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Kitaibela vitifolia

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Plenar lectures



Kitaibela vitifolia



Vegetation in Southeastern Europe in a wider European scale

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The presentation will deal with two recent developments in the field of vegetation science, where the vegetation scientists from the SE Europe are involved. Basically is our methodology inductive that means that it develops on basis of local studied that are later integrated on a higher level. As we already have a lot of data about the vegetation of the region, it is time to prepare some synthetic works. In the presentation two such study cases of integration will be presented.

After over than 100 years of phytosociology in Europe, a group of scientists guided by Laco Mucina decided to build an overlook of alliances in Europe, from Maconesia to Ural and from Cypus to Greenland. A part of this synthetic work is also the vegetation in SE Europe. Two case examples produced during this synthetic work will be presented. The first will be ravine broadleaved forests that have been till now treated as *Tilio-Acerion*; but in a new framework they will be divided into two alliances as *Fraxino-Acerion* and *Ostryo Tillion*. The other example is about *Pinus mugo* communities on carbonate bedrock that are now classified with the *Hyperico grisebachii-Pinion mugo*.

The other project that is going on in the region is the Red list of European habitats. The aim of the project is to provide the red list of all (semi)natural habitats of the Continent. The application will be useful in policy making and possible revision of Annex 1-types. At the beginning all potential habitats were described by experts. Then these descriptions were distributed to national experts that provided information about appearance, change in quantity and quality and the main threats on individual habitat in each country. After the county data will be collected and fused; the assessment on the whole Europe will be made. It will be based on the IUCN global Red list criteria for ecosystems. The project will finish in spring 2016.

Traditional, extensive grassland management in the Eastern Carpathians

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Traditional, extensive land use systems play an important role in marginalised communities in the mountainous regions and for biodiversity conservation as well. Understanding the still existing traditional grassland management systems could greatly help to improve our ability to preserve biodiversity in semi-natural grasslands. We carried out our research in the Gyimes region of the Eastern Carpathians (Romania), in a cultural, mosaic landscape (spruce forests, diverse mountain hay meadows and pastures). The investigated community has about 2000 members. We studied traditional ecological knowledge and grassland management both from cultural anthropological and ecological aspects, using semi-structured interviews and participatory observations.

The local (Csángó) community maintains the grasslands by a well-developed, but low-input farming system based on a detailed traditional ecological knowledge in the background. Locals are able to influence the vegetation dynamical processes and facilitate the regeneration of the hay meadows. Some practices convert the species-composition of the grasslands significantly. Deep ecological knowledge and farming practices help to maintain the appropriate quality and quantity of the hay. They “improve” their mountain hay meadows by (1) mowing; (2) optimizing seed and biomass production (rotating the hay-cut of meadow parcels from season to season); (3) removing ant hills, mouse hills, stones and branches; (4) cutting the trees, bushes, i.e. clearing; (5) overseeding with *Onobrychis viciifolia* or (6) application of hayseed from the barn; (7) manuring on certain parcels; (8) manual thinning of unwanted plants; (9) suppression of mosses; (10) small-scale drainage.

We argue that local people have wide-ranging knowledge on ecological processes (species, habitats, vegetation changes); they are aware of the effects of their daily farming activities on vegetation. This extensive, labor-intensive farming is able to maintain the diversity of HNV semi-natural grasslands in the region.

Oral presentations



Kitaibela vitifolia



Beech forest with peat moss in the Papuk Mt – unique in the vegetation of Croatia

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The Papuk Mt is situated in the Slavonia (Northeastern Croatia) region, within a mainly lowland area bordered by the rivers Sava to the south and Drava to the north. In this region Papuk is the largest and the highest mountain; the peaks are between 800 and 900 m a.s.l. Although the majority of Croatian mountains are built of Mesozoic limestone, this one has a high geological diversity dominated by metamorphic rocks, granites and different types of schists causing respective diversity of forest communities.

Unique forest community is developed on south eastern part of the mountain, on steep slopes made of quartzite and gneiss rocks covered by very thin soil layer and exposed to north-east. It is a beech forest characterized by dense, continuing carpet of peat moss (*Sphagnum quinquefarium*) in the ground layer. The soil is acidic, with pH ranging from 4.68 to 3.91 in water solution. Tree layer is dominated by *Fagus sylvatica* with sporadic occurrence of birch *Betula pendula* and *Castanea sativa*. In layer of low shrubs *Vaccinium myrtillus* is common, while herb layer has low diversity with low species abundances. The most common are *Luzula luzuloides*, *Avenella flexuosa*, *Hieracium murorum* and *Melampyrum pratense*. Altogether, only 17 species of vascular plants were recorded in all layers. However, some of them are rare in the flora of Croatia, e.g. *Diphasiastrum complanatum*, with the single recent locality in Croatia. On the other hand, bryophyte flora is very rich, comprising 52 species (17 liverworts and 35 mosses). The most prominent and the most abundant of all plant species is *Sphagnum quinquefarium*, which almost completely covers soil forming reddish carpets several dozen centimetres deep. Some other relatively abundant bryophyte species are *Dicranum scoparium*, *D. polysetum*, *Polytrichum commune*, *P. formosum*, *Leucobryum glaucum*, *Hylocomium splendens*, *Pleurozium schreberi*, *Scapania nemorea*, *Pedinophyllum interruptum*, *Diplophyllum albicans* and others. *Dicranum spurium* was recorded here for first time in Croatia. Due to its floristic composition and ecological characteristics, described community can be clearly affiliated to the suballiance *Luzulo luzuloides-Fagenion* (*Fagenion sylvaticae*, *Quercu-Fagetea*), but due to its peculiarities it should be considered as distinct association with high biogeographic and conservation importance.

A contribution to the knowledge of beech forests in the Pannonian area

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Beech forests in the Slavonian uplands are a basic feature of the region. They are distributed over considerable areas in exceptionally diverse synecological conditions and provide high scientific, scenic, protective, economic and other values. Their position on the border of various impacts, from the Illyrian and Pannonian to Central European, has conditioned the occurrence of a vast abundance of plant species and forest communities. Regrettably, since they have not yet been fully investigated and evaluated, a state-of-the-art methodology should be applied to study them on a scientific basis. Therefore, synecological-phytocoenological research into beech forests was conducted in over fifty localities according to the principle of the Zurich-Montpelier School (Braun-Blanquet 1964). The material for statistical analysis consists of both new relevés and phytocoenological relevés of beech forests of the wider area of the Pannonian hills. A total of four hundred phytocoenological relevés will be compared. The research is expected to provide a clear definition and nomination of all beech forests of the study area in accordance with the valid Code of Phytocoenological Nomenclature (Weber et al. 2000). The basic synecological factors decisive for the occurrence and distribution of the phytocoenosis will also be identified and determined in order to broaden the knowledge on the occurrence, distribution and synecological factors that lead to the occurrence of each particular vegetation unit. Previous and present research will be used to determine the sociological character of all the communities in the study area in relation to the related neighbouring and more distant communities. This refers in particular to the affiliation of the determined associations to the Illyrian and south-eastern European alliances and to differences from similar central European alliances. The research is aimed at complementing not only the vegetation picture of the Republic of Croatia but also that of South-Eastern Europe.



Phenotypic and Epigenetic Response to Drought Stress and Adaptability of *Quercus robur* L. Populations along a Latitudinal Gradient

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Pedunculate oak (*Quercus robur* L.) is one of the economically most valuable European forest tree species. It is the keystone climax species of forests which harbour high biodiversity and consequently has priceless ecological and social value. Survival of the species' populations in southern and southeastern Europe is endangered by predicted climate extremes such as prolonged drought. These populations are the "rear edge" of the species distribution range and their phenotypic response and adaptive capacity to climate change have not been well studied. Suggested spatial variability of climate change impacts in Europe implies that widespread species like pedunculate oak may face different levels of climatic risks in different parts of their ranges. Consequently, peripheral populations at southern range margins may face an increased risk of extinction and decrease of the overall within-species genetic diversity which may in return jeopardize the long-term adaptive potential and survival of the species in whole. Thus, the response of species to changing environments is likely to be largely determined by population responses at range margins. In contrast to the expanding edge, the low-latitude (rear) edge of species distribution remains understudied, and the critical importance of rear edge populations as long-term stores of species' unique genetic diversity and foci of speciation has been little acknowledged.

Our research will be carried out on progenies and plant samples derived from the nine European populations sampled along a latitudinal environmental gradient. The focus of the research will be placed on populations from the southern and south-eastern part of the species' distribution range (Croatia and Italy). We aim to compare adaptability, epigenetic and phenotypic responses to drought stress of southernmost populations with the populations from the central and northern part of the species' distribution range.

The main scientific objectives of the project are to determine: 1) neutral genetic diversity and structure of selected pedunculate oak populations along a latitudinal gradient; 2) their epigenetic diversity and structure; 3) their epigenetic response to long-term drought stress; 4) their physiological, phenological, morphological, biochemical and growth (i.e. phenotypic) response to drought stress; 5) their adaptive

genetic variability, differentiation and phenotypic plasticity; 6) current ecological niche preferences and main environmental variables driving its distribution 7) its future distribution under climate change scenarios based on ecological niche modelling and which parts of the contemporary distribution will suffer from decreased habitat suitability induced by climate change; 8) levels of adaptability of the studied populations by comparing their genetic and epigenetic variability and phenotypic plasticity.



Model of rocky grasslands recovery in National park “Krka” (southern Croatia) through controlled burns

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The large areas of National park „Krka” (Miljevački Plateau) were covered by grasslands belonging to order *Scorzonero-Chrysopogonetalia* H-ić et Ht. (1956). For centuries this area has been used as pastures and additionally maintained by permanent coppicing and occasional burning. The abandonment of this traditional land use in the second half of the 20th century caused gradual but major changes of grasslands through reinvasion of shrubs and trees due to strong depopulation and war crises. The most invasive among them is *Juniperus oxycedrus* L., causing transformation of grasslands into more or less dense shrubberies with lowered plant diversity. In order to study effects of controlled burns on recovery of grasslands three experimental permanent plots of cca 800 and 900 m² have been established: (1) control plot without burning, (2) experimental plot with only one controlled burn for continuous succession monitoring, (c) experimental plot with periodic controlled burns as a simulation of casual natural fires. The two burned areas, inside which plots were formed, cover 4400 m² and 4600 m². Vegetation was monitored in closed transect formed of 8 and 9 subplots (10x10m) using Braun-Blanquet extended scale. In addition, the vegetation height and functional groups were registered. The vegetation was sampled before and one month after the controlled burns was performed. The plant recolonization will be monitored continuously on monthly basis in the first six months after fire and during following three years seasonally. It is expected that results of this experiment will help to understand the dynamics of plant recolonization on rocky grasslands and provide a sustainable model for habitat maintenance.

Traditional Knowledge on the Use of Wild Plants as Food in Poljica, Croatia

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Poljica is historically specific region within Dalmatia (Croatia), since it had political autonomy in the past. Due to depopulation and change of lifestyle there is a threat of wild plants use knowledge loss. The traditional knowledge and contemporary use of wild plants for food and everyday teas in 17 villages was recorded. Fifty three interviews were conducted that included 64 local informants with an average age of 67. Approximately 80 species were documented, on average 13 per interview. The plants are used as raw salads, cooked as vegetables, raw fruit, teas, sweet drink concentrate, marmalade, and liqueurs. The knowledge of the “divje zelje” wild vegetable mixes is relatively alive because it is sold in the cities in springtime. The most commonly collected species are: *Sonchus oleraceus* and *S. asper*, *Cichorium intybus*, *Allium ampeloprasum*, *Asparagus acutifolius*, *Dioscorea communis*, *Foeniculum vulgare*, *Rosa* sp., and *Rubus ulmifolius*. A very small number of mushrooms is gathered by only four informers. Fruits picked and eaten in the nature are mostly memories from childhood and youth. Many people also stopped using wild greens. This research is a testimony of urgency of recording native knowledge of edible plants use.



IPA ManMon Project - Monitoring of Dalmatian Scilla (*Chouardia litardierei* (Breistr.) Speta) in Croatia

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Dalmatian Scilla or Amethyst Meadow Squill (*Chouardia litardierei* (Breistr.) Speta, syn. *Scilla litardierei* Breistr.) is an endemic Illyrian species and one of 20 Croatian Natura-plant species of interest to European union. It inhabits wet grasslands of many periodically flooded Croatian karstic fields of the mainland, coastline and northern-Adriatic islands. Main vegetation that dominates these habitats belong to the Order *Trifolio-Hordeetalia* Horvatić 1963 (*Molinio-Arrhenatheretea* Tx. 1937), and less the Orders *Molinio-Arrhenatheretea* Tx. 1937 and *Agrostidetalia stoloniferae* Oberd. 1967. In the mainland, Scilla grows mostly in the As. *Molinio-Lathyretum pannonicum* Horvatić 1963 and As. *Deschampsietum mediae illyricum* (Zeidler) Horvatić 1963, and less in the Alliance *Caricion davallianae* Klika 1934. In the coastal part (islands), Scilla grows in As. *Peucedano-Molinietum litoralis* Horvatić 1934 and As. *Trifolio-Hordeetum secalini* Horvatić (1934) 1958.

According to the schemes of the Croatian *State Institute for Nature Conservation* (SINP), a representative number of Scilla-habitats were put under a standardized monitoring-procedure during two-year range. In 2013, we conducted a monitoring procedure alongside vegetation investigations, in Plitvička jezera National Park and Velebit Nature Park, than in the Gacko, Plaško and Ličko carst fields. In 2014 we expanded the investigations to Imotsko, Mučko, Vrličko, Cetinsko, Paško, Lapačko and Krbavsko karst fields in the mainland, as well as to Vlašičko, Poveljansko and Kolan-sko carst fields on the island of Pag. Dalmatian Scilla is still fairly abundant in most of the investigated sites, being under threat mostly because of the lack of traditional human activities (abandonment of agricultural fields, regular pasturing and mowing).

Following the Permissions of Croatian *Ministry of environment and nature protection*, we also collected an acceptable number of seeds from several Dalmatian Scilla habitats to be preserved in our Botanical Garden seed bank. We also performed a series of standardized procedures to establish a rate of Dalmatian Scilla seed germination at various temperature and light regimes.

Plant Functional Traits Changes in Three Different Successional Seres

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In recent decades there is a common problem of land-use change in Croatia and Europe. A decline in traditional agricultural practices leads to the abandonment of agricultural land which leaves many of landscape areas exposed to the natural succession. In the colline and hilly landscapes of Slavonian mountains, as well as in other parts of the country, such areas are covered by a great mosaic of xerophilous and mesophilous grassland habitats (pastures and meadows). With time such areas are overgrowing with forest vegetation which results in decrease of bio- and landscape diversity.

The successional processes and their impact on biodiversity of inland was explored using the method of chronosequences and the multivariate analysis of ecological indicator values and plant functional traits. Among a large number of plant communities, one grassland community (*Scabioso ochroleucae-Brachypodietum pinnati* Klika 1933) and three shrubland communities (*Ligustro-Prunetum* R. Tüxen 1952, *Carpino-Prunetum* R. Tüxen 1952, *Rubo-Coryletum* Oberdorfer 1957) have to be pointed out as being described for the first time in the researched area. The course of succession is observed at the level of three series classified according to their different habitats and environmental factors, which significantly alter during the progression of succession.

The most significant changes were observed in the increasing humidity and nutrient values of the habitat, and on the other side in the decline of the EIV for light, temperature, pH and continentality. From plant functional traits, which are highly correlated to the successional pathway, a significant decrease of hemicryptophytes and an increase of macrophanerophytes has to be pointed out during succession progress. Also, a significantly increased in European floristic elements at the expense of Eurasian and cosmopolitan plants has been observed. In the later stages of succession species begin to flower earlier and have a shorter flowering duration. It also leads to a significant increase in diaspore and germinule weight compared to earlier stages. The aim of new insights on floristic, structural and environmental changes in the succession process is to serve as useful guidelines for effective management planning of such habitats in Croatia and beyond.



Development of vegetation after implementation of different forest management measures – case of Dinaric fir-beech forest, Slovenia

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For this study, Dinaric fir-beech forests within the Natura 2000 network with significant nature-conservation interest and timber production functions were selected. With the aim of testing the effects of different forest management options on biodiversity, and particularly on the plant diversity of these forests, three sites in the Slovenian part of the Dinaric fir-beech forest range were studied. In each site, 9 plots, each 400 m² in size, were established at the bottom of the karst terrain depressions (sinkholes). The plant species diversity was tested before and after the implementation of forest management measures of three intensities: 1. control plots – no logging, 2. logging of 50% of growing stock, 3. logging of 100% of growing stock.

Before the implementation of the forest management measures, a total of 151 plant species on all 27 plots were recorded, and the mean species number per plot was 48.8; the mean value of the Shannon diversity index H' was 2.41.

Two years after the logging, the mean species number per plot was 70.4, and varied between 41 and 106 per plot. The value of the Shannon diversity index H' after the logging was between 2.04 and 3.81 (mean: 3.07). The implementation of different forest management options caused different magnitudes of plant species turnover. The species turnover increased, and more than 100 new plant species, mostly early successional species and non-forest plants appeared in the forest gaps created by high intensity logging measures. After the measures changes in the functional composition of the vegetation were also observed; regarding the Grime's CSR strategies the importance of the ruderal component increased.

In addition to the increased plant diversity and changed functional composition of the vegetation other benefits of gaps created by logging could be expected. Species-rich forest gaps have high feeding potential for larger herbivores and, consequently they may reduce the harmful browsing of young trees in the nearby forest stands. It is expected that increased plant diversity also promotes diversity of other organisms such as insects and other pollinators.

Management actions that create the mosaic forest structures also improve habitat suitability for many bird species, including the endangered capercaillie. However, the size and position of forest gaps should be carefully adjusted to sensitive karst terrain, especially in the southern exposed slopes not to jeopardize forest regeneration and soil productivity.



Habitat generalism and specialism in *Carpino-Fagetea* forests in Slovenia

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Plant species differ in the range of tolerated environmental conditions. Some species are ecologically highly specialised, restricted in their distribution to a narrow range of habitat conditions. Other species occur along a wide range of environmental gradients and thus considered as generalists. Ecological specialization can be either considered as reflecting species' requirements or species' impacts. Therefore the estimation of relative niche width has been a persistent problem in ecology.

The aim of our research was to estimate ecological niche widths of plant species in mixed broad-leaved deciduous forests (class *Carpino-Fagetea*) and to estimate the dependence between ecological niche widths of plants and their functional traits and ecological indicator values. For the purpose of the research we used the dataset of 4556 phytosociological relevés. Using the co-occurrence approach (Fridley et al. 2007) we analyzed *theta* indexes for the degree of habitat specialization for 327 species. For 272 species we were able to compile 26 functional traits and Ellenberg indicator values.

We found habitat specialists in the Slovenian *Carpino-Fagetea* forests thriving primarily on the highest altitudes, on colder, dry and nutrient rich sites. Chamaephytes and spring green species showed up as specialist species. Regarding the morphological traits we found significant positive relationships between *theta* and three functional traits: habitat specialists tend to have smaller *seed diameter*, lower *leaf dry matter content (LDMC)* and lower *mean canopy height*. Significant negative relationships we found between *theta* and *specific leaf area (SLA)*. Our findings confirm results of different studies dealing with species specialization and offer some new ideas, especially about characteristic traits of specialist species.

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The vascular flora of the Kopački rit Nature Park (Croatian Danube Region)

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The Kopački rit Nature Park is situated in northeastern Croatia, between courses of the Danube and the Drava Rivers. This is a large fluvial-marshy floodplain, with an altitudinal range from 78 to 86 m. The appearance of the whole area, as well as the overall biodiversity, depends on the flooding regime of the Danube River, while the Drava River has much less importance. This area is protected since 1967, and proclaimed as nature park in 1999 on the surface of 231 km². In 1993 it is listed among wetlands of international importance (Ramsar area). Floristic field researches were carried out in the area of the Kopački rit Nature Park, during five-year period (2010-2014), at selected localities in various land, aquatic and wetland habitats. Based on the previously published records and results of fieldwork it was determined that vascular flora of the Kopački rit Nature Park includes 497 taxa, classified into 289 genera and 92 families. The diversity of macrophytes in the Kopački rit Nature Park comprises 159 species or 32 % of the total flora. The most diverse families with largest number of taxa are following: *Asteraceae* (42 taxa), *Poaceae* (38), *Lamiaceae* (34) and *Cyperaceae* (26). In the life-form spectrum dominates hemicryptophytes (40%); terophytes (23%); geophytes and hydrophytes (12% each), and phanerophytes (11%). A phytogeographical analysis shows that 34% of taxa belong to the Euro-Asiatic floral element; 27% are widespread plants; 11% to the European; and 7% to the South European floral element. A total of 49 alochthonous plant taxa were recorded, among which the Rufous Bulrush (*Scirpus pendulus* Muhl.) was found in July 2011 as the new taxon to the Croatian flora. New localities for many of rare and endangered taxa of the macrophytic and terrestrial flora were recorded during the fieldwork. The activities of floristic inventarization in the Kopački rit Nature Park are continuing, with a focus on monitoring changes of habitats, as well as population size and distribution of particular plant taxa.



Analysis of the functional composition of sub-Mediterranean grasslands along a drought stress gradient

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Within the Mediterranean-type climates, semi-natural grasslands are considered priority habitats by the European Union. Moreover, they are cultural landscapes, resulting from a long history of human management. In spite of this, they are threatened by abandonment, inadequate management and climate change. Generally, trends in climate change are expected to cause greater aridity during summer, worsening the grassland production gap and forage quality, thus leading to the decrease of extensive livestock rearing sustainability. Thus, aware grassland management is essential to face the effect of climate change, and predictive models are needed. The functional approach proved a useful tool for this purpose. Our main aim was to understand how environmental constraints affect functional composition of plant communities along a water stress gradient. We laid 130 plots in central Apennines. In each plot we collected species cover-abundance values, altitude (m a.s.l.), slope aspect (azimuth degrees), and slope angle (vertical degrees). We used Ellenberg indicator values as a proxy to assess climate variability and drought stress gradient inside the study area. The considered traits were life form, growth form, clonality, belowground organs, leaf traits, plant height and seed mass.

We observed changes of traits related to reproductive, acquisitive and herbivory defence strategies along the considered gradient. We found: a shift from tolerance, in more productive environment, to avoidance strategies in harsh environment; a change in resource allocation strategies shifting from those ensuring to face competition in productive conditions through an efficient vertical growth (tall stature), resource acquisition (persistent green leaves), and a rapid horizontal spread by runner/runner-like rhizome, to those which enable plants to face drought stress storing nutrients in belowground structures (tuber, bulb, tap root) or large seeds, those which maximize exploitation of patchily distributed soil resource niches (caespitose and pleiocorm growth forms), and limiting water losses (scleromorphic and scleromorphic/mesomorphic leaves; erosulate upright forbs). In addition, we found that the increase of temperature and water scarcity also leads to the establishment of regeneration strategies (i.e. bulbils, roots with adventitious buds, light seeds) giving the ability to cope with the unpredictability of spatio-temporal changes in stress intensity and duration.

Syntaxonomy of thermophilous deciduous forests of *Quercetalia pubescentis* in Bosnia and Herzegovina

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Comprehensive study of the literature and intensive field research of thermophilous deciduous forests of Bosnia and Herzegovina (B&H) have given substantial material for their formalized classification and nomenclatural revision. Supervised classification of all 673 *Quercetalia pubescentis* relevés from B&H was performed using Cocktail method, which resulted in 17 traditionally accepted associations recognized for B&H to which 483 relevés of the original data set were classified. Additionally, one newly described, ecologically and floristically well defined association, emerged after semi-supervised classification of the remaining 190 relevés not classified by Cocktail. The following 18 associations were recognized, and characterized by species composition, ecology and distribution: 1. *Quercus pubescenti-Carpinetum orientalis*; 2. *Rusco aculeati-Carpinetum orientalis*; 3. *Carici hallerianae-Quercetum pubescentis*; 4. *Cruciato glabrae-Carpinetum orientalis*; 5. *Seslerio autumnalis-Quercetum pubescentis*; 6. *Aristolochio luteae-Quercetum pubescentis*; 7. *Asparago tenuifolii-Quercetum pubescentis*; 8. *Seslerio autumnalis-Ostryetum carpinifoliae*; 9. *Rusco aculeati-Ostryetum carpinifoliae*; 10. *Quercus pubescenti-Ostryetum carpinifoliae*; 11. *Quercetum frainetto-cerridis*; 12. *Fraxino orni-Quercetum cerridis*; 13. *Lathyro nigri-Quercetum petraeae*; 14. *Aceri obtusati-Quercetum petraeae*; 15. *Cytiso hirsuti-Quercetum petraeae*; 16. *Festuco drymejae-Quercetum petraeae*; 17. *Potentillo micranthae-Quercetum petraeae*; 18. *Seslerio autumnalis-Quercetum petraeae*. The largest number of associations (13) occurs in Mediterranean biogeographical region of B&H. Dinaric and Pre-Pannonian regions harbor ten associations each, while in the Transitional Illyrian-Moesian region there are only five associations. Seven syntaxa previously reported for thermophilous deciduous forests of B&H were not recognized during the analysis. The validity and legitimacy of associations were checked and they were validated and corrected if needed, strictly following the rules of the International Code of Phytosociological Nomenclature.



Psammophytic vegetation along east Adriatic coast

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Coastal dunes are a complex and unstable ecosystem with specific vegetation depending on the topography, natural disturbance and distance to the sea. Eastern Adriatic coast has less developed sandy beaches as its coast is mainly rocky. Typical sand dunes are found in the south in Montenegro and Albania. This area was under researched in the past and is a white spot in well-known pan European vegetation type. We collected all available vegetation relevés (published and unpublished) and historical references of sand dune vegetation from east Adriatic coast (Croatia, Montenegro, and Albania). Classification and ordination were used to detect different plant communities along seashore-inland zonation and their geographical distribution. First group on embryonic foredunes comprises of the *Cakilo-Xanthietum*, *Euphorbia paralias* community and *Eryngio-Sporoboletum*, while second group is found on more stable foredunes with the *Euphorbio paraliae-Agropyretum junceiformis*, *Medicagini marinae-Ammophiletum australis*, and *Scabioso argenteae-Ephedretum distachyae*. Latter is newly described and is found only along Albanian coast. Geographical distribution of plant communities is presented and their diversity is compared to surrounding countries. Sand dunes are important habitats from nature conservation point of view. We provide list of habitat types found along east Adriatic coast: 'Annual vegetation of drift lines', 'Embryonic shifting dunes', 'Shifting dunes along the shoreline with *Ammophila arenaria*', 'Coastal dunes with *Juniperus* ssp', 'Wooded dunes with and/or *Pinus pinaster*', while habitat '*Crucianellion maritimae* fixed beach dunes' was not found. We urge for their protection as they are in are still in good conditions in Albania, while in Croatia are fragmentarily developed and in Montenegro under strong human impact.

How soil water availability affects the functional diversity in grazed and abandoned pastures

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Though the interplay of grazing intensity and the availability of resources is a key driver in grassland composition, very few studies focused on changes of functional traits after abandonment along stress gradients. Since the range of functions provided by a community largely depends on the diversity of functional traits, a useful approach for investigating ecosystem processes is the analysis of functional diversity, which proved to be widely applicable to grazing systems. Through a comparative approach, we aimed to assess the context dependent effects of long-term grazing cessation on functional composition and diversity in sub-Mediterranean grasslands. We hypothesized that, after long-term abandonment, variability of stress intensity due to different soil water regimes drives the trait-based recovery processes, also influencing the patterns of functional diversity. On a calcareous mountain ridge of central Italy, we collected data on species cover and traits, site characteristics, soil and vegetation structure in 0.5 x 0.5 m plots located in grazed pastures and in grasslands abandoned since the early 1970s. We analysed patterns of species, traits and functional diversity (*FD*, Rao's quadratic entropy) in relation to environmental variables and management type. We found that soil water availability on a fine scale determines *FD* and direction of trait response after grazing cessation. In plots with bare soil and lower water availability values, species and trait composition were less affected by abandonment. Instead, we observed a shift from strategies devoted to grazing resistance to those devoted to competition for light after grazing cessation at intermediate water availability. Grazing cessation decreased the overall *FD*, however in both the harsher and more productive conditions grazed and abandoned systems did not show significant differences. Instead, in intermediate conditions we documented significant differences in *FD* of many trait states, especially those related to resource acquisition and space occupation. Thus, our results indicate that the level of soil water resources determines the net effect of disturbance on the *FD* of grassland communities.



Differences between dominant and other species in the North Adriatic Karst grasslands on the basis of plant functional traits

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The dry and semi-dry grasslands in the North Adriatic Karst derived from centuries of low-intensity land use. They are among the richest grasslands in the world and harbour the highest small-scale density of plant species found in terrestrial habitats. This area, being at the edge of the Mediterranean basin, is defined as sub-Mediterranean and represents the most north-western part of the Balkan Peninsula. We examined floristic composition and functional trait structure in species rich dry and semi-dry grasslands of Scorzonero-Chrysopogonetalia H-ić et Ht. (1956) 1958 order (Festuco-Brometea Br.-Bl. et R.Tx. 1943 class) in sub-Mediterranean hilly region Čičarija (Slovenia and Croatia) to determine distinct vegetation types and to test, if dominant species differed in their traits from other species in determined vegetation types. As raw data, we used 188 phytosociological relevés (10 x 10 m plots) comprising 185 species. To provide visual differences in floristic composition between the grassland vegetation types DCA ordination was applied. Different natural conditions assemble different plant communities from the available species pool. DCA showed evident divergence, which strongly supports a clear division in two vegetation types: semi-natural pastures (ass. *Carici humilis-Centaureetum rupestris* Ht.1931) composed by sclerophyllous plants on oligotrophic conditions, and meadows (ass. *Danthonio-Scorzoneretum villosae* H&H-ić (56) 58), composed by mesophyllous plants and on mesic conditions. Plant species reaching dominance in the meadows (N = 77) and in the pastures (N = 111) were selected (the criterion being: at least 25 % cover in at least one plot); they were compared for biological and ecological traits with other species participating in the relevés (with at least 1 % cover in at least one plot). To establish the set of traits contributing to achieving dominance by species in that vegetation we used 9 functional traits: life forms, the beginning of blooming, the duration of blooming, the plant's height, indicator values for level of nitrogen and moisture in soil, ability of sprawling in space, C-S-R ecological strategy, specific leaf area (SLA), leaf dry matter content (LDMC) and growth form. Our research of dominant and other species of studied dry grasslands has shown that the predominant species on those grasslands are more adapted, than the non-predominant species.

Morphological variability of *Ulmus glabra* Huds. in Lika and Gorski kotar, Croatia

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The wych elm (*Ulmus glabra* Huds.) is a very valuable, noble hardwood species, taxonomically allocated to *Ulmaceae* family. It has northernmost distribution in relation to other European species of elm trees. According to phytocoenological determination, it is a typical tree of the zonal, mesophilic and rarely of the thermophilic beech forests, whereas it is a characteristic species in azonal communities of *Tilio platyphylli-Acerion pseudoplatani* alliance. The wych elm in Croatia occupies a specific ecological niche, and there is no possibility of creating hybrid swarms with the field elm, as is the case in the northern Europe.

On the basis of 10 foliar morphological traits, by means of modern statistical methods, our goal was to assess interpopulation and intrapopulation variability of the wych elm.

Material for the morphometric analysis was collected in 4 natural populations (Delnice, Vrbovsko, Otočac, Gospić) in the areas of Lika and Gorski kotar in Croatia. Although sampled populations were heavily compromised by the Dutch elm disease, our results suggest high variability of the observed morphological traits. Overall variability coefficient ranged from 11,94 % for angle between the main leaf vein and the line defined by the leaf base, and the point of the leaf edge where leaf lamina is widest to 52,94 % for the leaf base asymmetry trait. Partitioning of variance showed that differences among trees in a single population accounted for the most of variability determined, while the remaining component, the amount of variation attributable to differences among populations, was considerably smaller. From the UPGMA dendrogram it was evident that according to the researched leaf traits the most similar populations were Delnice and Vrbovsko, followed by population Otočac. The southernmost and geographically most distant population Gospić proved to be morphologically significantly different from the other three populations, which was particularly evident in relation to Delnice and Vrbovsko population.

Poster presentation



Kitaibela vitifolia



Methodology for assessment of grassland ecosystems condition and their services in Bulgaria

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The ecosystems represent an integration of social and ecological systems, and can be considered from different disciplinary standpoints (social, economic, ecological). A “grassland ecosystems” include dynamic associations of different species building pastures or meadows, livestock, other fauna, soils, water, and the atmosphere. As an EU member Bulgaria has to assess and report to the European commission the state of ecosystems and their services as a response to the Action 5 of EU Biodiversity Strategy to 2020. Few data has been collected so far in this respect. The best available information for guiding decisions is needed for the planning and implementation of sustainable use of natural resources and thus to preserve the economic potential of ecosystems. The focus on benefits implies that ecosystem services are open also to economic valuation. Consistent approach throughout the country is needed to integrate all information collected. The concepts of the methodology follow the MAES (2013) and CICES (2013). The proposed typology of “Grasslands” corresponds with the ecosystem classification of MAES (2013), combined with the European Nature Information System (EUNIS) habitat classification types. Currently, the typology of grassland ecosystems in Bulgaria is consisted of five classes – *Dry grasslands*, *Mesic grasslands*, *Seasonally wet and wet grasslands*, *Alpine and subalpine grasslands* and *Inland salt steppes*. The main criterion in selection of indicators for assessment of grassland ecosystems condition and their services was availability of data on national level. We have defined and quantified 11 indicators that are relevant for the grassland ecosystem conditions. The indicators represent the ecosystems structure and ecosystem processes of grassland types. The three main groups of ecosystem services follow CICES terminology. We expect an assessment of ecosystem services to be based on real parameters (measurable and available) and to present the Real (expert assessed) ESs Capacity.

Plant functional traits and diversity on the sand dunes in Serbia

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This paper presents diversity of the flora, plant functional traits and vegetation of sands that are distributed mainly along the Danube river in Serbia. Sand dune vegetation is very fragile and dynamic. Changes in the sand dune vegetation in Serbia, after almost one century of monitoring, were assessed on the basis of the changes in floristic diversity, plant functional traits, and the degree of presence and coverage of diagnostic taxa. Plant functional traits enabled us to distinct the successive stages between pioneering forms of vegetation on the sand and the steppe formations on stabilized sand mass and the regressive stages induced by human activities.

We have analyzed a database of 281 relevés (both literature and field data in accordance with the standard Braun-Blanquet approach), 357 plant species and 28 trait variables. Trait-species, trait-plot and species-plot matrices were built. We used hierarchical cluster analysis to explore functional strategies of plants on the sand dune areas of Serbia. We used multivariate analysis to explore the variability of functional traits and the factors that explain it.

One plant functional group shares similar responses to environmental conditions. Functional groups are widely used in analyses of different ecosystems. Classifications according to functional traits have been seen as a necessary tool for the simplification of floristic complexity in global vegetation models because they reduce the complexity of ecosystems and, therefore are particularly suitable for studies with diverse species composition.



Floristic, phytosociological and ecological investigation of the spring plant communities (*Montio-Cardaminetea*) in the Mecsek Mts. and the South-Zselic

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Although the wells possess in Hungary „ex lege” protection, the floristic, phytosociological and ecological investigation of the regionally endangered or critically endangered spring plant communities (*Montio-Cardaminetea*) lag behind from the neighbouring countries. There are some regions in Hungary, from where spring relevés were not mentioned before, such as the Mecsek and the South-Zselic. We recorded 38 relevés along natural, unset fountains in these areas, according to the guidelines of the Zürich-Montpellier School. According to our results, we distinguished 3 spring associations by the species composition, the species groups and the abiotic factors: 1. *Caricetum remotae*, 2. *Cardamino-Chrysosplenietum alternifolii*, 3. *Brachythecio rivularis-Cratoneuretum*. From this three crenal communities only the presence of *Cardamino-Chrysosplenietum alternifolii* were published in our country erstwhile. *Caricetum remotae* belonging to *Caricion remotae* is new to Hungary, like the *Brachythecio rivularis-Cratoneuretum*, which occupies crenal habitats surrounded by forests and belongs to the *Lycopodo europaei-Cratoneurion commutati*. This alliance was never mentioned from Hungary before. We detected 48 bryophytes and liverworts, some of them are rare, Red List species, like *Fissidens incurvus* (EN), *Palustriella commutata* (EN), *Philonotis marchica* (DD). The diversity of the vascular plants is surprising (131 species); protected, endangered taxa, moreover zoological curiosities (*Pomatias rivulare*, *Cordulegaster heros* (NT), *Carabus nodulosus*) occurred in some relevés. For this reason, the spring plant communities are not protectable only because of their habitat speciality, but the rare plants and animals, so should be examined at regional scale.

Taxonomy and horology of *Quercus pubescens* in the Eastern part of the Republic of Macedonia

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The genus *Quercus* L. is one of the most polymorphic woody genera in temperate zones of the northern hemisphere whose taxa reach up to tropical areas, but without crossing the southern hemisphere.

Out of this genus, the *Q. pubescens* is characterized by a high degree of intraspecific variability, which is expressed by allocating a larger number of lower taxa (subspecies, varieties and forms) that are insufficiently studied for the territory of the Republic of Macedonia. Due to its complexity this species present interest for further taxonomic and horological research. Some differences appear in the understanding of the species extent, which differs *Q. pubescens* s. str., “collective” species, and *Q. pubescens* s. lat., which includes - *Q. pubescens*, *Q. infectoria*, *Q. virgiliana*, *Q. brachyphylla*, *Q. congesta* and *Q. pyrenaica*.

As a result of the polymorphism of this species, certain features such as size and hairiness of leaves, number and shape of the leaf segments, the size and shape of the cupule, and the morphology of the cupule with scales, are characterized by more or less an expression of variability.

During the surveys of *Q. pubescens* in the Eastern part of Macedonia we concluded that on the largest number of sites, there are samples that match the description of subsp. *pubescens*. From it there are var. *pubescens* f. *pinatifida*, further var. *glomerata* and var. *undulata* with form - f. *disseccata*. Also present is a subspecies - *anatolica*.



Vegetation of the islet of Vrnik, southeastern Adriatic: Preliminary results

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The islet of Vrnik with surface area of 0.28 km² and coastline length of 2,300 m, is a part of the Pelješac Archipelago situated in channel between the Pelješac peninsula and island of Korčula in southern Croatia. The islet of Vrnik is the second largest in the whole archipelago composed of 19 islets and five rocks. It has a maximum altitude of 50 m a.s.l. The islet is not inhabited but it is much popular as tourist destination in the summer time having a population in excess of about 200 people in a very small settlement. The aim of this study was to present preliminary results of investigations on the vegetation of the islet of Vrnik. Generally, all islets are still completely botanically unknown, and only one floristic study has been made in the archipelago. The research was carried out during 2014 using the Braun-Blanquet approach. In total, eight associations and one community were determined within six vegetation classes: *Posidonietum oceanicae* Funk 1927 (Posidonietea), *Limonietum anfracti* Ilijanić & Hećimović 1982 (Crithmo-Limonietea), *Asplenio-Umbilicetum horizontalis* (Horvatić 1963) Trinajstić 2002 (Parietarietea judaicae), *Myrto communis-Pistacietum lentisci* (Molinier 1954) Rivas-Martínez 1975, *Pistacio lentisci-Pinetum halepensis* De Marco, Veri & Caneva 1984, *Quercu ilicis-Pinetum halepensis* Loisel 1971 (Quercetea ilicis), *Erico manipuliflorae-Cistetum cretici* Horvatić 1958 (Erico-Cistetea), community with *Mesembryanthemum nodiflorum* and *Hordeetum leporini* Braun-Blanquet 1936 (Stellarietea mediae).

Flora and vegetation of three islets in south Croatia, NE Mediterranean

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Flora and vegetation of the three small islets: Gospin Škoj (surface area 1.57 ha; perimeter 527 m; max. altitude 15 m a.s.l.), Srednjak (1.04 ha; 374 m; 8 m a.s.l.) and Goljak (3.31 ha; 686 m; 8 m a.s.l.) were intensively studied in 2014 and 2015. This study presents the flora and the vegetation of these islets for the first time, as well as a comparison with islets of a similar size on the eastern Adriatic Sea. Floristic surveys were conducted using the standard method described by Nikolić et al. (1998). Vegetation was studied in accordance with the principles of the Braun-Blanquet approach (Braun-Blanquet 1964). The islets are located in the vicinity of the village of Sreser within the Special Marine Reserve Mali Ston Bay and Malo More, enclosed by the mainland and the Pelješac peninsula in south Croatia. The islets' coasts are low and rocky. Sea depths around the islets are 2–13 m. Phytogeographically, the islets belong to the steno-Mediterranean vegetation zone of the *Oleo sylvestris-Ceratonion siliquae* alliance. The floristic data have been used in order to analyze life-form and chorological spectra and to assess species-area relationship, the occurrence of islet specialists and the risk of alien plants invasion. The islets showed a relatively low variety of plant taxa and plant communities. Benthic cormophyte communities in the eulittoral and infralittoral zones are represented by the *Nanozosteretum noltii* Harmsen 1936 (*Zosteretea marinae*) and *Cymodocetum nodosae* Braun-Blanquet 1952 (*Halodulo wrighthii-Thalassietea testudinum*) associations. The halophytic vegetation of the coastal rocks belongs to the association *Limonietum anfracti* Ilijanić & S. Hećimović 1982 (*Crithmo maritimi-Staticetea*). On the islet of Goljak, the *Myrto communis-Pistacietum lentisci* (Molinier 1954) Rivas-Martínez 1975 association mostly forms the strip between halophytic vegetation and the islet's central area covered by ca. 2.5 m high macchia with *Erica arborea*. The *Oleo sylvestris-Pistacietum lentisci* Braun-Blanquet 1931 association and macchia with *Erica arborea* cover the most surface areas of the Gospin Škoj and Goljak islets, respectively. Due to the presence of a large population of European rabbit, the ground layer of the dense impenetrable macchia with *Erica arborea* is extremely poor in species.



Floristic homogenization of railway tracks in the case of Pécs (South Hungary)

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Nowadays, more and more articles deal with the problem of floristic richness, floristic homogenization of roadsides or railway tracks, and the distribution pattern of plant species richness within urban and rural landscapes. According to the Flora Mapping System of Pécs the authors listed the vascular flora of the selected sections of railway tracks in the city and in its narrower surroundings. Analysing this dataset, we tried to answer the following questions:

1. How rich are the sections of the surveyed railway tracks from the floristic point of view?
2. How frequent are the rare, the red list and the protected species within the flora of the investigated tracks?
3. Can we demonstrate the taxonomic homogenization along the railway tracks, and if so, does it correlate with the pattern of the urban-rural gradient?

These problems above were investigated at larger scale (1km long and 4.5 m wide sections). We pointed out the relatively high floristic richness of railway tracks both in national and international relations. There were several rare and three red list species along the surveyed tracks, but we did not find any protected species. This result probably reflects the fact, that we only examined the bare part of tracks which is covered by breakstone. We detected a kind of filtering effect of railway tracks upon the vascular flora in larger scale, but the floristic homogenization was not detectable. It is mention worth, that the surveyed railway tracks, as usual, run through lowlands, and the flora of this landscape type is probably too homogeneous, originally.

Plant associations of the *Potametea pectinati* Klika in Klika & Novák 1941 class of two karstic rivers in Bosnia and Herzegovina

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Phytocoenological investigations of the perennial macrophytic communities based on the Braun-Blanquet approach were carried out in the Lištica and Trebižat karstic rivers in Herzegovina (Bosnia and Herzegovina) during the vegetation seasons from 2007 to 2009. The rivers belong to oligotrophic ecosystems with a slight anthropogenic influence. Altogether, 10 plant associations from three alliances were found in the rivers: *Potamion pectinati* (Koch 1926) Libbert 1931, *Nymphaeion albae* Oberdorfer 1957 and *Batrachion fluitantis* Neuhäusl 1959. Only three associations were common to both rivers: *Potametum perfoliati* W. Koch 1926, *Potametum graminei* W. Koch 1926 and *Ranunculo fluitanti-Sietum erecto-submersi* (Roll 1939) Th. Müller 1962. In both rivers, the most common associations were *Potametum pectinati* Cartensen 1955 and *Myriophyllo verticillati-Nupharetum lutei* W. Koch 1926. Five associations, *Potametum perfoliati* W. Koch 1926, *Potametum graminei* W. Koch 1926, *Potametum lucentis* Hueck 1931, *Potametum pectinati* Cartensen 1955 and *Myriophylletum spicati* von Soó 1926, were found as new associations for Bosnia and Herzegovina. The number of taxa within these associations were from seven to 23.



Relationships between vegetation of Macedonian pine (*Pinus peuce* Griseb.) and different types of soils on which is developing

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Functioning and stability of biogeocenosis depends on the interaction of its components and the impact of the external environment associated with anthropogenic influence. In forest ecosystems special role belongs to the structural and functional connection between its main components, soil and vegetation.

Correlation between the vegetation and soil is an important factor of syndinamic, further successive and pedogenesis development of ecosystems. The soil composition affects the structure of the phytocoenosis, while the vegetation is important for evolution of the soil and also significantly reduces soil temperature fluctuations protecting it from freezing in the deeper layers.

In this paper it is shown the relationships between vegetation of Macedonian pine (*Pinus peuce* Griseb.) and soils developed on different parent materials on the territory of Macedonia. It was analyzed the floristic composition on localities on limestone, dolomitic marble and silicate where it is determined that on first two parent materials are developed rendzinas on hard limestones and dolomites, and on silicate parent material- brown forest soils.

Also were processed mechanical and chemical properties of soil profiles. It was noticed, evident increased presence of carbonates in the soil of dolomitic marble of Mount Nidze unlike that of the Shar Mountain which are formed on the typical limestone. Although it is the same forest community, differences of the massifs, the regime of precipitation, geology, and other factors are responsible for the differences in their floristic composition and reason for the separation of two subassociations. On silicate terrain on Nidze Mt. Macedonian pine forest are developing also on brown forest soils with different floristic composition than on other two registered parent material. Floristic composition also was processed according Ellenberg indicator values for humidity, soil reaction, nitrogen and continental type.

New records of invasive species in Slavonian mountains, Croatia

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The largest number of invasive species, which are found in Croatia, originate from North and South America, and from various parts of Asia, Africa and other areas in the world. Thanks to their great ability of rapid propagation, high density coverage and successful adaptation to new environmental conditions, a great number of invasive species have ensured their existence in Croatia. This study is a part of the master thesis on the Faculty of Forestry on the University in Zagreb, which objective was to monitor and record the spread of some of the invasive species found on Slavonian mountains (Croatia). By now the Croatian flora has recorded the total of 74 invasive taxa, of which 44 were found during previous researches on the case study area of Slavonian mountains. During this research we recorded new localities for 23 species. The monitoring of invasive species is highly necessary, to prevent their potential ecological or economic harm in a new environment where they are not native.



Floristic researches of the island of Pašman, Croatia

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Pašman is an island in northern Dalmatia. It belongs to the archipelago of Zadar. Systematic floristic researches on the island of Pašman have not been performed yet. From 2010 to 2012 the flora of vascular plants has been studied. It have been recorded 745 species and 629 of them occurs naturally or are spontaneously spread from culture (556 species and 73 subspecies of 366 genera and 94 families). The rest of 116 species occurs only in cultures. From 745 species, 27 were previously recorded, while 718 are stated for the first time in these studies.

The most abundant families are Fabaceae (12.72%), Poaceae (11.13%), Asteraceae (6.84%) and Cichoriaceae (6.04%).

In the spectrum of life forms the most abundant are Therophytes (45.47%) followed by Hemikryptophytes (25.12%) as expected. The life forms spectrum of the flora of the island of Pašman largely matches to the spectra of other Adriatic islands.

The analysis of floral elements shows the highest share of Mediterranean plants (41.02%). There is a significant number of Southern European plants (17.33%) and widespread plants (15.74%). In the Mediterranean floral element the most common are the general Mediterranean plants (26.71%), but particularly important are the Illyrian-Adriatic plants (16 species, 2.55%).

In the flora of the island of Pašman 15 species are red listed. *Lathyrus ochrus* is critically endangered, five of them are endangered: *Carex extensa*, *Delphinium peregrinum*, *Glaucium flavum*, *Hibiscus trionum* and *Ophrys apifera*, and nine of them have the status of vulnerable species. Of special value is rich orchid flora, which mainly found on open and sun-exposed habitats such as rocky grasslands and pastures, sparse garrigues and maintained olive orchards.

The results show that the island of Pašman has a rich and diverse flora which can be interpreted as a result of its specific phytogeographic position and long-term, but extensive human impact. In terms of biodiversity high richness have rocky grasslands, garrigues, maintained olive orchards and coastal habitats. Due to the rapid development of tourism halophytic habitats are under strong threat pressure. On the other hand, flora and vegetation of rocky grassland, garrigues and underbrush are undergoing successional processes and are overgrown by expanding plantations of Aleppo pine (*Pinus halepensis*).

Diversity of flora and vegetation developed on saline habitats in the Republic of Serbia

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Salinas belong to fragile and highly vulnerable type habitats. These are specific ecosystems characterized by the presence of unusual flora and vegetation. In the Republic of Serbia different salt affected soils composition, climate and historical factors as well as geomorphological, geological and hydrological characteristics caused the occurrence of very diverse flora and vegetation at the north (Vojvodina region- Pannonia plane) and in the southern Serbia.

The aim of this paper is to show diversity of flora and vegetation, based on several years of field research and review of known literature data, and their basic ecological characteristics as well as the frequency of occurrence of rare and endemic species, and species with medicinal properties recorded in investigated plant communities.

Plant species recorded during field surveys are determined according to the relevant literature, as well as nomenclature and syntaxonomic data. Ecological data and frequency of occurrence of certain plant species are given according to own phytocenological relevés, and also based on data published in the previous articles.

Halophytic flora and vegetation are characterized by significant number of endemic, rare and vulnerable species. This type of habitat should be object of interest in future researches and prioritized protection due to great vulnerability and botanical values.



Analysis of the functional composition of the hilly forest landscape in the Monti Sibillini National Park

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Understanding ecological processes in forest communities is one of the most important goals for forest management and biodiversity conservation. Because the multi-dimensional complexity of ecological systems can be broken down into hierarchical levels, each characterized by a low number of interacting factors and by a specific pool of species, it is important to take into account the compositional and functional dimensions of biodiversity at different hierarchical levels.

The research aim was to test if the hierarchical pattern of species assemblage in the sub-Mediterranean forest communities (Monti Sibillini National Park, central Italy) underlies a hierarchically structured pattern of functional strategies.

In 205 plots (20 x 20 m), selected using a random stratified sampling design, we collected data on site characteristics and species cover. Data on species traits (life form, occurrence and type of storage organ and vegetative propagation, leaf anatomy and persistence, seed mass, flowering period) were collected from existing databases and supplemented by field observations. Data on bioindicator values of each species were desumed from literature. Species data were elaborated using cluster analysis. Differences in altitude, slope aspect, slope angle and bioindicator values between pair of clusters at each clustering step were performed using the Wilcoxon-Mann-Whitney test. Indicator traits of each cluster were highlighted using indicator species analysis.

The results emphasized that differences in species composition between groups of relevés at each partition of the dendrogram resulted in patterns of functional responses to stress intensity, involving traits related to strategies of resource acquisition, retention and reproduction. These differences were more marked in the herb layer than in the tree and shrub ones. More specifically, the functional responses in the herb layer followed similar patterns regardless of the hierarchical level under consideration. In general, the greater stress intensity due to the higher water stress and the lower nutrient availability, matched with the lower number of indicator trait states and functional strategies in the herb layer (therophytes and chamaephytes, later reproduction, summer green leaves, absence of storage organs). The least stressful condition was marked by a set of trait states devoted to a fast growth and reproduction strategy, long-lived leaves, and occurrence of storage organs.

Genetic investigation of natural hybridization between *Salvia officinalis* L. and *Salvia fruticosa* Mill. on the island of Vis

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Dalmatian sage (*Salvia officinalis* L.) and Greek sage (*Salvia fruticosa* Mill.) grow sympatrically on the island of Vis. In Croatia, *S. fruticosa* is found only on the island of Vis where it forms small isolated population in the vicinity of Komiza, whereas *S. officinalis* is distributed throughout eastern Adriatic coastal region. Detailed morphological analysis revealed the existence of morphologically intermediate individuals that indicated natural hybridization between the two species. Until now, spontaneous hybrids of the species were not observed, although their hybrid derived from artificial crossing has been described as *Salvia x auriculata* Mill. In order to confirm natural hybridization between *S. officinalis* and *S. fruticosa* on genetic level, SSR and AFLP markers have been utilized. The obtained results strongly supported the ongoing hybridization events. Our findings will not only contribute to conservation efforts but will also provide a solid foundation for future plant breeding programs and agricultural exploitation.



Phenotypic and genetic diversity of pedunculate oak (*Quercus robur* L.) in Europe

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The survival of the pedunculate oak in Europe could be threatened due to the upcoming climate change. These changes include the emergence of long dry periods changing the normal amount of rainfall and flooding regimes of large rivers which influences the survival of Pedunculate oak forests in the future. Will this changes influence in the same way and have the same impact on the populations of common oak from the northern, middle and southern part of Europe, it is not known. It is anticipated that due to the spatial variability of climate change populations from South and South-East Europe may face a significantly higher risk of extinction than the population of central and northern Europe. On the other hand, the trees have the ability to adapt to a certain level of change in environmental conditions in their habitat. This ability depends on the phenotypic and genetic diversity as well as on the breadth of the ecological niche.

All this can be experimentally proved and determined with appropriate models, which is planned to be implemented by this project. The measurement and comparison of some physiological, morphological and genetic features (assimilation of CO₂, transpiration of H₂O, development of leaves and shoots, diameter and height increment, analysis of SSR markers, etc.) on plants which are experimentally exposed to the same environmental conditions, but belong to different populations, should give us the answer to the question: how much is a certain population phenotypically and genetically diverse or how good it is adapted to the local environmental conditions? The more diverse the measured properties are, the greater is the potential adaptive capacity of a population to environmental changes. Accordingly, the level of phenotypic diversity determines the potential viability of individual populations affected by climate change.

This project is designed with the aim to determine and compare each other phenotypic and genetic diversity of nine oak populations from Europe. One population is from Estonia, Lithuania, Polish, Hungary and Italy, and four populations from Croatia (Koška, Otok, Repaš and Karlovac). In addition, based on the ecological niche modelling, the features of the ecological niche of common oak in Europe will be determined. The results of the project may contribute to a better understanding of adaptation processes in long living trees and provide useful information for future silvicultural strategies of Pedunculate oak under the conditions of climate change.

Indicator value analysis for support assessing the naturalness of tree species composition

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The investigation area is situated at the eastern escarpment of the Dobratsch-mountain, 5km western from Villach and is classified as Natural Forest Reserve. The forest, 50 ha in size, belongs to the submountainous belt with limestone as bedrock material. The stand is dominated by beech. Spruce, hop hornbeam and flowering ash are admixed or subdominant tree species.

In 1998 and 2001 the first time stand structure was assessed by 50 systematically selected sample plots. This procedure was repeated in 2014 and complemented with 4 vegetation samples (1m² in size) on each of the 50 sample plots. After the next decades this monitoring should give us insights into the development of the vegetation units.

By now, the species composition of the herbal layer was used to evaluate the ecological behavior of the frequent tree species by indicator values of moisture.

Thus beech dominates nearly the entire range of moisture according to its basal area from “moderate dry” to “moderate moist”. Beech with its synecological optimum on “moderate moist” sites (flora indicative 2010) shares proportions with spruce on “fresh” and with hop hornbeam on “moderate dry” and “fresh” sites. High basal areas of beech let us suggest that this tree species reaches its full competitiveness already on “fresh” sites. Anyway, hop hornbeam and flowering ash with their synecological optimum on “moderate dry” sites penetrate far into the beech dominated range. Hence, we assume that the occurrence of hop hornbeam and flowering ash on “fresh” sites are a consequence of former silvicultural cutting.



Mapping of forest vegetation of Plitvice Lakes National Park using SPOT satellite images

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Plitvice Lakes are the oldest Croatian National Park, and in 1979 were listed on the UNESCO List of World Heritage. The basic phenomenon is the combination of waterfalls and 16 cascading lakes formed as a result of permanent biodynamic process of creation and growth of tufa. The lakes are surrounded by forest vegetation of a total area 25.000 ha under the Park's jurisdiction. Forests are very interesting and complex for phytocoenological research, primarily due to its preservation, geographical position which is characterized by intermediate forms of continental and Mediterranean, Alpine-Central European and Balkan-Illyrian vegetation, various environmental conditions and floristic composition, as well as numerous successional stages on deforested, mostly former agricultural land.

Map of forest vegetation in scale 1:25.000 is made on the basis of SPOT satellite images (resolution 2.5 x 2.5 m). The field research included 424 plots (176 relevés and 248 control points). Individual coordinates in the radius of 30 m for each forest community (habitat type) were set up as the learning field for supervised classification. "Maximum likelihood" method which is integrated within the program ArcMap 9.1. was used. The results of classification in raster format are simplified by using the tools of generalization and then transferred to the vector form (polygons). Some polygons are manually adjusted on the basis of detailed fieldwork and testing results of the classification. Software tools QGIS and ArcMap 9.1. were used. The final map is complemented by analysis of geomorphological factors and the use of previous geological, soil, climate and other research.

On the vegetation map 30 cartographic units and 3 cartographic characters are presented. They are defined according to phytocenological principles taking into account the recent situation concerning the dominant species and the manner of their foundation or domination. They are divided into 4 different groups: natural forest communities, successional stages, forest plantations and secondary forest stands of anthropogenic origin and general group with the addition of cartographic signs of dominance or significant presence of certain tree species.

Decrease of summer rainfall negatively affects forage yield and sheep body state threatening farming sustainability: insight for facing climate changes

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Mediterranean climates proved to undergo to increase the summer aridity. Changes in the rainfall regime have serious consequences for ecosystem functions and services besides on extensive farming sustainability. In fact, increase in drought stress proved to worsen forage quantity and feed value. Thus understanding the effects of drought intensity on forage and animal welfare besides the definition of the threshold value of summer rainfall allowing for the maintenance of a sufficient animal welfare is a key issue. The hypothesis that the decrease of the summer rainfall amount, affecting forage yield, worsen the sheep body state was tested. The research was performed in 2007, 2008 and 2009; for each year daily temperature and rainfall amount were gathered from the climatic station of the Torricchio Mountain Natural Reserve. In order to assess the aboveground phytomass, 10 fenced stands were positioned on semi-mesophylous grasslands; the aboveground phytomass was collected from June 2nd to the end of August. To assess the body state of sheep, the Body Condition Scores (BCS) method was used since its relationship with both pasture and ruminal features was proved; also endocrine and metabolic blood indicators confirmed its reliability. Animals were evaluated after a period when nutrition was based on dry hay and cereals (T1), after the period of highest productivity and of pasture flowering peak (T2) and after the maximum of pasture dryness (T3). From a climatic point of view 2007 and 2008 years had summer rainfall lower than those of the average value (1950-2000) of the study area (-70% in 2007 and -17% in 2008); 2009 was characterized by a higher amount of summer rainfall (+15%). Also the net primary productivity showed high differences with the lower productivity in 2007 and the higher in 2009. The trend of grassland productivity follows that of the summer precipitations. BCS scores down to value near 2.0 in late summer 2007, notably below than the lower value of the central quartiles of BCS obtained by the whole data set (2.4); it is also below the lower value of the central quartiles of BCS obtained by the T3 data set (2.2). So, the summer rainfall amount of 2007 may be considered lower than the threshold value necessary to guarantee a sufficient grassland productivity to sustain animal wellbeing. In fact, the BCS range value of 2.2-2.4 can be considered as a threshold value.



New localities of *Orchidaceae* taxa from sub-Mediterranean grasslands of Čićarija Mt and Matokit Mt (Croatia)

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On the sub-Mediterranean grasslands of Čićarija Mt (Istria) and Matokit Mt (south Dalmatia) we found 21 *Orchidaceae* taxa that have no previously records for these localities. According to Rulebook on strictly protected species (NN 144/2013) all *Orchidaceae* taxa are protected, additionally a lot of taxa are reported as endangered in some of the IUCN risk categories.

On different grassland habitats (dry rocky pastures and mesophilous meadows) we found: *Gymnadenia conopsea* (L.) R.Br., *Limodorum abortivum* (L.) Sw., *Listera ovata* (L.) R. Br., *Neottia nidus-avis* (L.) Rich., *O. coriophora* L. subsp. *fragrans* (Pollini) K.Richt., *O. morio* L. subsp. *picta* (Loisel.) K.Richt. and *O. provincialis* Balb. ssp. *pauciflora* (Ten.) Camus.). Among IUCN risk categories eight taxa are vulnerable (VU): *Ophrys sphegodes* Mill., *Orchis coriophora* L., *O. militaris* L., *O. purpurea* Huds., *O. quadripunctata* Cirillo ex Ten., *O. tridentata* Scop., *O. ustulata* L. and *Platanthera bifolia* (L.) L.C.M. Richard. Six taxa are NT (near threatened): *Anacamptis pyramidalis* (L.) Rich., *Cephalanthera longifolia* (L.) Fritsch, *C. damasonium* (Mill.) Druce, *Himantoglossum adriaticum* H. Baumann, *O. mascula* (L.) L. and *O. morio* L.

The dominant habitats on the altitude between 250-750 m a.s.l., in both researched areas belong mostly to *Scorzonero-Chrysopogonetalia* H-ić. et Ht. (1956) 1958 order (*Festuco-Brometea* Br.-Bl. et R.Tx. 1943 class), that are characterized by Cfb Köppen climate type. Comparing both mountains that have similar environmental conditions, we recorded 14 *Orchidaceae* taxa at each mountain, among which nine taxa are in common. Our results showed that most species (10) grow on the habitats of pastures and meadows; eight grow only on dry pastures, and three only on mesophilous meadows. Regard to grassland management we found most taxa (> 80%) grow on the abandoned and used sites, and less taxa (< 20%) on continuously used sites of pastures and meadows. As a result of vegetation succession, highly valuable grassland habitats decrease in their surfaces, and generally leading to loss of biodiversity of *Orchidaceae* taxa. In fact only two orchid taxa were found in the shrubs or forest habitats. On the basis of distinctive orchids that appear in only one of the areas we conclude that the Mediterranean environment has a bigger impact on the Matokit Mt., while the continental climate has bigger influence on the Čićarija Mt.

A contribution to the knowledge on the distribution of *Damasonium polyspermum* Cosson (Alismataceae) in Croatia

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Damasonium polyspermum occurs only in the Mediterranean area, and is relatively rare across its whole distributional range. It grows in shallow standing water bodies with significant fluctuations of the water level, and is considered characteristic for Mediterranean temporary ponds, rare and endangered habitats listed on the Habitat Directive. According to IUCN, *D. polyspermum* is globally vulnerable (VU). In the Red Book of the Vascular Flora of Croatia this species is denoted as data deficient (DD), however, recently some authors have proposed the category endangered (EN). Until now, there were only two known localities of *D. polyspermum* in Croatia (Jezera on the island Murter, pond Bunari in National Park Krka), both in Northern Dalmatia. In June 2014 we have discovered a new locality of *D. polyspermum* in the area of Vransko lake in Northern Dalmatia, on two sites where the flood water had been only recently withdrawn. Due to the specific ecological requirements which account for the small number of findings, new locality of *D. polyspermum* represents a significant contribution to the knowledge on its distribution, which is necessary for the potential management and protection of this species.

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The meadows vegetation in the southern part of the Republic of Macedonia (Mariovo Region)

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The aim of the study is to identify main features of lowland meadow vegetation in the southern parts of the Republic of Macedonia (Mariovo - wider area of Bitola and Kavadarci region). Lowland meadow vegetation in the southern Balkan that is under sub Mediterranean climate is classified within the *Molinio-Arrhenatheretea* Tx. 1937, *Trifolio-Hordeetalia* Horvatić 1963 and alliance *Trifolion resupinati* Micevski 1957.

We built the database of all relevés of lowland meadows in the Republic of Macedonia consisted of 150 published and 50 new relevés from research area. We performed cluster analysis and DCA ordination. Pignatti indicator values and climatic data were applied to show the influence of site and climate on species composition. The percentage representation of different life forms and chorotypes were analyzed statistically.

We established five associations of lowland meadows (*Trifolion resupinati*) in the Republic of Macedonia, as *Hordeeto-Caricetum distantis* Micevski 1957, *Cynosuro-Caricetum hirtae* Micevski 1957, *Trifolietum nigrescentis-subterranei* Micevski 1957, *Trifolietum resupinati-balansae* Micevski 1959 and *Bromo-Alopecuretum* Micevski 1965. In the studied area were registered three of them - *Cynosuro-Caricetum hirtae*, *Trifolietum nigrescentis-subterranei* and *Trifolietum resupinati-balansae*.

As the research area is one of the most extensive parts of the country, the mowing practice is in a great extent abandoned and this cause changes in floristic composition of lowland meadows. They are invaded by species from the neighboring areas, such as forest edges, shrub and forest communities, as well as by many ruderal and alien species.