifolii* (syn. *Galio-Urticetea*).

After the analysis with the PC ORD program, the reaserched forest edge vegetation from Galichica mountain is defined as the already described ass. *Urtico-Geranietum aristati* Čarni et al. 1997. From the spectrum of life forms, hemicryptophytes have the most dominant participation with 73%. While from the spectrum of floral elements, representatives from the Eurasian floral element are the most represented (41%).

Key words: vegetation classification, Galicica Mt, *Mulgedio-Aconitetea*

The impact of management practices on the plant diversity in olive groves on Murter island, Croatia

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Murter is an island located in the Dalmatia region in the Adriatic Sea covering a total area of 17.58 km². The most common landscape type is karst, followed by fields, vineyards and olive groves often abandoned and overgrown by woody vegetation. Tourism is the main driver of the island's economy which throughout the years led to the abandonment of traditional management practices, landscape changes, and biodiversity loss. The goal of the research was to determine the impact of different management practices on vascular plant diversity in olive groves with an emphasis on the conservation status of present plants. Phytosociological relevés were placed along the disturbance gradient of different management styles. The highest species richness was present in regularly mown olive groves, whereas overgrown olive groves had the lowest taxonomical diversity. Protected and endangered species were mostly present in regularly and occasionally mown groves. Alien species were found only in the highly disturbed, plowed groves. Mediterranean habitats are resilient to moderate human disturbances but a strong disturbance leads to negative consequences. Based on the results, the best management strategy for keeping the plant diversity high without the presence of alien species is regular mowing.

Key words: management, plants, vegetation, biodiversity, island, olive groves

Growth of common beech and sessile oak saplings under drought and phosphorus fertilization

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The negative impact of drought on plant growth may be modified by different availability of mineral nutrients and by their adaptation to different local habitat conditions. In this study, we examine the impact of drought, fertilization with phosphorus and provenance, as well as their interactions, on the growth and allometric growth relationships between belowground and aboveground organs of common beech (*Fagus sylvatica* L.) and sessile oak (*Quercus petraea* (Matt.) Liebl.). The research was conducted on saplings originating from two mature mixed stands (dry and wet provenances) dominated by these species. In the common garden experiment, saplings were exposed to regular watering and drought in interaction with moderate and high phosphorus concentrations in the growing substrate (achieved by phosphorus fertilization). The obtained results indicate the negative impact of drought and phosphorus fertilization on the growth of both species. In common beech, a negative impact of phosphorus fertilization on the adaptive capacity to drought was demonstrated by unfavorable ratios between fine root mass and the mass of other organs. The sessile oak provenances under the impact of drought showed a different root collar diameter/stem height increment ratio, which indicates their different phenotypic plasticity as a consequence of adaptation to different frequencies of dry periods in their natural habitats.

Key words: *Fagus sylvatica*, *Quercus petraea*, provenance, allometric growth relationship, adaptation to drought

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Charophyte vegetation of the Plitvice Lakes (Croatia)

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Plitvice Lakes are situated in Dinaric region of Croatia characterized by different karst formations. One of them is the system of 16 larger and several smaller cascading lakes stretched 8 km in length and interconnected by numerous waterfalls of different size. Lake water is characterized by pH values higher than 8, high transparency and low concentration of dissolved organic matter. Furthermore, these lakes are the largest area with charophyte vegetation in Croatia. This vegetation was studied in the period 2021-2023 in 13 lakes. The charophytes were recorded and collected from the boat along depth transects using different types of rakes. At each sampling point depth and geographical coordinates were recorded using depth sounder and GPS device. In total seven species of charophytes were recorded. The most frequent and abundant species is *Chara contraria* present in 10 lakes and in nine forming extensive monodominat swards (*Charetum contrariae* Corillion 1957). It is followed by *Chara globularis* forming the swards in eight lakes, in the deeper belt in comparison to previous species. These swards are monodominant (*Charetum globularis* Zutshi ex Šumberová et al. 2011) or intermixed with previous species in shallower lakes. The swards of other species are much less frequent - *Charetum delicatulae* Doll 1989 ex Gąbka et Owsianny 2010 and *Charetum asperae* Corillion 1957 in two lakes each, *Charetum hispidae* Corillion 1957 and *Charetum vulgaris* Corillion 1957 in one lake each. *Nitelletum opacae* Corillion 1957 is present only in the deepest waters of the two largest lakes. *Chara subspinulosa* does not form swards and it is present in two lakes with low abundance. In comparison to the similar research from 1980-ties, it is evident that the lakes have the same or even larger surfaces of charophyte swards, but they are more uniform, composed of lower number of species although their total number in all lakes is the same.

Key words: *Charetea intermediae*, Dinaric ecoregion, freshwaters, macrophytes, SE Europe, stoneworts

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The spontaneous flora of the urban area of Tirana (Albania)

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This study investigates the diversity and characteristics of spontaneous flora in urban areas of Tirana, capital of Albania. Field surveys, based on a defined methodology, conducted during the spring-summer period of 2023 revealed a total of 274 plant species belonging to 54 families. The taxonomic distribution highlights Poaceae and Compositae as the most species-rich families. Three new plant species were documented for the first time in Albania, increasing the list of flora diversity of the country. Biogeographical analysis indicates a dominance of Euro-Mediterranean species, reflecting the region's geographical influences. Raunkiaer's classification reveals prevalent adaptation strategies among therophytes and hemicryptophytes in Tirana's urban flora. Furthermore, an analysis of flowering periods shows seasonal variations, with summer hosting the highest number of flowering species. These findings contribute to our understanding of urban plant diversity, adaptation strategies, and biogeographical patterns in Tirana. Nevertheless, the surveyed area is rather small, only 125 ha and further research in the future is needed and might reveal new findings.

Key words: new records, spontaneous flora, Tirana, urban areas

The effect of hummocky meadow micro-relief on the eggleaf twayblade *Neottia ovata* (L.) Bluff & Fingerh macro-morphological trait variability

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In the Triglav National Park (Julian Alps, Slovenia) there is a special type of species-rich meadows; the hummocky meadows, a geomorphological post-glacial type of surface, which appears on loose carbonate material. Such micro-terrain is characterized by a numerous humps (convex landform) and pits. At the top of the humps the vegetation typical for drier and shallower soils was found. At the bottom of the humps the vegetation of moist, deeper and fertile soil was observed. In general, plant species richness is greatest in the middle of humps. A single, typical hummocky meadow, located near the Vršič mountain pass was studied, 382 flowering *Neottia ovata* (Orchidaceae) specimens were morphologically evaluated. Morphological trait values were correlated with micro relief-measured, hummocky meadow hump values; hump height, substratum depth, slope inclination etc. in order to reveal the effect of the micro-relief on morphological trait variability. The location (specific relative height) of orchids on the slopes of the hump was determined as important. Flowering *Neottia ovata* plants growing on the hump slopes expressed larger measured trait values compared to those located at the very top or at the bottom of the humps. These results correlate with the changing edaphic conditions on the humps. Hummocky meadow micro-relief reveals small-scale-patchiness, niche-specific and micro-edaphic localities with specific ecological conditions. Hummocky meadows have not only a nature conservation value, but also a cultural value. In recent decades, hummocky meadows of the Julian Alps were deliberately levelled, some also turned into a forest stages due to overgrowth. Since hummocky meadow species richness and diversity were poorly studied, it is of great importance to preserve these typical alpine meadows regularly managed.

Key words: Triglav national Park, hummocky meadows, micro-relief, *Neottia ovata*, morphometrics, morphological trait variability, ecology

Floristic features of tall herb vegetation in White and Samarian Rocks Strict Reserve (Croatia)

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Tall herb vegetation represent an important habitat type that is strongly influenced by various environmental factors (Odland et al. 1995, Karst et al. 2005) that is not insufficiently studied in Croatia. Based on general description in the National Habitat Classification of the Republic of Croatia (NN 27/2021, NN 101/2022), this research deals with presentation of floristic features of tall herb vegetation in the Samarian Rocks Strict Reserve area. The study included an analysis of species composition based on a spectrum of life-forms, chorological types, spectrum of plant families, level of protection and threat status. Vegetation was studied according to the principles of the Braun-Blanquet approach (Braun-Blanquet 1964) while taxonomy and plant nomenclature were unified according to the Euro+Med PlantBase (2023). The data on the life forms of Raunkiær from Dřevojan et al. (2023) and the data on the chorological types from Pignatti (2005) were also used. The protection level was adjusted in accordance with the Regulation on Strictly Protected Species (NN 144/2013, NN 73/2016), while the data on the threat status from the Red Book of Vascular Flora of Croatia (Nikolić and Topić 2005) were taken into account. The original dataset consisted of 25 relevés collected at representative sites during the 2023 growing season. Based on the conducted research, a total of 120 species of vascular plants were identified and classified into 52 families. The most represented families were Asteraceae and Ranunculaceae, while the highest relative representation of life-forms belonged to the hemicryptophytes (H). Moreover, the most represented chorological type in the area was Eurasian (43.6%). The habitat type contained a total of 2 strictly protected (SZ) and 3 near threatened species (NT). The results of this study represent the first floristic features of tall herb vegetation in a strictly protected area of the Republic of Croatia and contribute to the expansion of our knowledge of this habitat type.

Key words: chrological types, life-forms, protection level, threat status

Truffle mycorrhiza in forest ecosystems

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Forest ecosystems are richest in fungi, many of which form mycorrhizal relationships with woody plants. Mycorrhiza is a mutualistic relationship between plants and fungi in which fungi provide mineral nutrients to plants, and in contrast, plants provide habitat and photosynthetically fixed carbon to fungi. There are two main types of mycorrhiza: ectomycorrhiza and endomycorrhiza. Ectomycorrhizal fungi (EMF) are important in temperate forests, forming symbiotic bonds crucial for their life cycle with approximately 60% of the world's trees. Among these, truffle species from the genus *Tuber* are EMF. Some of the plant species with which they form an ectomycorrhiza belong to genera *Quercus, Corylus, Ostrya, Carpinus, Tilia, Pinus, Fagus, Cistus*, *Populus* and *Salix*, representing only a small portion of the total population of terrestrial plants. However, they also often dominate forest ecosystems, making them economically and ecologically significant.

It is estimated that there are between 180-230 species of truffles in the world, about 30 of them from Europe, while approximately 13 are used commercially. The economically most important truffle species are *Tuber magnatum* Picco, *Tuber melanosporum* Vittad., *Tuber aestivum* (Wulfen) Spreng. and *Tuber borchii* Vittad., all of which are present on the territory of the Republic of Croatia.

Given the significant impact of climate change on natural truffle populations and their economic value, it is an imperative to develop efficient truffle cultivation methods. Modern truffle cultivation revolves around producing inoculated seedlings with truffle mycorrhiza. The applications of such seedlings are diverse, ranging from reforestation and habitat recovery to plantation establishment and agroforestry. These innovative agricultural alternatives not only contribute to rural development but also serve as a proactive response to climate change. CFRI is currently implementing a project to inoculate seedlings with black truffles, which is financed by the Environmental Protection and Energy Efficiency Fund (FZOEU, ZO-ENU-1/22).

Key words: ectomycorrhiza, mycorrhizal fungi, plant-host, truffles, *Tuber*

Potamocoenoses of Trebišnjica river in Trebinje city (Southern B&H)

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Aquatic flora and vegetation have been sparsely researched in Bosnia and Hercegovina. In our paper we contribute to insufficiently known topics with floral and vegetation characteristics of Trebišnjica river, inside the city of Trebinje. There are compiled from four cross sections along the river in the city, and one from lateral channel of the Trebišnjica. Flora recorded 21 species, included in 4 associations and 5 subassociations of macrophytes vegetation.

Key words: aquatic flora and vegetation, Trebišnjica river

Insight into the ecology and chorology of some rare and endangered plant species in Serbia

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The most recent estimates indicate that the vascular flora of Serbia comprises approximately 4,246 species and subspecies, native and non-native naturalized. Of this estimated total number of taxa, almost 28% are considered endangered. Despite the extensive research conducted on the flora of Serbia over the past decades, new species are still being discovered as well as new localities for the species that were previously considered extinct or critically endangered. During the field research carried out in Serbia in previous years, new sites were discovered for the following rare and endangered taxa: *Cardamine amara* subp. *amara*, *Cardamine waldsteinii*, *Hypericum androsaemum*, *Matteuccia struthiopteris*, *Typha shuttleworthii* and *Tulipa sylvestris* subsp. *australis*.

The distribution of these taxa was determined through a comprehensive review of numerous floristic literature, herbarium collections, and our own field data. This information is presented on UTM grid maps at a scale of 10x10km. Furthermore, the habitats in which the aforementioned plants are found and the status of the populations are described, thereby providing a comprehensive overview of their current status in Serbia.

Key words: vascular flora, distribution, habitat, red lists, Serbia

Acknowledgements: This research was supported by the Science Fund of the Republic of Serbia under Grant number 7750112, Balkan biodiversity across spatial and temporal scales patterns and mechanisms driving vascular plant diversity – BalkBioDrivers.

Microtopography and nearby woody cover influences the response of an open steppe grassland to extreme drought

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Extreme droughts are becoming more frequent with climate change and have the potential to initialise ecosystem transformation. To understand, which factors support grassland resilience we examined a found experiment: the extreme drought of 2022 at the KISKUN Long Term Ecological Research (LTER) site at Fülöpháza, Hungary. The event caused massive, however spatially uneven dieback of grass biomass. We hypothesized that microtopography and the cover of nearby woody vegetation were responsible for the variation in the response to drought. Input data consisted of phytosociological relevés in 2023 and a fine-resolution topographic map. We analysed the effect of microtopographic variables (slope, aspect and topographic position) and woody species cover within a 10 m circle of each plot. Slope had a direct decreasing effect on the dieback, while aspect, topographic position and woody cover acted in two-way interactions. Nordic aspect, lower topographic position and higher woody cover decreased grass dieback each enhancing the effect the other variables. Thus topographic and vegetation heterogeneity contributes to the survival of open sandy grasslands, as it provides microrefugia where dominant grass species can endure extreme weather events.

Key words: grass dieback, landscape effects, open sand grasslands

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Anthropogenic and environmental drivers of plant diversity across medieval fortresses in Bosnia and Herzegovina

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With the objective to reveal the most important factors determining the floristic diversity of specific anthropogenic habitat types, seven medieval limestone fortresses situated in different biogeographical regions of Bosnia and Herzegovina and subjected to different intensity of anthropogenic influence were selected. All native and subspontaneous alien vascular plants were recorded, resulting in a total of 652 species and subspecies, ranging from 214 to 381 in individual sites, the highest being found in southern, Mediterranean influenced Počitelj and Stolac. Functional analysis showed that continental localities (Banja Luka, Sarajevo and Srebrenik) have the highest proportion of taxa with competitive (C) ecological strategy, while southern localities experience a shift of CSR signatures towards the R-S axis. The similar pattern can be observed in the proportion of life forms, whereas the share of chamaephytes, geophytes, and therophytes is higher in southern localities, as opossite to phanerophytes and hemicryptophytes. The ordination results indicate that the first axis can be interpreted as biogeographical and climate gradient which runs from the warmer and dryer southern localities (Blagaj, Počitelj, Stolac, Ljubuški) to more humid and colder continental sites (Banja Luka, Sarajevo and Srebrenik). This gradient is negatively correlated with the level of endemism and competitors, while positively with ruderals and stress-tolerators and also number of UFO (urbanophobic) and UNE (urbanoneutral) species. On the other hand, the second axis shows the separation only among the continental localities, which could be interpreted as the west-east gradient. This axis is positively correlated with distance from urban center and IF (indicator of fluctuation changes), which are both indicators of the strong anthropogenic influence on the floristic composition. Overall, our analysis suggests the stronger influence of environmental factors (biogeography and climate conditions) compared to anthropogenic influences on the floristic composition of flora of medieval fortresses in B&H.

Key words: Balkans, biogeography, climatic gradient, ecological strategies, floristic diversity, ordination

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