13th Symposium on the Flora of Southeastern Serbia and Neighboring Regions

Stara planina Mt. 20th-23th June, 2019

Plenary presentations

David A. Hill (1952-2017) - a great naturalist among the linguists

Ranđelović, N., Ranđelović, V.

Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

* vladar@pmf.ni.ac.rs

David A. Hill was born in Walsall, United Kingdom in 1952. He spent his life working in education, first as a primary school teacher in the UK, then as an EFL teacher in many different institutions, in the UK, Italy and ex-Yugoslavia. In the period from 1980 to 1986, he was the English language lektor in Serbia, first in the high school for pedagogy in Prizren, then at the Faculty of Philosophy in Niš. He was a favorite professor of English language among the students of the University of Niš - he wrote poetry, played guitar and was accustomed with the culture and language of the Balkans. It is a little known in a public sphere that David was a great fan of nature, especially plants and birds. He expressed his affection for nature early in his high school days. His high school essay deals with caddisflies in the rivers located in his school's surrounding. During his stay in Serbia, David studied plants, with the special emphasis on the crocuses and orchids. He made a significant contribution to the knowledge of the genus Crocus in Serbia. Together with Novica Ranđelović, he described a new species from the genus Crocus - C. rujanensis. As a result of cooperation with the authors of this text, a monograph "The genus Crocus L. in Serbia" was published in 1990. He was also expanding the knowledge of the distribution of orchids in the southern parts of our country. Consequently, the article "Orchids in southern parts of Serbia: some recent findings" was published in proceedings of the first SFSES, called "Simpozijum Stogodišnjica flore okoline Niša" at that time.

Unfortunately, our friend and coworker David A. Hill died at the age of 65, after a long struggle with a serious illness on October 23rd, 2017.

Research of urban flora and vegetation in Serbia and SE Europe - where are we now?

Jovanović, S. [1], Glišić, M[2]

[1]University of Belgrade, Faculty of Biology, Institute of Botany and Botanical Garden, Belgrade 11000, Serbia

[2]Higher agricultural school of vocational studies in Šabac, Šabac 15000, Serbia

* *sjov@bio.bg.ac.rs*

Spontaneous flora and vegetation of urban areas is a specific example of interactions between natural processes and complex human impacts. Urban areas are especially important in the context of biological invasions since they might represent the zones from which alien species disperse to the surrounding natural areas, where they can become naturalized and even invasive. However, a significant number of specialized species, including certain rare and endangered, inhabit urban areas as some sort of refugial habitats. Urban vegetation also contributes to ecosystem services and affects the citizens' well-being. The researchers have long considered that urban areas are not worth the scientific attention and studies of flora and vegetation were, until recently, mostly focused on natural or semi-natural environments. During the 1960s and 1970s, ecologists began to direct their attention to urban ecosystems. In the last two decades, the number of research papers with a focus on urban ecosystems in Europe has increased significantly. However, explored cities are very unevenly distributed, and most of the studies are focused on central Europe. The aim of this analysis was to provide a realistic insight into the state of the previous research period, as well as the investigation trends in Serbia compared with the other SE Europe countries. Additionally, this overview aimed to affirm the importance and needs of a systematic methodological approach to recent and future research of urban flora and vegetation in this region.

Published works were searched and collected on the basis of clearly established criteria, and then classified according to the topic, the concept of research and the country to which they relate. Online search was carried out using the following keywords: "urban flora", "urban vegetation", "urban plants", "urban plant species", "urban plant communities", "urban forests", combined with the names of countries and cities of South East Europe. All studies that partially or completely relate to the characteristics of recent spontaneous flora and vegetation of cities were included in the analysis. In addition to the studies that include the floristic and phytocenological approach to the research, studies based on the application of remote sensing technology in the research of urban vegetation from the aspect of landscape ecology were also taken into consideration. Apart from research related to urban areas in the strict sense, the studies of periurban flora and vegetation were also included into the analysis, since those areas are adjacent to urban zones and are under strong

anthropogenic influence. Studies of individual species or a small number of species in cities were only taken into account if they were related to their spatial distribution, abundance, population dynamics, and habitat preferences, whereas those related to the morpho-anatomy, ecophysiology and phenology were not considered. In addition, the analysis does not include the studies of planted dendroflora and ornamental herbaceous plants in the parks, explorations of heavy metals contents, radioactivity and effects of pollutants to plants, economic, social and psychological importance to humans, as well as palynological and paleobotanical studies. Papers published in the previous 30 years with an abstract in English were included in the statistical analysis.

The analysis covered a total of 170 papers that were classified according to the topic and concept of research, with some contributions belonging to two or more categories. Studies related to the composition and other characteristics of urban flora were the most frequent (~69 %). However, a small number of these papers were related to the complete flora of cities, and they were mostly restricted to the studies of certain groups of plants, particular habitat types or specific city areas. Special attention was given to the invasive and alien species, and approximately 20 % of titles contained one of the following words - „invasive", „alien", „neophytes" or „neophytic". Phytocoenological studies were underrepresented with approximately 7 % of analyzed contributions. Studies regarding the landscape ecology of urban areas, as well as those using the methods of remote sensing, are becoming more frequent recently (~17%). Explorations of the abundance, distribution, or habitat preferences of individual species or several species in cities were also included in the analysis (~8 %). Floristic or landscape studies of urban and periurban forests were represented with approximately 10 %, whereas studies of conservation, management, and urban planning contributed to approximately 5 % of analyzed papers.

In the last 30 years, the number of papers related to urban flora and vegetation of SE Europe increased considerably. During the 80s and 90s of the last century, 0 - 1 papers from this field were published annually, but the situation has recently changed. Namely, starting from 2010, in average 19 papers were published annually. Floristic studies are still the most frequent, and the last decade is also characterized by a high number of studies of invasive species, as well as landscape ecology of urban vegetation.

Exploration rates of urban flora and vegetation vary considerably across the countries of SE Europe with the following production and distribution of papers: Croatia – 45, Serbia – 30, Romania – 26, Slovenia – 24, Greece – 20, Bosnia and Herzegovina – 20, Bulgaria – 13, Montenegro – 9, Albania – 8, North Macedonia – 2, with several papers being related to the cities from multiple countries. The floristic approach was the most common in most of the countries. In comparison to the rest of SE Europe, Serbia could be considered as a country with a good rate of exploration of urban flora. However, Serbia has a low rate of phytocoenological studies of urban communities, urban and periurban forests as well as studies dealing with the aspects of landscape ecology of urban vegetation.

Although some countries of Southeast Europe have a significant number of floristic studies, cities in this area are still less explored in comparison to the cities of other European regions. The low frequency of papers published in the SCI journals was also noted. A large number of contributions are available only in the form of abstracts from different scientific conferences and symposia, whereas some of the studies are only available in the local language. In addition, the methods used by researchers from different countries differ, resulting in the inability to adequately compare results and make relevant conclusions. At the same time, studies in other parts of Europe often have a broader spatial framework and uniform methodology, while studies in Southeast Europe often refer to individual cities, to specific habitats within the city or to certain parts of the city.

It would be beneficial if the region of SE Europe would be included in the studies at large scales, which would include other European countries. Also, conducting studies in the entire region of SE Europe, using the model applied in central Europe should also be considered. Collaboration of researchers and scientific institutions from different countries of the region should be fostered through international meetings, as well as national and international projects, which would facilitate the organization of comparative studies of urban flora and vegetation in Southeast Europe and provide an opportunity to prepare a comprehensive synthesis on the floristic, vegetation and phytogeographic level.

Acknowledgments. The Ministry of Education, Science and Technological Development of the Republic of Serbia supported this research through Grant 173030

13th Symposium on the Flora of Southeastern Serbia and Neighboring Regions

Stara planina Mt. 20th-23th June, 2019

Taxonomy and Sistematics

INTRODUCTORY LECTURES

Micromorphology and anatomy in systematics of Asteraceae. An old-fashioned approach?

Janaćković, P., Marin, P.D.

University of Belgrade – Faculty of Biology, Institute of Botany and Botanical Garden "Jevremovac", Department of Morphology and Systematics of Plants, Strudentski trg 16, 11000 Belgrade, Serbia

* *pjanackovic@bio.bg.ac.rs*

The comparative study of plant morphology intertwined with anatomy, have always been the basis for the plant systematics, which strives to explain diversity, evolution and phylogeny of plants. In molecular era some authors diminishe importance of morphology and especially anatomy in systematic and phylogenetic studies of plants. But, are molecular data exclusively primary and self-sufficient approach in taxonomic research of plants? Let us see some examples. Studies of some Asteraceae taxa showed that morphological, micromorphological and anatomical data are extremely important in systematics. Investigation of Cichorieae anthers micromorphology has shown their taxonomic relevance on the species level. Senecioneae floral microstructures provide the most important diagnostic characters in the tribe, as in the family as a whole. In Arctotideae morphological and micromorphological characters confirmed close relationships between the *Gorteria* clade and*Berkheya* clade. Anatomy of several members of the tribe Senecioneae showed that they possess resin ducts in stems, leaves and roots, sometimes also in floral parts, and even in cotyledons. Some leaf blade characters have shown to be diagnostic to set apart *Aster*, *Galatella* and *Tripolium*. This occurs in the tussilaginoid as well as in senecioid group. Involucral bracts and petal microcharacters (trichomes and crystals - sylvite and weddellite) of two *Xeranthemum* species links this species with other - annual Xeranthemineae i.e. *Chardinia*. Micromorphological traits of leaves, involucral bracts and cypselae of some Xeranthemineae taxa showed to be informative at a species level and contribute to a better understanding of intergeneric relationships and phylogeny of the subtribe. Some well defined qualitative anatomical characters of *Xeranthemum* taxa strengthen taxonomy of the genus and points towards an adaptation of mesophilous ancestors to xeric habitats. A comparative anatomical investigation of some *Artemisia* taxa showed species-specific characters, which contribute to the genus taxonomy. New opportunities for systematic morphology, micromorphology and anatomy in case of Asteraceae taxonomy, but certainly also in other plant groups, that were not present in the premolecular era, are opening regarding synergistic multidisciplinary taxonomic, evolutionary and phylogenetic

studies which combine molecular with morphological, anatomical and other analyses, keeping in the throne these "old fashioned" approaches.

Acknowledgements. We acknowledge the financial support provided by the Serbian Ministry of Education, Science and Technological Development, project No. 173029.

Development and importance of identification keys: case study in Slovenia

Jogan, N.

Department. of Biology, BF UL, Večna pot 111, SI-1000 Ljubljana, Slovenia

* *nejc.jogan@bf.uni-lj.si*

When facing complex problems, as recognition of one species among thousands definitely is, gradual narrowing of probable results pool by successive decisions (~filters) is probably inherent to human logic. So the well known concept of identification keys was not so much invented as it was simply transferred to the paper form. That happened already in pre-Linnaean times but after first edition of Flore Française (J. B. Lamarck 1778) it became standard tool. In printed versions keys are mostly single-access and dichotomous.

A series of plant identification keys published in Slovene language (Glowacki 1912-13, Bevk 1927, Piskernik 1941, 1951, Martinčič & Sušnik 1969, 1984, Martinčič & al. 1999, 2007) was analysed and compared also with some other relevant keys to recognize the structural evolution and estimate quality of the keys. For that purpose keys for *Equisetum* and *Dryopteris* were compared.

For each key topography was recognized (average number of steps (nodes) to identification, number of taxa and key nodes, strictly dichotomous / not), further on it was checked whether it is strictly antithetic, average characters number per node counted, and some additional data gathered (micro-character included, names: Latin, synonyms, vernacular, species description, distribution, ecology, conservation, ploidy, phenology). At the end it was estimated if identification is possible for incomplete material and the reliability estimation was scored.

ORAL PRESENTATIONS

Diversity of the genus *Ramaria* (Basidiomycetes) in alpine forests of Pokljuka and Bohinj mountains

Piltaver, A.

Institute for the systematics of higher fungi, Zofke Kvedrove ul. 24, 1000 Ljubljana, Slovenia

* *anpiltaver@gmail.com*

During the fungal survey, conducted in the Triglav National Park in the two - year peroid from 2013-2014 in managed forest stands of Pokljuka and non-managed forest stands in the Bohinj mountains, a great diversity of macrofungi was found with 342 fungal species determined. Among mycorrhizal fungi, during the survey periode, the genus Ramaria was most abundant, probably because of specific weather conditions during this periode. Special attention was put in collecting and documenting every single specimen or group of them during the survey, determining in all 14 different species, the most common of them, *Ramaria longispora* Marr & D.E. Stuntz, recorded for the first time for Slovenia. The diversity of this poorly known genus is discussed. It can not be determined without microscopic examination and therefore escapes the limits of knowledge of amateur mycologists using only macroscopic features for their determination.

Acknowledgements. The author expresses sincere thanks to The Triglav National Park, which enabled the survey within the Recharge-Green project, cofinanced by the EU fond for regional development within the Alpine space area.

Sempervivum ciliosum sensu lato: morphological variability and possibility of differentiation

Jovanović, M.[1], Lakušić, D.[2], Gussev, Ch.[3], Lazarević, P.[2], Zlatković, B.[1]

[1]Faculty of Sciences and Mathematics, Department of Biology and Ecology, University of Niš, Niš, Serbia

[2]Faculty of Biology, Institute of Botany and Botanical Garden "Jevremovac", University of Belgrade, Belgrade, Serbia

[3]Department of Plant and Fungal Diversity and Resources, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Science, Sofia, Bulgaria

* *maja.jovanovic1@pmf.edu.rs*

Sempervivum ciliosum sensu lato is a group of yellow-flowered *Sempervivum* taxa endemic for the territory of the Balkan Peninsula. In accordance with the current taxonomy of genus *Sempervivum*, the following taxa are included in above-mentioned group: *S. ciliosum* Craib, *S. jakucsii* Pénzes, *S. klepe* Micevski, *S. octopodes* Turrill and *S. galicicum* (A.C.Sm.) Micevski. Due to highly expressed phenotypic variability and lack of the more detailed studies of morphological variability, it is not possible to certainly establish whether all listed taxa are morphologically well-defined. Delamination among two species belonging to *S. ciliosum* group is presented here based on univariate and multivariate (PCA, DCA) analysis of morphological characters. A total of 35 quantitative characters (17 characters of the vegetative and 18 characters of the flowering region) were examined for 45 individuals from 3 populations, tentatively identified as *S. galicicum* and *S. ciliosum s.s.* Obtained results indicate that to the separation of analyzed populations, to a greater extent, contributes the characters of the flowering region. Thus, the results of multivariate analysis have shown that *S. galicicum* separates from *S. ciliosum*. Results indicate that most of the selected morphological characters can be used to differentiate the taxa within *S. ciliosum sensu lato*.

Acknowledgements. This study was funded by The Ministry of Education, Science and Technological Development of the Republic of Serbia, grant no. 173030.

Red flowered *Sempervivum* species from the central Balkans: morphological variability and differentiation

Stojiljković, B.[1], Jovanović, M.[2], Cvetković, A.[2], Mitić, Z.[2], Lakušić, D.[3], Zlatković, B.[2]

1Institute for Nature Conservation of Serbia, Unit in Niš, Niš, Serbia

2Faculty of Sciences and Mathematics, Department of Biology and Ecology, University of Niš, Niš, Serbia

3Faculty of Biology, Institute of Botany and Botanical Garden "Jevremovac", University of Belgrade, Belgrade, Serbia

* *bogosav.stojiljkovic@zzps.rs*

This study considers the red flowered *Sempervivum* species collected from the territory of the central Balkan Peninsula. The analysis included 3 groups of individuals tentatively identified as *Sempervivum marmoreum* Grisebach, *S. erythraeum* Velenovsky and *S. kosaninii* Praeger which, according to literature, are regarded as taxonomically related. However, due to the pronounced phenotypic plasticity, it is very difficult to reliably determine their taxonomical relations. The aim of this study was examining the morphological variability of these 3 species and defining of taxonomically significant characters that can be used to identify the above mentioned taxa. A total of 32 quantitative characters (15 from vegetative and 17 from flowering region) were processed in the Statistica 8.0., including univariate variance analysis (ANOVA), canonical discriminant analysis (CDA) and principle component analysis (PCA). The obtained results indicate a clear difference between the analyzed taxa, both in the characters from vegetative and flowering region. The results have shown that the taxonomically important characters in their delimitation are: length of the upper part of the rosette leaf, number of petals, length of petals and width of petals.

Acknowledgements. This study was funded by The Ministry of Education, Science and Technological Development of the Republic of Serbia, grant no. 173030.

Chemotaxonomic significance of n-alkanes in the differentiation of three *Satureja* species

Dodoš, T., Rajčević, N., Marin, P.D.

University of Belgrade - Faculty of Biology, Studentskitrg 16, 11000 Belgrade, Serbia,

* *tanjadodos@bio.bg.ac.rs*

The genus *Satureja* (Lamiaceae) comprises ca. 30 species, distributed mostly in the Mediterranean area, but not exclusively. Species of this genus have been the object of research from different aspects. However, the literature survey shows that *n*-alkanes were poorly studied as chemotaxonomic markers in *Satureja* species and, particularly, their variability within and between natural populations growing in the Balkans. The object of this research was to study the variability of leaf *n*-alkanes in *S. montana* L., *S. kitaibelii*Wierzb. ex Heuff.and *S. subspicata* Bartl. ex Vis. Plant material was collected from 25 wild-growing populations. Extracts of leaf *n*-alkanes were analysed using GC-FID and GC-MS. ANOVA and the post-hoc test showed differentiation between taxa based on five out of seventeen *n*-alkanes including three dominant ones. The multivariate analyses (HCA and DA) showed a higher similarity between *S. montana* and *S. kitaibelii* than with *S. subspicata*. Given results further confirm a closer relationship between *S. kitaibelii* and *S. montana* in comparison to *S. subspicata*, which is in accordance with the previous findings. Furthermore, *S. kitaibelii*is sometimes treated as a subspecies of *S. montana*. It could be assumed that geographic isolation of the populations led to differentiation and speciation of these two taxa from a single taxon.

Acknowledgements. This study was supported by a grant from the Ministry of Education, Research and Technological Development of Serbia (Grant No. 173029)

Teucrium × *rohlenae*, a new natural hybrid in flora of Croatia - Morphological and chemical evidence

Zbiljić[1], M., Lakušić, B.[1], Marčetić, M.[2], Bogdanović, S.[4], Lakušić, D.[3]

[1]Department of Botany, Faculty of Pharmacy, University of Belgrade, Vojvode Stepe 450, 11060 Belgrade, Serbia

[2]Department of Pharmacognosy, Faculty of Pharmacy, University of Belgrade, Vojvode Stepe 450, 11060 Belgrade, Serbia

[3]Institute of Botany and Botanical Garden "Jevremovac", Faculty of Biology, University of Belgrade, Takovska 43, 11221 Belgrade, Serbia

[4]Department of Agricultural Botany, Faculty of Agriculture, University of Zagreb, Svetošimunska cesta 25, 10000 Zagreb, Croatia

* *milos.zbiljic@pharmacy.bg.ac.rs*

Teucrium × *rohlenae* Maly is a natural hybrid between *T. montanum* and *T. polium*. It was found in the surrounding of Kotor (Montenegro) by L. Čelakovski fil. and reported by J. Rohlena as *T montanum* × *polium* in 1922. This hybrid is validly described by K. Maly in 1951. After the original description, *Teucrium* × *rohlenae* have not been reported in the Balkan Peninsula, but hybrids between *T montanum* and *T. polium* have been cited in Italy (as *Teucrium x castrense*) and Moldova (as *Teucrium* × *bogoutdinovae*). In sympatric population of *T. montanum* and *T. polium* in the surrounding of Trilj near Split (Croatia), we found intermediate individuals with potentially hybridogenic origin. The aim of the study was to analyse 44 morpho-anatomical characters of stem, leaf, inflorescens and calyx, and chemical composition of volatile compounds of parental species and their potential hybrid *Teucrium* × *rohlenae*. The composition of hexane extracts of aerial parts was determined using GC-FID and GC-MS methods. A detailed morpho-anatomical analysis has shown that parental species are well differentiated, while potential hybrids have an intermediate position. Volatiles of potential hybrid represented both species, main hydrocarbon compounds were alike volatiles of *T. polium* while the terpene profile was more similar to *T. montanum* terpenes.

Acknowledgements. This work was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, Projects No. 173021 and 173030.

Flower in *Ornithogalum* as a taxonomic tool for species identification

Rat, M.[1], Andrić, A.[2], Anačkov, G.[1]

[1]University of Novi Sad, Faculty of Sciences, Department of Biology and Ecology, Trg Dositeja Obradovića 2, 21000 Novi Sad, Serbia

[2]University of Novi Sad, BioSense Institute, Dr Zorana Đinđića 1, 21000 Novi Sad, Serbia

* *milica.rat@dbe.uns.ac.rs*

Genus *Ornithogalum* is mostly described as morphologically variable („execrable“) genus, without clear morphological distinction among species. What is noticeable in *Ornithogalum* – is low number of distinctive qualitative morphological characteristics, in the first place among closely related species. Seed texture was nominated as species specific characteristic, but the latest research refuted that. The flower has the most quantitative characteristics, and using morphometric analysis *Ornithogalum s.s.*species can be differentiated. To present flower differences of eight *Ornithogalum* species (*O. comosum, O. montanum, O. dalmaticum, O kochii, O. umbellatum, O divergens, O sibthorpii, O. refractum*), in total 21 characteristics were analysed. Parameters of flower length (perigon length) were correlated with scape, inflorescence and pedicel length, with an aim to merge these characteristics for plant determination key. *Ornithogalum comosum* and *O. montanum* were separated as species with „small“ flowers, while *O. kochii* has medium size flowers. All other investigated species have „large“ flowers. Different combinations of analysed flower characteristics allow species discrimination to some extant. For some species, however, additional characteristics (as scape, inflorescene and pedicel length) are needed for correct plant identification.

Acknowledgements. This work has been supported by the Ministry of Education, Science and Technological Development, Republic of Serbia, under Grant 173030 and 173002.

A pre-Miocene Irano-Turanian origin of the species-rich monocot genus *Gagea* (Liliaceae)

Harpke, D.[1], Peterson, A.[2]

[1]Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), Gatersleben, Germany

[2]Institute of Biology, Martin-Luther-University of Halle-Wittenberg, Halle/Saale, Germany

* *harpke@ipk-gatersleben.de*

Although the Irano-Turanian (IT) floristic region is considered an important centre of origin for many taxa, there is a lack of studies dealing with typical IT genera that also occur in neighbouring areas. The species-rich monocot genus *Gagea* Salisb. with a centre of diversity in the IT region and a distribution in adjacent regions, represents a good study object to investigate spatial and temporal relationships among IT region and its neighbouring areas (East-Asia, Euro-Siberia, Himalaya, and Mediterranean). Our study was aimed to (*i*) infer the origin of the genus and its major lineages, (*ii*) estimate divergence times and (*iii*) reconstruct colonisation events by analysing sequences of the ribosomal DNA internal transcribed spacer (ITS) region of 418 individuals and chloroplast intergenic spacers sequences (*psb*A-*trn*H,*trn*L-*trn*F) of 497 individuals, representing 116 species from all sections of the genus and nearly its entire distribution area. The reconstruction of ancestral distribution ranges revealed that *Gagea* most likely originated in southwestern Asia, where the genus first diversified starting in the Early Miocene. Migrations to neighbouring regions started in the Middle Miocene and became possible due to Miocene climate changes creating open and dry habitats. The Mediterranean basin, today a second centre of diversity for the genus, was colonised multiple times from southwestern Asia or Euro-Siberia. The high species diversity in the Mediterranean particularly of *G.* sect. *Didymobulbos* can be explained by an early colonisation of the region, followed by extensive in-situ speciation.

Pre-drying preparation of herbaria specimens: A theoretical case study for genus *Crocus* L. (Iridaceae)

Tanev, A.

Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Acad. G. Bonchev Str., bl. 23, 1113 Sofia, Bulgaria

* *atanas.tanev@abv.bg*

The herbarium specimens represent important documents of natural history storing valuable information for centuries. As such they must be prepared with great care, quality materials and vast knowledge of the significant taxonomical characteristics that must be emphasized regarding the specimen. Unfortunately, in literature the essential aspect of pre-drying preparation of the herbarium specimens is rarely, if ever, discussed. In some taxa the most important characteristics are located on plant organs with high repeatability but in others those organs are represented by low count repeats going as low as one per individual. Such taxa, as the latter, can be found in genus *Crocus* L. (Iridaceae), where the individuals mainly produce only one or two flowers at a time with generative organs bearing important taxonomical characteristics not exceeding the perigon segments. There are 4 known ways of possible arrangements of the flower prior to drying the *Crocus* specimens. In this study I am taking a theoretical approach to evaluate the advantages and disadvantages of each and to suggest naming conventions for every way of arrangement, so as to ease communication and labeling.

On the border - A new species of *Crocus* (Iridaceae) from the Northern Pindus

Jovanović, M.[1], Raca, I.[2], Shuka, L.[3], Harpke, D.[4], Ranđelović, V.[2]

[1]Faculty of Agriculture, University of Niš, Kosančićeva 4, 37000 Kruševac, Serbia

[2]Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

[3]Department of Biology, Faculty of Natural Sciences, Tirana University, Bld. ZOG I, 1001 Tirana, Albania

[4]Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), Corrensstrasse 3, D-06466 Gatersleben, Germany

* *milica.zeka@yahoo.com*

Species delimitation is challenging especially in young and fast evolving species groups. The taxa complex around *C. veluchensis* in the Pindus presents such a fast evolving and challenging group, where species borders are often unclear. The deep yellow flowering crocus population on Mt. Gramos in the northern Pindus mountain range on the border of Albania and Greece, was up to now considered as *C. cvijicii*. According to chloroplast makers, nrITS region, nuclear single-copy markers as well as a genome-wide single-polymorphism data, the population on Mt. Gramos is close related to *C. veluchensis* and *C. novicii*. The low degree of genetic differentiation particularly to other Northern Pindus populations of *C. veluchensis* suggests that it presents a recently evolved taxon. In contrast, morphologically it can be clearly distinguished by flower color, stigma color or the style-stamen ratio from the type population of *C. cvijicii* or from *C. novicii* and *C. veluchensis*. As consequence, it will be describe as a new species named *C. gramensis*.

Acknowledgements. The Ministry of Education, Science and Technological Development of the Republic of Serbia has supported this research under Grant 173030.

Saffron comes from Attica (Greece)

Nemati, Z., Harpke, D., Kerndorff, H., Blattner, F.R.

Leibniz Institute of Plant Genetics and Crop Research (IPK), D-06466 Gatersleben, Germany

* *nemati@ipk-gatersleben.de*

Saffron, *Crocus sativus*, is the source of the worldwide most expensive spice. It is a male-sterile triploid that cannot be bred and that is cultivated as a single clone. There has been a centuries-long debate regarding the possible parental species of saffron and where it was domesticated. Identification of parents could lead into improving of this economically important plant by breeding. To trace the evolution of triploid saffron, we did a nested analysis approach reaching from phylogeny of the species group where saffron belongs to, using several chloroplast and nuclear markers, through detection of parents and to the identification of the area of domestication of the crop using chloroplast genomes and genotyping-by-sequencing (GBS) data. Here we clarified the relationships of the crop within series *Crocus* and could place 99.3% of saffron GBS alleles in *Crocus cartwrightianus*, sometimes called 'wild saffron,' identifying it as the sole progenitor involved in saffron formation. Our result also indicated that the *C. cartwrightianus* population from Attica is most similar to *C. sativus*. We conclude that saffron is an autotriploid plant derived from the fusion of two different genotypes of Attic *C. cartwrightianus*.

Crocus randjeloviciorum Kernd., Pasche, Harpke & Raca in Serbia - State of the art

Raca, I.[1], Manić, J.[1], Harpke, D.[2], Jušković, M.[1], Jovanović, M.[3], Ranđelović, V.[1]

[1]Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

[2]Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), Corrensstrasse 3, Gatersleben, Germany

[3]Faculty of Agriculture, University of Niš, Kosančićeva 4, Kruševac, Serbia

* *irena.raca@pmf.edu.rs*

By confirming that *Crocus adamii sensu lato* can't be found western from the Anatolian Diagonal, the recent studies put the presence of *C. adamii* in Serbia under question. Consequently, the new species from Tupižnica, Serbia was described as *C. randjeloviciorum*. This work represents an extension of *C. randjeloviciorum* investigation, with the aim to examine potential differentiation trends in between the population from the *locus classicus* and 8 other populations (formerly defined as *C. adamii*). The detailed analysis of morphometry (14 characters) and leaf anatomy (20) had been performed, followed by the multivariate statistics of the data processing, including the Principal component and Cannonical discriminant analysis. The graphs revealed that the population from the type locality is separated from the others. The morphometric characters significant for the differention were: the bulb height and width, the outer and inner perigone segment height and width, the leaf width and the number of flowers. The highest contributors among anatomical characters were: the cross section height and length, the arm length, the white stripe width, the parenchyma, xylem, phloem and sclerenchyma area. The differentiation is correlated with the ecological features of the habitats, however future researches should be focused on its eventual genetic background.

Acknowledgements. This study was funded by The Ministry of Education, Science and Technological Development of the Republic of Serbia, grant no. 173030.

Morphological variability of species *Anacamptis coriophora* from Balkan Peninsula and Pannonian Plain

Radak, B.[1], Anačkov, G.[1]

[1]Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 2, Novi Sad, Serbia

* *boris.radak@dbe.uns.ac.rs*

Species *Anacamptis coriophora* is geophytic orchid with Central European-Mediterranean distribution. This species can be divided into two subspecies (subsp. *coriophora* and *fragrans*), which are very well differentiated genetically and somewhat less morphologically, especially in areas where their ranges overlap, such as Balkan Peninsula. In order to determine morphological characters that are suitable for good separation of this two subspecies, as well as to investigate morphological variability at the interpopulation level within and between these two taxa, 25 populations (288 specimens) of *A. coriophora* originating from Balkan Peninsula and Pannonian Plain were subjected to morphometric analyses followed by statistical analyses. A total of 32 morphometric characters within the plant generative region were analyzed. Dissected flowers were scanned and measured using Digimizer software ver. 5.3.2. Statistical analyses were done in Statistica ver. 13.5. On the basis of the obtained results, it can be observed that populations within both subspecies that lived in similar habitats are grouped together and that the geographically close populations of subsp. *coriophora* are a more similar one to another. The population of the subspecies *fragrans* from Peloponnese has a unique position among analyzed populations being morphologically significantly different from all others. Median lip lobe length, and petal and lateral sepal width are characters that contribute most in the morphological separation of analyzed populations and subspecies.

Acknowledgments. This research was conducted within the project no. 173030, funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

POSTER PRESENTATIONS

Typification of the plant names published in "*Elenchus plantarum vascularum quas aestate a. 1873 in Crna Gora legit Dr. J. Pančić*"

Vukojičić, S.[1], Lakušić, D.[1], Kabaš, E.[1], Lazarević, P.[1], Djurović, S.[1,2], Clementi, M.[3]

[1]University of Belgrade, Faculty of Biology, Takovska 43, 11 000 Belgrade, Serbia

[2]University of Niš, Faculty of Agriculture, Kosančićeva 4, 37 000 Kruševac

[3]University of Padova, Department of Biology, Via Ugo Bassi 58 B, 35131 Padova

* *sneza@bio.bg.ac.rs*

Thanks to his extensive investigations of the plant life of Balkans, Josif Pančić was the first one to wrote the first editions of the Floras of Bulgaria, Serbia and Montenegro. During investigation of Principality of Montenegro in 1873., Josif Pančić noticed almost 1300 taxa. On that occasion, he met for the first time the mountain plants of the Dinarides, especially those of the mountain ranges Durmitor and Komovi. There, he discovered and described numerous taxa new to science. In our work, we provide information on the typification of the names described by Josif Pančić in *Elenchus plantarum vascularum quas aestate a. 1873 in Crna Gora*, published in 1875. The original descriptions in the protologues were studied and compared with the type specimens found. Lectotypes for eight validly published names are designated: *Astragalus spruneri* var. *glabrescens*, *Campanula glomerata* var. *macrodon*, *Carduus ramosissimus*, *Geranium oreades*, *Heliosperma macranthum*, *Koeleria grandiflora* var. *subaristata*, *Valeriana bertiscea* and *Verbascum leptocladum*. Most of the plants are held in the special collection of Josif Pančić - *Herbarium Pancicianum*, within the herbarium of the University of Belgrade (BEOU). We were not able to find any specimens pertaining to the original material of*Orobanche cruenta* var. *adusta* and *Sonchus pallescens*.

Acknowledgements. The Ministry of Education, Science and Technological Development of the Republic of Serbia has supported this research under Grant 173030.

A preliminary checklist of Ascomycota from Suva Planina Mountain, Serbia

Kajevska, I.[1], Stojanović, D.[2]

[1]Faculty of Science and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

[2]Mycological Society of Niš, Bul. Svetog cara Konstantina 37/34, 18000 Niš, Serbia

* *iskra.kajevska@pmf.edu.rs*

The current knowledge of Ascomycota species diversity on Suva Planina Mountain is summarized, and the presence on a total of 119 taxa has been identified. Registered species are listed alphabetically in a form of a preliminary checklist compiled based on specimens collected during mycological surveys carried out from 2004 to 2019, available published and unpublished data as well as revised fungarium specimens. The vast majority of the species listed in the present checklist have not previously been reported from this area. According to current data the following species can be highlighted as rare in the country: *Parascutellinia carneosanguinea*, *Plectania melastoma*, *Pseudoplectania nigrella*, *Sowerbyella fagicola*, *Spathularia flavida* and *Urnula mediterranea*. Suva Planina Mt. is currently the only known locality in the country for the species *P. carneosanguinea*and *S. fagicola*. The aim of this study is to enrich the information about Ascomycota diversity in Serbia especially due to deficient data of this taxonomic group from the southeastern part of the country.

The lichen collection of the Herbarium Moesiacum Niš (HMN) - Taxonomical Analysis

Marković, M.[1], Aleksić, G.[1], Stamenković, S.[1], Raca, I.[1], Ristić, S.[2]

[1]Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

[2]Faculty of applied sciences, University "Union - Nikola Tesla", Dušana Popovića 22a, Niš, Serbia

* *sslavisa@pmf.ni.ac.rs*

The lichenarium of the HMN currently consists of 935 specimens collected in the last ten years (2009-2018) in Serbia and Bulgaria. The greatest contribution to the formation of this collection was made by Gordana Aleksić (885 lichen specimens) and Slaviša Stamenković. The rest of the specimens were provided by Bojan Zlatković, Gordana Stojanović, Marina Jušković, Violeta Mitić and Vesna Stankov-Jovanović. The results of the taxonomic analysis have revealed the presence of 244 species belonging to 92 genera and 41 families. Families with the highest number of genera are: Parmeliaceae (27 genera), Physciaceae (6), Graphidaceae (4) and Verrucariaceae (4). Genera with the highest number of species are: *Cladonia* (21), *Lecanora* (19), *Physcia* (11), *Ramalina* (8), *Peltigera* (8), *Collema* (7) and *Usnea* (6). The most abundant families are: Parmeliaceae (58 species), Lecanoraceae (25), Cladoniaceae (21) and Physciaceae (21).

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, grant number: OI 171025.

Polystichums in Bulgaria

Ivanova, D.

Department of Plant and Fungal Diversity and Resources, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 23 Acad. Georgi Bonchev str., Sofia, Bulgaria

* *dani@bio.bas.bg*

Bulgarian representatives of the fern family Dryopteridaceae have been a subject of biosystematic investigations for more than 15 years. Only two genera of this family occur in Bulgaria: *Dryopteris* and *Polystichum*. Genus *Polystichum* is one of the most species-rich fern genera in the World, comprising between 260 and 500 species. It is also one of the most widespread, morphologically diverse and taxonomically complex genera. A critical taxonomic revision of all *Polystichum* representatives in Bulgaria with emphasis on their overall morphology, spore characteristics, cytology, ecology, and distribution was made. Currently it is known that *Polystichum* is represented by 6 taxa (species and hybrids) distributed from 10 to 2640 m altitude. Morphological comparison between Bulgarian taxa showed that the frond morphology of the two known hybrids is intermediate between their parents. Additionally, their spores are abortive and greatly vary in shape and size. Plants from many localities were checked cytologically. The taxa were diploid (2n=82), triploid (2n=123) and tetraploid (2n=164). Illustrations of some important morphological characters of leaves, perispore sculpture and chromosome numbers are presented. Distribution maps of the taxa based on revised herbarium materials as well as personal collections are given. An identification key is included.

Needle volatiles as phytochemical markers in differentiation of natural populations of *Abies alba* and *A.* x *borisii-regis*

Nikolić, J.[1], Zlatković, B.[1], Jovanović, S.[2], Stojanović, G.[2], Marin, P.D.[3], Mitić, Z.[1]

[1]Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

[2]Department of Chemistry, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

[3]University of Belgrade-Faculty of Biology, Institute of Botany and Botanical Garden "Jevremovac", Studentski trg 16, 11000 Belgrade, Serbia

* *jelenanikolic9311@gmail.com*

Abies x *borisii-regis* Mattf. is a taxon endemic to the southern Balkans whose hybrid origin, taxonomic status and distribution range have not been elucidated yet. The present study is the first report on the phytochemical diversity of 10 natural fir populations tentatively identified as *A.* x *borisii-regis* and *A. alba* Mill. (one putative parental species) regarding needle headspace (HS) volatile compounds and their possible differentiation. β-Pinene and limonene + β-phellandrene were the major HS volatiles in most populations of *A. alba*, while *A.* x *borisii-regis* populations were characterized by domination of β-pinene and α-pinene. According to the multivariate statistical analyses (CDA and AHC), two phytochemical entities could be recognized: "alba" group included fir populations from territory of Romania, Serbia, Bulgaria and Macedonia, while "borisii-regis" group comprised populations from the central Greece. It could be speculated that the obtained results supported the hypotheses that only central Greek fir populations belong to *A.* x *borisii-regis*, while Macedonian and Bulgarian populations are closer with *A. alba*. Nevertheless, as in this study populations of the second putative parental species (*A. cephalonica* Loud) have not been included, the distinctiveness of *A.* x *borisii-regis*populations from the central Greece at the level of HS volatiles cannot be fully supported.

Acknowledgements. This research was supported by Grants No 173029 and 172047 by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

Study of anatomy and essential oil of *Pimpinella alpina* Host (Apiaceaea) from Serbia

Slavkovska, V.[1]; Zlatković, B.[2]; Lakušić, B.[1]; Kovačević, N.[3]; Drobac, M.[3]

[1]Department of Botany, Faculty of Pharmacy, University of Belgrade, Vojvode Stepe 450, 11221 Belgrade, Serbia

[2]Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

[3]Department of Pharmacognosy, Faculty of Pharmacy, University of Belgrade, Vojvode Stepe 450, 11221 Belgrade, Serbia

* *violetas@pharmacy.bg.ac.rs*

This study explores the shoot anatomical structure, content and composition of the essential oils of the vegetative organs and fruit of the *Pimpinella alpina*. The plant material was collected at Mt. Besna Kobila in South-Eastern Serbia, and Šar planina in Metohija. The anatomical studies were conducted on permanent slides obtained by standard method of preparation. The essential oils obtained by hydrodistillation from flowering aerial parts, fruits and roots (from flowering and fruiting period), were analysed by GC-FID and GC-MS. Anatomical analysis showed that the rhizome has a secondary structure in the bark zone, while in the zone of vascular tissues it has a primary structure. The stem has a primary structure, with vascular bundles. The leaf is dorsiventral, amphistomatic. Secretory channels are numerous in all organs. Sesquiterpene hydrocarbons with (E)-β-farnesene (23.1-52.1%) were dominant in the essential oils from aerial parts, fruit and roots, except in the root sample from Šar planina, which was characterised by high amount of phenylpropanoids (44.2%) with epoxy-pseudoisoeugenyl 2-methylbutyrate (25.9%). Phenylpropanoids with pseudoisoeugenol skeleton, which are unique to *Pimpinella* species essential oils, were also present in prominent amounts (7.9-26.8%) in other samples. This is the first report on content and composition of *P. alpina* essential oil.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant № 173021 and 173030).

Anatomical features of underground organs of *Inula* L. taxa growing in Serbia

Karanović, D.[1*], Zorić, L.[1], Zlatković, B.[2], Luković, J.[1]

[1]Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 2, Novi Sad, Serbia

[2]Department of Biology and Ecology, Faculty of Sciences, University of Niš, Višegradska 33, Niš, Serbia

* *dunja.karanovic@dbe.uns.ac.rs*

Inula L. species are known as medicinal plants and their aerial and underground organs are widely used for medical purposes. However, in contrast with the anatomical studies of aerial vegetative organs, there are limited data in the literature on anatomical features of their subterranean organs. In accordance with the fact that Inula species are of interest to the pharmaceutical industry, it is important to increase the available knowledge about their anatomy and secretory structures. Consequently, the objective of this study was to investigate anatomical characteristics of the subterranean organs of ten *Inula* taxa growing in Serbia. Cross sections of the rhizome and root were obtained using cryotechnique procedure, while detailed descriptions of their anatomical characteristics were given using a light microscopy. Distribution of secretory canals in the root (*I. heleniumm* L.) and organization of parenchyma cells in root and rhizome (*I. britannica* L.) are unique characteristics of of these two species. Specific qualitative features that characterize each of the analysed taxa will be discussed. Since anatomical features of rhizome and root of analysed taxa have not been documented so far, obtained data might be useful in their identification and represent the valuable contribution to knowledge of their biology.

Acknowledgements. This work was financially supported by the Ministry of Education, Science and Technological Development, Republic of Serbia, grant no. 173002.

Anatomical and micromorphological features of *Artemisia pontica* (Asteraceae) from Serbia

Janaćković, P.[1], Gavrilović, M.[1], Rančić, D.[2], Zlatković, B.[3], Dajić-Stevanović, Z.[2], Marin, P.D.[1]

[1]University of Belgrade - Faculty of Biology, Institute of Botany and Botanical Garden "Jevremovac", Studentski trg 16, Belgrade, Serbia

[2]University of Belgrade - Faculty of Agriculture, Nemanjina 6, Belgrade, Serbia

[3]Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *mgavrilovic@bio.bg.ac.rs*

In the present work we examined anatomical and micromorphological characteristics of vegetative organs of *Artemisia pontica* L., wild-growing in Serbia. Microscopic slides were prepared following the standard histological procedures. Young root shows typical structure, while secondary tissues occur in the older root. The secondary xylem is the dominant part of the old rhizome cross sections. The upper stem cross section has more or less polygonal shape with one-layered epidermis, and cortex, made up of collenchyma and parenchyma, below. Collateral vascular bundles are arranged in a circle. Large parenchyma cells are in the central region of the upper stem and rhizome. Petiole has irregular triangular shape, with one-layered epidermis, alternately arranged collenchyma and chlorenchyma below, and one central and, in each rib, two lateral vascular bundles. On the leaf cross section, the prominent main vein and two lateral ribs with depressions, are observed. Leaves are with well developed cuticle and have amphistomatous and isolateral structure. Secretory canals are present in the rhizome and upper stem cortical parenchyma and in the leaf parenchyma. Aerial parts are covered with nonglandular T-shaped and glandular biseriate trichomes. Obtained data contribute to anatomy and taxonomy of the genus *Artemisia*.

Acknowledgements. The authors thank to the Ministry of Education, Science and Technological Development of the Republic of Serbia for financial support (Grant no. 173029).

Morphological variability of interspecific *Centaurium* hybrid (Gentianaceae) and its parental species

Đurović, S.[1,3], Jelić, M.[1], Dragićević, M.[2], Mišić, D.[2], Skorić, M.[2], Nestorović Živković, J.[2], Lakušić, D.[1], Šiler, B.[2], Banjanac, T.[2]

[1]University of Belgrade, Faculty of Biology, Takovska 43, 11000 Belgrade, Serbia

[2]University of Belgrade, Institute for Biological Research "Siniša Stanković", Bulevar despota Stefana 142, 11060 Belgrade, Serbia

[3]University of Niš, Faculty of Agriculture, Kosančićeva 4, 37000 Kruševac

* *sdjurovic@bio.bg.ac.rs*

Two tetraploid sister species *Centaurium erythraea* and *C. littorale* often hybridize and have offspring with various ploidy levels. Different ploidy levels in comparison to parental species can provide instant reproductive isolation of the hybrids, while phenotypes can be a display of mosaic of both parental and intermediate morphological characters rather than just intermediate ones, as well as novel characteristics may appear. In Vojvodina (northern Serbia), stable hexaploid populations of a hybridogenic taxon provisionally named "*C.* x *pannonicum*" were documented and are here analysed using morphometric markers. Morphometric analyses of vegetative and reproductive characters were performed on 127 individuals from nine populations (three representing *C. erythraea*, four *C. littorale* and two *C. pannonicum*). Principal component analysis (PCA) and linear discriminant analysis (LDA) were performed. Both two-dimensional PCA scatterplot and the results of LDA showed *C. erythraea* and *C. littorale* individuals being two morphologically distinct groups, while the cloud comprised of the hybrid individuals was rather scattered but positioned between the two clouds made up of the parental species individuals. Leaf tip angle, leaf length/width ratio and calyx length were found to be the most informative morphological characters in delimitation of the parental taxa, whereas hybrids had rather intermediate values.

Morphometric characterization of *Achillea* x *prodanii* Degen: evidence for its hybrid origin

Stojanović, J.[1], Mitić, Z.[1], Marin, P.D.[2], Zlatković, B.[1]

[1]Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

[2]University of Belgrade-Faculty of Biology, Institute of Botany and Botanical Garden "Jevremovac", Studentski trg 16, 11000 Belgrade, Serbia

* *jelenapstojanovic93@gmail.com*

Hybridization is a prominent phenomenon in the genus *Achillea* (Asteraceae) that especially occurs among species from section *Achillea*. During the floristic investigations of Pčinja river valley in Serbia *Achillea* x *prodanii*Degen (*A. coarctata* x *A. collina*), a possibly new taxon for the flora of Serbia, was discovered. In order to provide sufficient morphometric data for its characterization and hypothetical hybrid origin the relation with its presumed parental species was examined. In that purpose, a detailed morphometric analysis of *Achillea* x *prodanii* and four additional yarrow species growing in the region (*A. coarctata*, *A. millefolium*, *A. crithmifolia* and *A. nobilis*) was performed. A total number of 105 individuals from 7 populations were compared at the level of 9 quantitative characters. Multivariate statistical analyses (PCA and CDA) indicated intermediate position of*Achillea x prodanii* between *A. coarctata* and *A. millefolium*, demonstrating even greater morphological similarity to *A. millefolium* than to *A. coarctata*. In order to establish more precise position of the reported hybrid, it is necessary to include *A. collina* (*A. millefolium* agg.) as the second parental species, occurring at the same locality where the hybrid individuals were found. Further studies should also define relationship between *Achillea* x*prodanii* and *A. vandasii*, a similar species that has already been recorded in flora of Serbia.

Acknowledgements. This research was supported by Grant No 173029 by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

Compared analysis of bioaccumulation potential and metals translocation in plant species *Achillea millefolium* L. i *Leucanthemum vulgare* Lam

Đelić, G.[1], Vasić, P.[2], Jakšić, T.[2], Branković, S.[1], Timotijević, S.[1], Novaković, M.[1], Simić, Z.[3]

[1]Department of Biology and Ecology, Faculty of Sciences,University of Kragujevac,R. Domanovic 12, 34000 Kragujevac, Serbia

[2]Faculty of Sciences and Mathematics Lole Ribara street 29, 38220 Kosovska Mitrovica, Serbia

[3]Department of Chemistry, Faculty of Sciences,University of Kragujevac,R. Domanovic 12, 34000 Kragujevac, Serbia

* *gdjelic@kg.ac.rs*

Abstract In this study was carried out the research of plants from fam Asterace from the industrial sanitary landfill Žitkovac (Trepča). The aim of the study was to investigate and compare the accumulation and distribution of Mn, Ni, Ca, Mg, Fe, Zn, Cr, Pb Cu in the species *Achillea millefolium* and *Leucanthemum vulgare*. The concentration of metals in the soil and the samples of plants was determined by flame atomic absorption spectrometry. In order to analyze the translocation of metals from the root to the above-ground organs, authors used translocation factor (TF). The obtained results indicate that, based on the determined quantities, all the investigated metals in the soil can be compared to the series Fe>Mg>Ca>Mn>Pb>Cr>Ni>Zn>Cu; in the case of A. millefolium species Ca>Mg>Fe>Mn>Zn>Ni>Pb>Cr>Cu and for the species L. vulgare Ca>Mg>Fe>Mn>Zn>Pb>Cr>Ni>Cu. The largest quantities of Mn, Fe, Zn, Cr and Pb were found in L. vulgare.The root of L. vulgare contains the largest amounts of Cu, a root A. millefolium contains the largest amount of Ni, Ca and Mg. Based on the results of the variance analysis, we can conclude that there are statistically significant differences in the content of the investigated metals between A. millefolium and L. vulgare.

Comparative analysis of morphological and anatomical characters of species *Gagea pratensis* (Pers.) Dumort. (Liliaceae) from Serbia and Montenegro

Stojanović, J.[1], Raca, I.[1], Jevtić, J.[1], Jušković, M.[1], Ranđelović, V.[1]

[1]Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *jovanagreen6@gmail.com*

In this study, morphological and anatomical properties of species *Gagea pratensis* (Pers.) Dumort. were investigated and described. Comparative analysis included six distantly separated populations from Balkan Peninsula (Serbia and Montenegro). The aim of the study was to quantify morphological and anatomical differences between investigated populations. Statistical analyses were carried out for 19 morphological and 5 anatomical characters of 122 specimens using program STATISTICA 7. Applied statistical analyses were analysis of variance (ANOVA), principal component analysis (PCA) and discriminant analysis (CDA). Analyzis of variance showed that almost all investigated characters have statistical significance in differentiation of analyzed populations. According to principal component analysis characters that contributed the most to the separation of populations were height of the whole plant, bulb width, width and length of basal leaf, width and indumentum type of peduncle, lenght of first cauline leaf, width and lenght of second cauline leaf, and width of outer and inner segments of perigone. The results obtained from discriminant analysis showed the existence of grouping among different populations, and separation of population from locality Gamzigradska banja from allother populations.

Acknowledgements. This work was funded by the Ministry of Education, Science and Technological Development of Republic of Serbia (project no. 173030).

Anatomical study of *Bolboschoenus* taxa distributed in Serbia

Nikolić, D., Marinković, J., Jušković, M., Jenačković Gocić, D., Raca, I., Ranđelović, V.

Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *danid@pmf.ni.ac.rs*

Anatomical characteristics of *Bolboschoenus maritimus*, *B. planiculmis*, *B. laticarpus* and *B. glaucus* were analyzed and compared in order to identify diagnostic characters that support their differentiation. Twelve quantitative characters of stomata and epidermal cells and 13 morpho-anatomical characters of leaves and stems were investigated within 8 populations of *Bolboschoenus* taxa. The results of Principal Component Analysis (PCA) and Canonical Discriminate Analysis (CDA) have shown lack of differentiation between the studied species regarding the quantitative characters of stomata and epidermal cells, in contrast to morpho-anatomical characters of leaves and stems. CDA analyses based on anatomical characters of leaves and stems revealed existence of two groups of populations. One group corresponds to populations of *B. glaucus* while the other included populations of *B. planiculmis*, *B. maritimus* and *B. laticarpus*. Slight differentiation was noticed between populations of *B. laticarpus* and populations of *B. maritimus* and *B. planiculmis*. The anatomical characters with the greatest contribution to differentiation were: number of sclerenchyma strands in midrib, number of air cavities in leaf lamina, number of peripheral air cavities on one side of stem, number of marginal vascular bundles on stem, number of central vascular bundles of stem and number of sclerenchyma strands on one side of stem.

Acknowledgments: This research was supported by the Ministry of Education Science and Technological Development of the Republic of Serbia [grant number 173030].

Comparative chemical analysis of nine taxa of the genus *Mentha* L. by headspace gas chromatography-mass spectrometry

Bokić, B.[1], Kladar, N.[2], Anačkov, G.[1], Božin, B.[2]

[1]Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 2, Novi Sad, Serbia,

[2]Faculty of Medicine, University of Novi Sad, Hajduk Veljkova 3, Novi Sad, Serbia

* *bojana.bokic@dbe.uns.ac.rs*

The genus *Mentha* L. comprises about 30 taxa and represents one of the most economically important members of the family Lamiaceae. The importance originates from high content of essential oil known for various applications in medicine, cosmetics and food industry. However, difficulties in taxonomy and systematics of the genus lie in the fact that hibridization favored by gynodiecy is not a rare event, which leads to a high level of polymorphism. Additional problems in the genus are cultivation, polyplody and vegetative propagation. In order to perform qualitative and quantitative chemical analyses of the genus representatives, the aerial parts from the wild populations of the *Mentha arvensis* L., *M. aquatica* L., *M. longifolia* (L.) L., *M. microphylla* K. Koch., *M. pulegium* L., *M. spicata* L., *M.* x *dumetorum*Schult., *M.* x *gentillis* L. and *M.* x *verticillata* L. were collected at the territory of the Balkan Peninsula. After drying process, easily volatile organic compounds (VOCs) were analyzed by gas chromatography coupled with mass spectrometry and headspace sampler (HS-GC-MS), which is one of the most used techniques for characterization of VOCs. The conducted analysis revealed the most dominant compounds for every analyzed sample. Volatile profiles of the samples were compared with each other and in relation to *M.* x *piperita* L. Certain differences were emphasized and discussed.

Acknowledgements. The work was supported by the Ministry of Science, Education and Technological Development of the Republic of Serbia (Project No. 173030).

Chromosome studies of some thalloid liverworts in Bulgaria

Gospodinov G.[1,2], Natcheva, R.[1]

[1]Department of Plant and Fungal Diversity and Resources, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 23 Acad. Georgi Bonchev str., Sofia, Bulgaria,

[2]Department of Plant Physiology and Molecular Biology, University of Plovdiv, 21 Tsar Asen Asen st. BG-4000 Plovdiv, Bulgaria

* *gospodinov.bryol@gmail.com*

Abstract text: In this study, we report for the first time chromosome counts for bryophytes from Bulgaria. We studied mitotic chromosomes from gametophytes of five thalloid liverwort species: *Aneura pinguis* n=10, *Pellia epiphylla* n=9, *P. neesiana* n=9, *Riccia fluitans* n=8, *R. rhenana* n=16. All counts correspond to previous reports from other parts of species' range. This is the first unequivocal evidence for the presence of *Riccia rhenana* in Bulgaria. The aquatic form of this species is sometimes difficult to separate from its close relative *R. fluitans* but the chromosome count easily distinguishes both species the first being polyploidy (presumably autodiploid) and the latter being haploid.

Acknowledgements. This research is part of project КП-06-Н21/15/19.12.2018 „Cryptic species in Bulgarian flora – molecular species delimitation in the Aneura pinguis complex" financed by the National Science Fund of Bulgaria.

13th Symposium on the Flora of Southeastern Serbia and Neighboring Regions

Stara planina Mt. 20th-23th June, 2019

Phytogeography, Floristics and Phytoecology

INTRODUCTORY LECTURE

Briology in Serbia: from floristic to chemosystematics

Veljić, M.

University of Belgrade, Faculty of Biology, Institute of Botany and Botanical Garden "Jevremovac", 11000 Belgrade, Serbia

* *veljicm@bio.bg.ac.rs*

History of briology in Serbia can be divided into several directions of floristic bryology **(**bryoflora**).** The first authors who mentioned moss are Grisebach and Pančić. Significant investigation started at the end of the 19th century and it last up to the middle of twenty century, with contribution of folowing authors: Ilić, Adamović, Simić, Jurišić, Katić, Košanin, Podpera, Černjavski, Soške, Rudski... This phase is described in an important Pavletić's book entitled "Prodromus of the bryophyte flora of Yugoslavia', which records 374 taxa. Only several floristic-phytocenological studies from the folowing authors: Slavnić, Jovanović, Pavletić, Tatić, Čolić, Popović, Martinčič, Gajić are recorded in the next thirty years.

Second phase starts in the last decade of the 20th century when several researchers start investigations about moss: Veljić, Pavić, Sabovljević, Cvetić, Pap, Pantović, Ilić... Research is directed at briologically interesting environment such as well-springs, rivers, peatlands, mountains... This phase of intensive research of bryoflora and moss ecology is still in progress, and several master and Ph.D thesis are obtained from this topic. Significant number of new taxa has been found, revision of an old data are performed and it has been concluded that the number of taxa in Serbian bryoflora is currently 831.

Since the general way of botanical research has been in progress, multidisciplinary research is accepted in bryology as well. Group of younger researchers (Bukvički, Novaković, Vujičić) started research about phytochemical analysis, biological activities, biotransformation of isolated components and stress physiology of Bryophyta. Sabovljevic et al., developed a recognizable school of moss conservation, with an emphasis on active protection and reintroduction. The colection of more than 260 moss species (from all over the world) is located in the Institute of Botany and Botanical Garden 'Jevremovac'. Sixty percentage of these species are regional or globally endangered.

In this chronological review a partial display of bryology in Serbia is shown and also highlighted new approaches in moss investigation.

Acknowledgements. This research was supported by the grant from the Ministry of Education, Science and Development of Serbia (Project No. 173029).

ORAL PRESENTATION

Using Biologer to record plants distribution in Serbia

Popović, M.[1], Koren, T.[2], Burić, I.[2], Golubović, A.[3], Živanović, N.[4], Dožai, J.[5]

[1]University of Niš, Faculty of Sciences and Mathematics, Department of Biology and Ecology, Višegradska 33, 18000 Niš, Serbia

[2]Association Hyla, Lipovac I no. 7, 10000 Zagreb, Croatia

[3]University of Belgrade, Faculty of Biology, Studentski trg 16, 11000 Belgrade, Serbia

[4]ZoozDev, Laze Nančića 36, 21000 Novi Sad, Serbia

[5]Association of Environmentalists Riparia, Matije Korvina 9, 24000 Subotica, Serbia

* *mpopovic@pmf.ni.ac.rs*

Ongoing development of various biodiversity software enables collecting, storing and analysing biodiversity data. In Serbia only several closed and proprietary solutions for data collecting exist. To improve this situation we developed Biologer, an online platform licensed as open source software. Biologer encourages citizen science initiatives, open data and open source software, but allows users to choose data and image licenses. It is designed as an user-friendly online interface for entering species occurrences and a simple android application for collecting data directly in the field. Biologer.org was created in 2018 and has been used by about 200 people who collected 47.486 data about species occurrences. Although the software is currently collecting only occurrences from the field, further development will enable entering literature records, data from personal and museum collections and transects. Beside Serbia, we have started a local community in Croatia (biologer.hr) and our team is open for creating new communities in the region. We are also planing to extend taxonomic coverage of the project and create unique taxonomic tree for all local communities. In 2019 a list of plants was prepared counting a total of 4520 taxa, allowing biologer.org to collect occurrence data on plant species in Serbia. We hope this platform will speed up data collecting on this group of organisms and fill the missing gap in plant distribution in the country.

Acknowledgements. The project was financed by the Rufford small Grants foundation (20507-B, 24652-B), Ministry of Education, Science and Technological Development of Republic of Serbia (173025, 173043) and MAVA.

First five years of digitisation of ZA and ZAHO collections (Croatia) – What did we learn?

Šegota, V.[1], Vilović, T.[2], Rešetnik, I.

[1]Division of Botany, Department of Biology, Faculty of Science, University of Zagreb, Marulićev trg 20/II, Zagreb, Croatia

[2]Department of Pharmaceutical Botany, Faculty of Pharmacy and Biochemistry, University of Zagreb, Schrottova 39, Zagreb, Croatia

* *vedran.segota@biol.pmf.hr*

With over 200.000 sheets, ZA is the oldest and the largest herbarium collection in Croatia, while the ZAHO stores as many as 78.000 sheets. Digitisation was initiated in 2015 resulting in 11.5 % of digitised sheets so far. Based on 3.721 sheets analysed, we determined specific temporal biases with different peak collections, e.g. orchids from 1870's to 1910's, aquatic plants in 1910's, 1960's and 2010's, fagetal species from 1900 to 1950, and invasive flora from 1960 to 1970 and after 2010. Moreover, the average age of those collections is 90 years. Disproportionally large percentage of specimens collected by very few individuals indicates the presence of collector biases too. The ZA keeps a dozen aquatic taxa as the only evidence of their presence in Croatia. As herbaria usually follow invasions from the first recorded colonizer onwards, we searched whether the collections hide data on the arrival of aliens in Croatia. The first record of 17 taxa occurred much earlier in herbaria than in literature, with gaps that sometimes counted more than 100 years. Based on the study of several common and easily recognizable fagetal taxa, we found that they are rarely collected and their representation in the collections is inversely proportional to their number and distribution in nature.

Contribution to the exploration of the bryophyte flora of Serbia in the last 20 years with a special attention to the species of conservation interest

Papp, B.[1], Szurdoki, E.[1], Pantović, J.[2], Sabovljević, M.[2]

1Botanical Department, Hungarian Natural History Museum, H-1431, Budapest, Pf. 137, Hungary

2Institute of Botany and Botanical Garden, Faculty of Biology, University of Belgrade, 11000 Belgrade, Serbia

* *papp.beata@nhmus.hu*

Since 1998, 14 bryological field trips were organised in co-operation between the Hungarian Natural History Museum and the Institute of Botany and Botanical Garden of the University of Belgrade. Mainly national parks and protected areas were explored. During these field trips more than 5000 specimens were collected and 133 species (38 liverworts and 95 mosses) were reported for the first time in Serbia. The bryophyte flora of Serbia now counts 723 species (139 liverworts and 584 mosses) according to the latest checklist of Europe published in 2015. The number of bryophyte species of European conservation interest is very high in Serbia and our knowledge on them increased considerably in the last 20 years. In the Red data book of European bryophytes published in 1995 only 26 species were included, but now already 119 species (15 liverworts and 104 mosses) occurring in Serbia are on the candidate list of the new Red data book of European bryophytes. Besides these, several species are rare in the Balkans. Bryophytes living in wetlands and high mountain areas are the most threatened mainly due to climate change and anthropogenic influence. An overview will be given on the species of conservation importance in various habitat types.

Progress in knowledge on bryophyte flora in Croatia

Alegro, A.[1], Rimac, A.[1], Šegota, V.[1], Vuković, N.[1], Koletić, N.[1], Papp, B.[2]

[1]Division of Botany, Department of Biology, Faculty of Science, University of Zagreb, Marulićev trg 20/II, Zagreb, Croatia

[2]Botanical Department, Hungarian Natural History Museum, PO Box 137, 1431 Budapest, Hungary

* *vedran.segota@biol.pmf.hr*

Fourteen moss taxa were recorded for the first time in Croatia, many of which (*Conardia compacta*, *Cynodontium tenellum*, *Dichodontium flavescens*, *Rhabdoweisia crispata* and *Schistidium trichodon* var. *trichodon*) are of boreal-montane or (sub) arctic distribution, found in mountain areas of the country. *Myurella sibirica* can be considered a glacial relict in the western Dinarides, where particular microhabitat with specific relief and spring influence enabled its survival. The study of ephemerals of drawdown zones resulted in finding of a new species *Physcomitrium eurystomum*, confirmation of dubious *Riccia cavernosa* and *R. frostii* and new localities of rare *Physcomitrella patens* and *Leptobryum pyriforme*. *Ricciocarpos natans* was discovered in backwaters of Danube, Drava and Mura rivers. Finding of rare Natura 2000 hornwort*Notothylas orbicularis*, reported only from four C European countries, is the first in SE Europe and the southernmost in Europe. Furthermore, we recorded *Anthoceros agrestis* and *Phaeoceros carolinianus*, rare or overlooked species in SE Europe. Aquatic *Fissidens fontanus* and Mediterranean epiphyte *Orthotrichum philibertii* were also new for country. Revision of *Tortella bambergeri* revealed neglected *Tortella fasciculata* in Croatia. New localities of rare *Didymodon tophaceus* subsp. *sicculus*, *Ephemerum serratum*, *Mannia triandra*, *Oxystegus tenuirostris* and *Sphaerocarpos michelii* were found. The further spread of invasive *Campylopus introflexus* was detected.

Syntaxonomy and biogeography of (sub)alpine and oromediterranean grasslands on calcareous substrates in the Central and Southern Balkans

Ćušterevska, R.[1*], Matevski, V.[1,2], Kostadinovski, M.[1], Čarni, A.[2,3,4]

[1]Institute of Biology, Faculty of Natural Sciences and Mathematics, University of Ss. Cyril and Methodius, Gazi Baba bb, MK-1000 Skopje, Republic of N. Macedonia

[2]Macedonian Academy of Sciences and Arts, Bul. Krste Misirkov, 2, P. O. Box 428, MK-1000 Skopje, Republic of N. Macedonia

[3]Institute of Biology, Scientific Research Center of the Slovenian Academy of Sciences and Arts, Novi trg 2, SI-1000 Ljubljana, Slovenia.

[4] University of Nova Gorica, Vipavska 13, SI 5000 Nova Gorica, Slovenia

* *renatapmf@yahoo.com*

In this this study, the main focus is possibly the most problematic segment of the Balkan dry grassland vegetation – the grasslands over calcareous substrates. We shall target south-central Balkans – a region where several grasslands classes (Festuco-Brometea, Elyno-Seslerietea, Daphno-Festucetea) converge on a relative small area. We assume that the regional species pools, characteristic of these classes, are shaping the variability of the dry grasslands. Because of the transitional biogeographic position of the studied region as well as considerable large elevation span across latitudes, the diversity of vegetation types is high. The indication a putative new dry-grassland order the mid-high altitudes of the Southern Balkans points upon a necessity of re-assessing the Balkan vegetation occupying the community niche between the low-elevation dry grasslands (Festuco-Brometea) and those typical of high elevations (Elyno-Seslerietea andDaphno-Festucetea), seeking parallels to patterns described from the Western Alps, Pyrenees, and Apennines. This syntaxonomic unit is poised to expand the concept of the Festuco hystricis-Ononidetea striataeto the Balkans. The study is based on relevés from literature sources (Greece, Albania, N. Macedonia, Bulgaria and Serbia) and own relevés from the territory of N. Macedonia, Albania and Greece, that have been carried out during the years 2010-2017. We determined the chorological spectrum, ecological variables and the influence of the geomorphological variables (altitude, aspect, slope) in the distribution of researched plant communities. Numerical calculations were performed to compare results with several other studies and drew conclusions. The analysis indicated a

distinction on the basis of their altitudinal levels and geographic location and revealed different ecological responses and environmental variables along the studied areas.

New locality of *Orchis spitzelli* Sauter ex W.D.J. Koch (Orchidaceae) in Bosnia and Herzegovina

Šabanović, E.[1], Boškailo, A.[2], Šarić, Š.[3], Sarajlić, N.[4], Ranđelović, V.[5]

[1]Public institution "Native museum" Visoko, ul. Alije Izetbegovića 29, Visoko, Bosnia and Herzegovina

[2]University "Džemal Bijedić" in Mostar, Teachers faculty, Univerzitetski kampus bb, Mostar, Bosnia and Herzegovina

[3]JP ŠPD-ZDK d.o.o Zavidovići, Alije Izetbegovića 25, BA-72220 Zavidovići, Bosnia and Herzegovina

[4]Ornitological society "Naše ptice", Semira Frašte 6/14, Sarajevo, Bosnia and Herzegovina

[5]University of Niš, Faculty of Science and Mathematics, Department of Biology and Ecology, Višegradska 33, Niš, Serbia

** zavicajnimuzejvisoko@gmail.com*

Orchis spitzelii Sauter ex W.D.J. Koch belongs to the *Orhis mascula* group of orchids and it is one of the seven European orchids described in Serapiadinae in Orchidoideae. This species has a strong conservative value in the flora of Bosnia and Herzegovina. Although it is recorded on a number of sites, in Red List of vascular plants of the Federation of Bosnia and Herzegovina its status is Critically Endangered (CR). During the field research in the spring and summer in 2018, a new locality of this species was found in central Bosnia, in Kamensko, in the northern part of the municipality Olovo. The new population are not in good condition and egsist with a few registered individuals. In the new locality, there are threats to the species population were registrated.

Contribution to the knowledge of orchid flora of Retezat National Park (Southern Carpathians, Romania)

Milanovici, S.[1]*, Danau, C.[2]

[1]Natural Science Section, National Museum of Banat, Timișoara, Timiș County, Romania

[2]Retezat National Park Administration, Nucşoara, no. 284, Salaşul de Sus, Hunedoara County, Romania

**orchids_mils@yahoo.com*

Retezat National Park established in 1935, situated on the mountainous massif with the same name, is the oldest and the most popular National Park in Romania. Regarding its importance, the park represents one of the biggest places of refuge from the southern Carpathians, where rare and endemic species of plants and animals find their homes. National Park's surface includes a very variable relief structure, predominantly mountain and alpine relief, which, from the landscape point of view, offers a particular spectacularity. It should be mentioned that here we can find over 20 peaks above 2000 m altitude (Peleaga peak – 2509 m, Păpușa peak – 2508 m, Bucura peak 2432 m, etc.), glacial basins with 58 relict glacial lakes, glacial valleys, rocky slopes. The field studies on the Orchidaceae family in Retezat National Park area, regarding the species richness, distribution, size and dynamics of populations as well as the acknowledgment of the threats with (direct and indirect) impact upon the orchid species and populations have started in 2009 and ended in 2017, and have covered the following areas of the park: Lăpușnicul Mare valley, Bucura valley, Peleaga valley, Scorota valley, Albele, Stănuleții Mici, Câmpușel and Piatra Iorgovanului areas. We have found 19 species of orchids in the mentioned area of study.

Non-forest vegetation of sand dunes of Velika plaža (Montenegro)

Stešević, D.[1], Küzmič, F.[2], Milanović, Đ.[3], Stanišić, M.[1], Šilc, U.[2]

[1]Faculty of Natural Sciences and Mathematics, University of Montenegro, Džordža Vašingtona bb, Podgorica, Montenegro

[2]Research Centre of the Slovenian Academy of Sciences and Arts, Institute of Biology, Novi trg 2, Ljubljana, Slovenia

[3]Faculty of Forestry, University of Banja Luka, Stepe Stepanovića 75A, Banja Luka, Bosnia and Herzegovina

* *djordjije.milanovic@sf.unibl.org*

Velika plaža (Ulcinj, Montenegro) is the largest sandy beach along the Balkan-Illyric coast with still well-developed sand-dune vegetation. Although the characterization of flora and vegetation of Velika plaža have been researched by many authors, the vegetation remained purely known - only two plant communities were reported so far: *Cakilo-Xanthietum italici* and *Euphorbio paraliae-Agropyretum junceiformis*. Based on 147 relevés (both from literature and recent field work), our results show that vegetation of Ulcinjska plaža is much more diverse. Altogether, 17 asociations from 6 vegetation classes were identified. Among them we described two new associations: *Cuscuto-Lippietum nodiflorae* and *Onobrychido caput-galli-Vulpietum fasciculatae*.

Eastern Adriatic distribution of *Ophioglossum lusitanicum* L. (Ophioglossaceae) – ongoing recent discoveries of a long forgotten fern

Vuković, N.[1], Budinski, I.[2], Brana, S.[3], Šegota, V.[1], Rimac, A.[1], Hršak, V.[1]

[1]Division of Botany, Department of Biology, Faculty of Science, University of Zagreb, Marulićev trg 20/II, Zagreb, Croatia

[2]Association BIOM, Preradovićeva 24, Zagreb, Croatia

[3]Istrian Botanical Society, Trgovačka 45, Vodnjan, Croatia

* *nina.vukovic@biol.pmf.hr*

Ophioglossum lusitanicum L. is a small, inconspicuous fern, with aboveground parts occurring during late autumn to spring. The plants are tiny and green, hardly distinguishable from the surrounding vegetation, therefore easily overlooked and neglected in the field. Several historical findings from the Eastern Adriatic coast dating from the 19th century were followed by almost a hundred years without records, and consequently, the species was considered regionally extinct for decades. More recently, detailed field surveys revealed the existence of over 20 populations in southern Istria and contributed to the inclusion of the species into the Croatian Red book as a critically endangered taxon. Interestingly, historical findings from southern Dalmatia (Hvar archipelago) were never confirmed since the mid-19thcentury. After the last published data, during the years 2015-2019, we have discovered new populations of *O. lusitanicum* in southern Istria, however, the species was also found for the first time on the southern Dalmatian islands Korčula, Mljet and Lastovo. All recently found populations were recorded in a dynamic environment, i.e. early successional stages of disturbed habitats. We presume that the species is distributed even widely, but generally overlooked due to its indistinctive appearance and early time of emergence.

Novelties for the flora of Bosnia and Herzegovina from Klek peninsula

Milanović, Đ.

University of Banja Luka, Faculty of Forestry, Stepe Stepanovića 75A, 78000 Banja Luka, Bosnia and Herzegovina

* *djordjije.milanovic@sf.unibl.org*

Abstract text: Systematic study on flora and vegetation of the Klek peninsula (Neum, Bosnia and Herzegovina) has been carried out in the period 2010–2018. Among 551 taxa on subspecies level registered for the Peninsula (literature data + new data) 14 are recorded as new for the flora of the country: *Allium subhirsutum* L. subsp. *subhirsutum*, *Argyrolobium zanonii* (Turra) P. W. Ball subsp. *zanonii*, *Artemisia caerulescens* L. subsp. *caerulescens*,*Carex extensa* Gooden., *Carpobrotus acinaciformis* (L.) L. Bolus, *Centaurium tenuiflorum* (Hoffmanns. & Link) R. M. Fritsch subsp. *acutiflorum* (Schott) Zeltner, *Erigeron sumatrensis*Retz., *Heteropogon contortus* (L.) Roem. & Schult., *Linaria simplex* (Willd.) DC., *Ononis ornithopodioides* L., *Prospero elisae* Speta, *Rhagadiolus edulis* Gaertn., *Serapias parviflora* Parl. and *Trifolium mutabile*Port.

Acknowledgements. The paper arose from the project "The achievement of conservation of biodiversity through establishing and operative management of protected areas, and capacity building for Nature protection in Bosnia and Herzegovina", financed by UNEP (United Nations Environment Protection) and implemented by CENER 21 - Center for Energy, Environment and Resources. The author would like to thank to Nikša Čamo, Ivica Krmek and Maja Jaćimovska for logistical support during field work.

Macrophyte vegetation of artificial water bodies in Croatia

Alegro, A., Koletić, N., Rimac, A., Šegota, V., Vuković, N.

Division of Botany, Department of Biology, Faculty of Science, University of Zagreb, Marulićev trg 20/II, Zagreb, Croatia

* *antun.alegro@biol.pmf.hr*

During vegetation seasons 2016 and 2017 macrophyte vegetation of 36 (21 in Dinaric and 15 in Pannonian ecoregion) artificial water bodies – reservoirs and accumulations was studied in order to get insight into macrophyte diversity and to develop assessment method for water quality using macrophytes according to EU Water Frame Directive. The vegetation was surveyed using transects positioned perpendicular to the bank and stretched to the depth limit of macrophyte occurrence. Extended, nine-degree, Braun-Blanquet scale was used for estimation of species cover-abundance. Physico-chemical and hydromorphological parameters were also included in analyses. In total, 110 species were recorded with very uneven distribution. High water level fluctuations are the most limiting factor for macrophyte occurrence, followed by water turbidity and some chemical parameters. For estimation of ecological classes of water quality, reference index was developed based on system of indicator species (indicators of good status and referent species, indifferent species and indicators of degradation). It was shown that reference index is significantly correlated with environmental parameters and therefore can be used as measure of water quality. In general, artificial water bodies in Dinaric ecoregion have higher macrophyte diversity and higher water quality i.e. ecological status in comparison to those in Pannonian ecoregion.

Diversity of macroalgal aggregations in the Jelovičko spring

Mitrović, A.B., Đorđević, N.B., Simić, S.B.

Institute of Biology and Ecology, Faculty of Science, University of Kragujevac, Radoja Domanovića 12, Kragujevac, Serbia

* *aleksandra.mitrovic@pmf.kg.ac.rs*

Karst springs represent one of the most important freshwater habitats due to the specific hydrological, physical and chemical characteristics as well as specific living communities which rarely could be found in other aquatic ecosystems. However, these springs are biologically very poorly investigated in Serbia. The Jelovičko spring, located in the Vidlič part of the Nature Park Stara mountain (Eastern Serbia), belongs to the group of limnocrene siphonal karst springs. Algological research of this spring was conducted in August 2018. Samples of macroscopic algal aggregations were collected and physical and chemical parameters of water were measured. Seven types of macroscopic aggregations were identified: free filaments (*Paralemanea* sp.), brown threads (colonies of *Melosira varians* and *Diatoma* sp.), green threads (*Spirogira* sp. and colonies of *Diatoma* sp.; *Microspora* sp. and colonies of *Diatoma* sp.), brown gelatinous threads (colonies of *Diatoma* sp., *M. varians*, and chironomid eggs), green gelatinous threads (*Tribonema* sp., colonies of *Diatoma*sp. and *M. varians*), gelatinous filaments (*Batrachospermum* sp.), cushion-like forms (*Vaucheria* sp.). This paper presents the new findings of two rare Rhodophyta of the genus *Batrachospermum* and *Paralemanea*in Serbia and the first occurrence of two Rhodophyta species at the same locality in Serbian aquatic ecosystems.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Project III43002, TR 31001).

POSTER PRESENTATION

Wild mints of Lake Kerkini National Park (GR1260001)

Mertzanidis, D.[1], Koureas, D.[1,2], Assimopoulou, A.N.[3], Kokkini, S.[1]

1Laboratory of Systematic Botany and Phytogeography, School of Biology, Aristotle University of Thessaloniki, Thessaloniki, Greece

2Naturalis Biodiversity Center, 2300RA, Leiden, the Netherlands

3Organic Chemistry Laboratory, School of Chemical Engineering, Aristotle University of Thessaloniki, Thessaloniki, Greece

* *dmertzanidis@bio.auth.gr*

Mentha plants (mints) are widely cultivated all over the world for their essential oils which have a wide range of commercial applications. Wild growing mints were collected from the lake Kerkini National Park (GR1260001), phytogeographical region of Northern Eastern Greece. Four different taxa of the genus were taxonomically identified on the basis of their inflorescence and leaf morphology, i.e. *M. longilfolia* subsp. *longilfolia*, *M. spicata*, *M. aquatica* and *M. pulegium.* These are ecologically isolated, grown in different altitudes and habitats. Besides differences in their smell, intensity and type was recorded. The essential oil (EO) content (mL $100g^{-1}$ dry weight) was estimated using a Clevenger type apparatus. The highest values of EO content were found in the two Spicatae mints, *M. longifolia* subsp. *longifolia* and *M. spicata* (up to 1. 6%) and the lowest in the Capitate *M. aquatica* (< 0.5%). Furthermore three different organoleptically smells were received during wild plant collection, indicating the occurrence of different chemotypes in that area.

Acknowledgements. This research has been supported by the project “Upgrading the Plant Capital (PlantUp)” (MIS 5002803) which is implemented under the Action “Reinforcement of the Research and Innovation Infrastructure”, funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014–2020) and co–financed by Greece and the European Union (European Regional Development Fund)

Preliminary data on lichens from Albanian Alps (Razëm locality, Northern Albania)

Xhulaj, S.

Research Center of Flora and Fauna, Faculty of Natural Sciences, University of Tirana, Bulevardi Zog I, Nr. 25/1, Tirana, Albania

* *xhulaj@yahoo.com*

This study provides data for lichens collected in a mountain forest (primeval) with old beech trees in an altitude of 1100 m, located in Kastrat NE of Koplik, in Razëm area. A very rich locality indeed with great number of remarkable species. There were found 82 species in all. 64 species were recorded on trees. A few stones were picked up together with common terricolous species, 18 in all. The findings show many aspects. *Parmellia atlantica, Peltigera collina, Nephroma laevigatum, N. parile, Leptogium saturnium, Lecanora intumescens, Ramonia luteola* and *Catillaria artropurpurea* show that the forest is primeval, i.e. that the area has never been without forest. The two last mentioned species also show an alpine feature together with *Lecanora leptyrodes, Buellia poeltii, Phaeophyscia poeltii* and *Lecanora coiliocarpa*. An oceanic feature is disclosed by *Physma omphalarioides, Collema subnigrescens* and *Parmellia atlantica*. Especially the habitation, but also a road through the area bring about the presence of *Physcia, Xanthoria* and *Rinodina* species, and *Lecanora allophana*. Everywhere in the mountain area a rather common species on deciduous trees was *Parvoplaca* cf. *suspicosa* which is a Scandinavian species (hitherto found only in the north of Sweden). Presumably the specimens found in Razëm represent some Mediterranean alpine species. They have not been finally determined.

A miraculous lichen spot in the Jablanica Mts (Northern Macedonia)

Farkas, E.[1], Lőkös, L.[2], Varga, N.[1]

[1]Institute of Ecology and Botany, MTA Centre for Ecological Research, Hungarian Academy of Sciences, H-2163 Vácrátót, Alkotmány u. 2–4, Hungary

[2]Department of Botany, Hungarian Natural History Museum, H-1089 Budapest, Könyves Kálmán krt. 40, Hungary

* *edit.farkas@okologia.mta.hu*

Old trees or small groves are frequently kept near or around churches, chapels in many countries predominantly for religious purpose, partly for symbolising eternity, partly for serving as a shade for the religious people, like pilgrims. However, these trees are rather good habitats or refugia also for rare epiphytic lichen and bryophyte species. During our field trip in the Jablanica Mountains (Northern Macedonia) a pretty nice forest (ca 1 hectare) was visited around a small church near Vishni village along the road between Struga and Gorna Belica. Trunks and branches of old oak trees were fully covered by lichens and bryophytes. More than 30 lichen species were detected with great abundance, most of them full with fruit-bodies even those which are predominantly sterile in other habitats of their distribution area. Foliose macrolichen species of oceanic or suboceanic character (e.g. *Collema nigrescens*, *Leptogium saturninum*, *Lobaria amplissima*, *Nephroma resupinatum*) mixed with well-developed fruticose lichens (e.g. *Evernia*, *Pseudevernia*, *Ramalina*, *Usnea* spp.) and bryophytes made a very impressive view. It is not clear why this luxuriant cryptogamic community was found in the Jablanica Mts only here, in this tiny forest stand around a church, but the habitat most probably represents excellent microclimatic conditions.

Aknowledgements. We are indebted to B. Papp, J. Pantović, M. S. Sabovljević and E. Szurdoki for their help in the field work. It was supported by the Hungarian National Research, Development and Innovation Office, NKFI K 124341.

Developing and managing bryophyte collection BEOU: achievements until 2019

Grdović, S.[1], Pantović, J.[2], Veljić, M.2, Sabovljević, M.[2]

[1]Faculty of Veterinary Medicine, University of Belgrade, Bulevar oslobođenja 18, 11000 Belgrade, Serbia

[2]University of Belgrade, Faculty of Biology, Institute of Botany and Botanical Garden, Takovska 43, 11000 Belgrade, Serbia

* *cecag@vet.bg.ac.rs*

Bryophyte collection within the Herbarium of University of Belgrade (BEOU) is largest in Serbia and it is still ongrowing. It is estimated that contains about 18000 specimens within two working collections. Work on the inventory and digitization has begun, and 7506 specimens have been processed up to day. Collection has been established in the beginning of the 1990s, hence almost all stored specimens were collected after 1990. So far, it contains only 225 specimens from the earlier period. More than half (4242) of the material is from the area of Serbia, while the rest is from 46 countries from 6 different continents. However, majority of the foreign material is from Europe (e.g. Montenegro, Slovenia, Bosnia and Herzegovina etc.). Herbarium contains 797 different taxa and 294 genera. More than 60% of the records in Bryo BEOU were collected by Sabovljević and his co-workers. Most of the records were made during spring and summer months, with peaks in May and July. Current period of bryological research has brought many new records which represent important source of information, especially for Serbia and other Balkan countries. Nevertheless, collection is expanding over time and the work is not close to the final yet.

Flora of Midzhur peak, Stara Planina Mts, Bulgaria

Vladimirov, V.

Department of Plant and Fungal Diversity and Resources, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Acad. Georgi Bonchev St., bl. 23, 1113 Sofia, Bulgaria & Faculty of Forestry, University of Forestry, 10 Kliment Ohridski Blvd., 1797 Sofia, Bulgaria

* *vladimir_dv@abv.bg*

Midzhur (2168 m a.s.l.) is the highest peak of Western Stara Planina Mts (Balkan Range) and is situated at the border between Bulgaria and Serbia. The flora of the Bulgarian part of the peak has been investigated. The study area covers some 2200 ha and is situated on the E, NE and N slopes of the peak, on siliceous bedrock, at 700 to 2168 m a.s.l. It has natural orographic boundaries and comprises the watershed of River Barza, the main tributary of River Lom. Most of the territory – up to 1550–1600 m is occupied by *Fagus sylvatica* forests, whereas the area above is represented by subalpine communities. More than 600 species of vascular plants have been recorded. The poster presents the taxonomic structure, biological and ecological spectra and the phytogeographical relations of the flora, as well as the taxa of conservation concern. The endemism is relatively low compared with this for the entire Bulgarian flora which is typical for poorly isolated areas in the country on siliceous bedrock.

Acknowledgments. Part of this study has been carried out under project ‘Flora and vegetation research: diversity, distribution, biosystematics, dynamics and conservation significance. Stage II’.

An overview of the number and analysis of flora of northwestern Serbia and Sumadija

Brković, D.[1], Marković, G.[1], Branković, S.[2], Đelić, G.[2]

[1]Faculty of Agriculture Čačak, University of Kragujevac, Cara Dušana 34, Čačak, Srbija

[2]Faculty of Natural Sciences and Mathematics, University of Kragujevac, Radoja Domanović 12, Kragujevac, Srbija

* *duskobrkovic@gmail.com*

The objective of this research was to determine the total number of taxa at the level of species and subspecies in the flora of part of northwestern Serbia and Šumadija. As determined by systematic field surveys and based on very few published references available on floristic and phytocenologicaldata, the flora of northwestern Serbia and Šumadija includes 1333 taxa at the level of species and subspecies classified into 535 genera and 115 families. Among the taxa, flowering plants predominate with 1302 taxa, including1070 species and subspecies that belong to the class Dicotyledones, making up 94 families and 418 genera; andflowering plants of the class Monocotyledones comprising 12 families, 100 genera and 229 species and subspecies. Pteridophyta are represented by 8 families, 11 genera and 26 taxa. Gymnospermae embrace only 2 families, 6 genera and 8 species. The taxonomic analysis of the flora of northwestern Serbia and Šumadija shows that the following families predominate in terms of the number of taxa: Compositae (Asteraceae), Graminea (Poaceae), Leguminosae (Fabaceae), Labiatae (Lamiaceae), Rosaceae, Cruciferae (Brassicaceae) and Umbelliferae (Apiaceae) etc. Moreover, the most abundant genera are *Carex*, *Veronica*, *Vicia*, *Euphorbia*, *Hieracium*+(*Pilosellla*) *Trifolium*, *Lathyrus*, *Ranunculus*, *Galium*, *Allium*, *Silene*, *Potentilla*, *Geranium*, *Campanula*, *Dianthus*, *Festuca*, *Bromus*, *Hieracium*, *Stachys* etc.

Anatomical differentiation of populations *Trollius europaeus* L. (Ranunculaceae) from Serbia

Jušković, M., Nešić, M., Stojanović, J., Jenačković-Gocić, D., Nikolić, D., Ranđelović, V.

Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *marinaju@pmf.ni.ac.rs*

Anatomical analysis of *Trollius europaeus*, from three different sites in Serbia, was examined in order to determine the variation between populations. We also discuss anatomical characters in relation to the environmental conditions of the species habitats. Univariate statistic analysis included 21 quantitative characters related to thestem, leaves and petiole anatomy. To present variability of anatomical characters, multivariate analyses (PCA, DA) were performed. These populations developed different response levels to the environmental factors studied and plants of each population exhibited mesomorphic characteristics. Inter-population differences refer to variations in thickness of lamina, thickness of palisade tissue, thickness of spongy tissue, as well as to stem cortex thickness. Also, results confirmed variability of the all characters, while PCA and DCA showed that populations could be separated based on their quantitative anatomical characteristics. On the other hand, all the data obtained, which subjected to a comparative multivariant analysis of anatomical characteristics of the three populations from different geological substrate and altitudes, have shown that the species *T. europaeus* has maintained quite a stable, conservative anatomical structure.

Acknowledgements. This work was funded by the Ministry of Education, Science and Technological Development of Republic of Serbia (project no. 173030).

Orchids in Serbia: Additions to the An Annotated Checklist of Vascular Flora of Serbia 1

Radak, B., Peškanov, J., Vlku, A., Prodanović, M., Anačkov, G.

Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 2, Novi Sad, Serbia

* *boris.radak@dbe.uns.ac.rs*

In the 2018 Annotated Checklist of Vascular flora of Serbia 1 was published. This work contains all vascular plant taxa (except dicots), among them members of the Orchidaceae family, that are known for the flora of Serbia. As a result of the ten-year field and laboratory work of the team from the Department of Biology end Ecology in Novi Sad on the orchids diversity in Balkans and Pannonian Plain, new data, not included in the Checklist, emerged. We registered three orchid taxa of hybrid origin new to Serbia - *Orchis* × *beyrichii*, *O.* × *angusticruris*, and *Anacamptis* × *timbali*. All of them were registered during our field works in Vojvodina Province. Three taxa, listed as present in Central Serbia, are new for the territory of Vojvodina - *Epipactis purpurata*, *E. leptochila* subsp. *neglecta* and *Neotinea* × *dietrichiana*. These taxa were registered on several localities on the Fruška gora Mt in 2018. Presence of *A. morio* subsp. *caucasica* was confirmed for the territory of Central Serbia at several sites. Finally, *Cephalanthera* × *schulzei* which is listed in the Checklist as present in Vojvodina (and Serbia), was published on the basis of incorrect determination of *Cephalanthera longifolia* specimen. Nevertheless, this taxon is probably present in Serbia.

Acknowledgments. This research was conducted within the project no. 173030, funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

Distribution patterns of orchids in the mountain areas of western Serbia

Djordjević, V.[1], Tsiftsis, S.[2,3], Lakušić, D.[1], Jovanović, S.[1], Niketić, M.[4], Lazarević, P.[1], Stevanović, V.[1,5]

[1]Institute of Botany and Botanical Garden, Faculty of Biology, University of Belgrade, Takovska 43, Belgrade, Serbia

[2]Department of Forestry and Natural Environment Management, Eastern Macedonia and Thrace Institute of Technology, Drama, Greece

[3]Global Change Research Institute, Academy of Science of the Czech Republic, Belidla 4a, 603, Brno, Czech Republic

[4]Natural History Museum, Njegoševa 51, Belgrade, Serbia

[5]Serbian Academy of Sciences and Arts, Kneza Mihaila 35, Belgrade, Serbia

* *vdjordjevic@bio.bg.ac.rs*

The aims of this study were to determine the orchid species richness of 11 mountain areas and the surrounding low-altitude areas in western Serbia, and to explore the role of habitat heterogeneity in the patterns of their distribution. For identification of floristic similarities among the mountain areas, the clustering method based on Jaccard distances and unweighted pair-group average hierarchical sorting strategy (UPGMA) was used, whereas linear regression analysis was used to explore the relationship between orchid species richness and habitat heterogeneity. The results indicated that the areas of Tara-Zvijezda-Mokra Gora with 45 species and Zlatar-Jadovnik-Ozren-Kamena Gora-Jabuka (42 species) represent the most important centres of orchid richness and diversity in western Serbia. The cluster analysis of floristic similarities allowed the identification of four sets of mountain areas. The results showed that habitat heterogeneity significantly influences orchid species richness of most mountain areas, except for Mokra Gora (Prokletije) and the Pešter-Rogozna area. Furthermore, the number of orchid species grows more intensively with the increase of the habitat heterogeneity in the mountainous areas of Zlatibor, Ovčar-Kablar-Jelica, Javor-Mučanj-Čemernica and Podrinje mountains-Cer-Vlašić than in other areas. This study highlights the complex effect of ecological factors (altitude, vegetation type, bedrock type) on determining orchid distribution patterns.

Acknowledgements. The Ministry of Education, Science and Technological Development of the Republic of Serbia has supported this research under Grant 173030. The authors thank Tara National Park, Forest Estate‘Golija’ Ivanjica, Tourist Organization of Čačak, Citizens Association ‘Jadovnik’ for hospitality and logistical field support.

Phytosociologal analysis of the mesophilous *Quercus frainetto* forests from the Western Balkans

Stupar, V.

University of Banja Luka, Faculty of Forestry, Stepe Stepanovića 75A, Banja Luka, Bosnia and Herzegovina

* *vladimir.stupar@sf.unibl.org*

Quercus frainetto is a subendemic south European tree species with the center of distribution in Central Balkans. It is generally considered that this species is either main or subordinated member of xero-thermophilous forests, and it is accepted that it builds a zonal community in the region of lowlands and hills in dryer continental climate of central Balkans. This zonal community can be tracked to the western and northwestern boundaries of distribution of *Quercus frainetto* itself (e.g. Bosnia & Herzegovina and Croatia). However, in this area, where temperate Central European climate takes over, *Quercus frainetto* is found in more and more mesophilous sites. This paper deals with the mesophilous community of Hungarian oak which is found in NW Serbia and NE B&H. Numerical analysis, which included all accessible relevés of *Quercus frainetto* forests from the Western Balkans along with the relevés of mesophilous forests of Carpinion betuli and Erythronio-Carpinion betuli from this area, showed that these forests do not belong to thermophilous deciduous forests of *Quercion frainetto*, but they are rather part of the mesoneutrophilous alliance of *Carpinion betuli*. New, mesophilous, association of *Quercus frainetto* and *Carpinus betulus* was described and floristically and ecologically characterized.

Vascular plants in beech forests of central Slovakia: How environmental factors affect species composition and species diversity?

Slezák, M.[1,2], Hrivnák, R.[2], Valachovič, M.[2]

[1]Institute of Forest Ecology, Slovak Academy of Sciences, Ľ. Štúra 2, Zvolen, Slovak Republic

[2]Plant Science and Biodiversity Centre, Institute of Botany, Slovak Academy of Sciences, Dúbravská cesta 9, Bratislava, Slovak Republic

* *milan.valachovic@savba.sk*

Beech-dominated forests represent one of the most widespread woodlands in submnotane and montane zone of Central Europe. They have been well-described from the phytosociological point of view, but much more effort is needed to study drivers and mechanisms controlling community diversity. We asked how species composition and species richness (alpha diversity) of vascular plants in beech forests respond to environmental predictors. We sampled 25 vegetation plots with uniform size and shape (20 × 20 m) and recorded a group of environmental (soil, light, topographic and climatic) factors in mesic beech forests of central Slovakia. Species compositional-environmental relationships were tested using redundancy analysis (RDA) with forward selection procedure, whereas species richness was modelled using generalized linear model (GLM). RDA determined three factors (soil pH, total soil N, canopy openness) responsible for variation in species composition. Their marginal effect was 30.2%, but explained variance decreased towards the pure effect (14.2%) using only significant contribution of soil pH and total soil N. GLM identified four variables (soil pH, altitude, canopy openness, radiation) that jointly accounted for 57.3% of variation in species richness data. They had positive linear effect on number of vascular plants, with soil pH and altitude showing the highest explanatory power.

Acknowledgements. This contribution was supported by the Slovak grant agency VEGA no. 2/0031/17.

Sect. *Polygonum* (*Polygonum* L.) in Serbia – diversity and distribution based on the revision of herbarium material

Obradov, D.[1], Saichanaphan, P.[2], Jaramaz, B.[1], Anačkov, G.[1]

[1]Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 2, Novi Sad, Serbia

[2]Department of Biology, Faculty of Science, Prince of Songkla University, 15 Kamjanavanich Rd., Hat Yai, 90110 Songkhla, Thailand

* *dragan.obradov@dbe.uns.ac.rs*

Section *Polygonum* comprises about 45 species, most of them occurring in temperate areas. There are 22 species of this section registered in the Flora of Europe, whereby only 4 of them in the Flora of Serbia. The main aim of the paper was to determine the diversity of this section in the Serbian flora, by examining and revising herbarium material. Four collections were studied - herbariums of the Faculty of Sciences, University of Novi Sad (BUNS), the Institute for Nature Conservation of Vojvodina Province (PZZP), the Institute of Botany and Botanical Garden "Jevremovac", University of Belgrade (BEOU), and the Natural History Museum in Belgrade (BEO). The total number of 388 herbarium sheets was examined, of which 193 were deposited in BUNS, 49 in PZZP, 59 in BEOU and 87 in BEO collection. Identification and revision of the material were made according to the Flora Europaea and the regional floras relevant for the investigated genus, while the nomenclature alignment was done using the latest literary and online sources. The presence of 7 species and one subspecies was determined. Material revision posed many questions about the diversity of this group, particularly about the diversity of the polymorphic aggregate *Polygonum aviculare*.

Acknowledgments. This research was conducted within the project no. 173030, funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

Variation of morpho-anatomical leaf characteristics in populations of *Vaccinium* species from Central Balkan

Bjedov, I.[1], Obratov-Petković D.[1], Rakonjac, V.[2], Skočajić, D.[1], Stefanović, M.[3], Dajić–Stevanović, Z.[2]

[1]University of Belgrade - Faculty of Forestry, Kneza Višeslava 1, 11000 Belgrade, Serbia

[2]University of Belgrade - Faculty of Agriculture, Nemanjina 6, 11080 Beograd - Zemun, Serbia

[3]Institute for Biological research "Siniša Stanković", Bulevar Despota Stefana142, 11000 Belgrade

* *ivana.bjedov@sfb.bg.ac.rs*

Morpho-anatomical characteristics of *Vaccinium myrtillus, V. uliginosum* and *V. vitis-idaea* leaves, from several sites of the Central Balkan were examined within this study. The aim of this study was to investigate morpho-anatomical leaf traits of these species in studied populations and identify traits that follow specific trend along the gradients of climate factors. Leaf traits that discriminate *Vaccinium* species were: adaxial cuticule depth, palisade tissue thickness, spongy tissue thickness, abaxial epidermal cells height, abaxial cuticule thickness and leaf thickness. Intraspecific variability of studied species, on the basis of morpho-anatomical traits, has been explored by Principal component analysis (PCA), Cluster analysis (CA) and Analysis of variance (ANOVA). CA based on morpho-anatomical traits have shown that populations of *V. myrtillus* and *V. uliginosum* that grow on lower altitudes (characterized by higher mean annual temperature) are more similar. Especially *V. myrtillus* was responsive to the elevational gradient and exhibited the most plasticity in morpho-anatomical leaf traits. Populations of *V. vitis-idaea* had different pattern of differentiation along elevational gradient. CA have shown that population on the lowest and population on the highest altitude were more similar according to morpho-anatomical leaf trait, meaning that evergreen leaves were more resistant to environmental conditions.

Distribution and new chorological data of *Centaurea murbeckii* – endemic species from the Balkans

Novaković, J.[1], Zlatković, B.[2], Hasanbegović, A.[3], Lakušić, D.[1], Marin, P.D.[1], Janaćković, P.[1]

[1]University of Belgrade – Faculty of Biology, Institute of Botany and Botanical Garden "Jevremovac", Studentski trg 16, 11000 Belgrade, Serbia

[2]University of Niš – Faculty of Sciences and Mathematics, Department of Biology and Ecology, Višegradska 33, 18000 Niš, Serbia

[3]National Museum of Bosnia and Herzegovina, Zmaja od Bosne 3, 71000 Sarajevo, Bosnia and Herzegovina

* *jelica@bio.bg.ac.rs*

Centaurea murbeckii Hay. 1901 (Syn. *C. heterotoma* (Borb.) Malý 1904, *C. atropurpurea* Waldst. & Kit. var. *diversifolia* Murb. 1891, *C. atropurpurea* Waldst. & Kit. var. *heterotoma* Borb. 1891) belongs to subgenus *Acrocentron*, subtribe Centaureinae (Compositae). This is the Illyrian-Balkan mountain species, endemic for the central Dinaric Alps. *C. murbeckii* inhabits dolomite grasslands of alliance *Festucion illyricae* (Horv.) Ritter and *Peucedanion neumayeri* Ritter. The new chorological data, obtained from the literature, herbaria (BEOU, BEO, BUNS, MKNH, SO, SOA, SOM, ZA, ZAHO, SARA) and field observation are presented. These data were georeferenced using software OziExplorer 3.95 4s. and DIVA-GIS 7.5. Map of distribution is constructed using ArcGIS 10.4. According to our results, *C. murbeckii* is distributed in western parts of the Balkan Peninsula - in Bosnia and Herzegovina. We constructed the map which represents general chorology of *C. murbeckii*, fragmented areas and isolated population as points. *C. murbeckii* is recorded in the mountain zone, in the range of 1100 m a.s.l to 2350 m a.s.l. Based on the collected and analysed data, it was determined that this species can be found on the mountains Plazenica, Prenj, Igman, Velež, Lukomir, Obalj, Bjelašnica, Vlašić, Veliki Borje, Cigelj, Maglić, and Bjelašnica.

Acknowledgements. We acknowledge the financial support provided by the Serbian Ministry of Education, Science and Technological Development, projects No. 173029 and 173030.

Biochemical response of *Phragmites australis* grown on highly contaminated mine tailing pond in Bor, Serbia

Prica, M.[1], Jovanović, Ž.[3], Andrejić, G.[2], Rakić, T.[1], Dželetović, Ž.[2]

[1]Department of Plant Ecology and Phytogeography, Faculty of Biology, University of Belgrade, Takovska 43, 11000 Belgrade, Serbia

[2]Institute for the Application of Nuclear Energy (INEP), University of Belgrade, Banatska, 31b, 11080 Belgrade, Serbia

[3]Department of Biochemistry and Molecular Biology, Faculty of Biology, University of Belgrade, Studentski trg 16, 11000 Belgrade, Serbia

* *milijana.prica@bio.bg.ac.rs*

Tailings that remain after ore processing in the mining industry contain toxic amounts of heavy metals and represent the serious source of environmental pollution. The wetland species *Phragmites australis* is highly ecologically tolerant, even to heavy metal contamination. It naturally grows at the old mine tailing pond of "RTB Bor", in the substrate extremely contaminated with *Cu*. High metal concentration in plant induce generation of reactive oxygen species which cause oxidative damages in the cell and disturb its normal functions. Metal stressed plants tend to increase the antioxidant enzyme activities leading to antioxidative protection. The aim of this study was to examine heavy metal accumulation in plant organs and to assess its impact on antioxidant enzymes activities, total antioxidant capacity and pigment content. The exceptionally high *Cu* concentrations were detected only in roots, whereas in leaves they were below value that is considered phytotoxic to most plants. Chlorophyll *a* amount and antioxidant enzyme activities were higher comparing to control. This study showed that common reed is highly resistant to high *Cu* concentrations and can be effective in metal stabilization and revegetation of transitional zone of old mine tailings ponds.

Acknowledgements. This work was supported by the Serbian Ministry of Education, Science and Technological Development, grant No. 173030.

The locality of the taxa *Seseli elatum* L. ssp. *osseum* (Crantz) P. W. Ball in the Požega Valley, Republic of Croatia

Zima, D.

Polytechnic in Požega, Vukovarska 17, HR-34 000 Požega, Republika Hrvatska

*dzima@vup.hr

According to botanical research it has been established that the flora of the Požega Valley and the surrounding mountains numbers 1654 plant species and subspecies. On the Lapjak ridge, inside the protected area of Papuk Nature Park, at an altitude of 452 m, was noted the locality of *Seseli elatum* L. ssp. *osseum* (Crantz) P. W. Ball. It comes very dispersed from rocks or rocks in rocky meadows on a slope of 30-40%, southern exposure on a carbonate (dolomitic) substrate with very little shallow brown carbonate soil (rendzine). The area of the site is about 200 x 300 m. The list of plant taxa was found on the site and the nomenclature of the species was aligned with Flora Croatica, Index Florae Croaticae and Flora Europae. In the flora of the lawns dominated plants of the Southern European floral element (32.46%), dominated life forms are hemicryptophytes (42.14%), and given the ecological factors dominated plant of light. The plant is very rare in the Republic of Croatia, and this is the only locality of the *Seseli elatum* L. ssp. *osseum* (Crantz) P. W. Ball in the Požega Valley and the surrounding mountains.

Distribution of *Campanula carpatica* Jacq. in Ukraine

Zhygalova, S.[1], Dremliuga, N.[1], Olshanskyi, I.[1], Futorna, O.[2].

[1]Department of systematics and floristics, M.G. Kholodny Institute of Botany of NAS of Ukraine, Tereschenkivska 2, Kyiv, Ukraine

[2]O.V. Fomin Botanical Garden, Educational-Scientific Centre "Institute of Biology and Medicine", National Taras Shevchenko University of Kyiv, Simon Petlyura 1, Kyiv, Ukraine

* *zhygalova2015@gmail.com*

The purpose of our work was to analyze the herbarium and literary data and establish the exact distribution of rare species *Campanula carpatica* Jacq. (Campanulaceae) in Ukraine. It is included in the Red Data Book of Ukraine as a "rare". Relictive endemic species on the northeastern boundary of the range (Kagalo, Sychak, 2009). According to Y. Kobiv (2011), there is an endemic Carpathian taxon with an intracarpathian disjunction. According to A. Malinovsky (1991), the species is paleoendemic, which is characterized by strong morphological and geographical isolation. In Ukraine it is known from Svydivets, Chornogors and Marmaros Alps (Kozurak, 2005; Kagalo, Sychak, 2009). We have created distribution map of *C. carpatica* for the territory of Ukraine on the basis of herbarium data (KW, LW, LWS, LWKS, CBR**, LE), as well as the literature data. Also, we revealed that there is no data in the literature on the reduction of the *C. carpatica* range. On the other hand, the removal of generative specimens of rare species populations takes place because of the recreational boom in the highlands of the Ukrainian Carpathians. To our oppinion, according to IUCN categories, *C. carpatica* may have a "near treatened" (NT) status in Ukraine.

Karyology of the genus *Armeria* (Plumbaginaceae) in the Balkan Peninsula

Buzurović, U.[1], Tomović, G.[2], Niketić, M.[1], Lazarević, M.[2]

1 Natural History Museum, Belgrade, Njegoševa 51, 11000 Belgrade, Serbia

2 Chair of Plant Ecology and Phytogeography, Institute of Botany and Botanical Garden "Jevremovac", Faculty of Biology, University of Belgrade, Takovska 43, 11000 Belgrade, Serbia

* *uros.buzurovic@nhmbeo.rs*

Genus *Armeria* (Plumbaginaceae) comprises about 120 species. Most of them are distributed from Madeira and Portugal in the west to Anatolia and Lebanon to the east. There are about 40 species in Europe and the center of its current distribution is in the Iberian Peninsula. Basic chromosome number in the genus *Armeria* is x=9. Most species are diploids with $2n=2x=18$ chromosomes, while polyploids are only sporadically reported. Eight species are present in the Balkan Peninsula: *A. alpina* (DC.) Willd., *A. canescens* (Host) Boiss., *A. icarica* J.R. Edm., *A. johnsenii* Papan. & Kokkini, *A. rumelica* Boiss., *A. sancta* Janka, *A. undulata* (Bory) Boiss. and *A. vandasii* Hayek. Among them polyploids are reported only for some populations of *A. alpina* from the Iberian Peninsula. In the present study, chromosome numbers and karyomorphometric analysis of three species (*A. alpina*, *A. canescens*, and *A. rumelica*), comprising 21 populations from Albania, Bosnia and Herzegovina, Croatia, Greece, Northern Macedonia and Serbia, from different substrates, are examined. All analyzed populations are diploids with $2n=2x=18$. Differences in their karyotypes are analyzed taking into account taxonomy and ecology of the species.

Acknowledgements. This research was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, grant no. 173030 "Plant biodiversity of Serbia and the Balkans – assessment, sustainable use and protection".

Dianthus sect. *Carthusianum* in flora of Vojvodina

Rat, M., Putnik, A., Bokić, B., Polić, D., Anačkov, G.

University of Novi Sad, Faculty of Sciences, Department of Biology and Ecology, Trg Dositeja Obradovića 2, 21000 Novi Sad, Serbia

* *milica.rat@dbe.uns.ac.rs*

Althouth genus *Dianthus* is well known since ancient times as an important horticultural group, scientific knowledge regarding its taxonomy, ecology and habitat preferences is insufficient. In Serbian flora there are 36 species, and numerous infraspecific taxa. However, for most of the taxa small amount of data is available, and genus is poorly investigated in general. In order to assess the presence of taxon *Dianthus* sect. *Carthusianum* in the area of Vojvodina, plant material in the herbarium BUNS was revised. In the region of Vojvodina, *Dianthus* sect. *Carthusianum* have two representatives that are considered as Pannonian endemics: *Dianthus diutinus* and *D. giganteiformis* subsp. *pontederae*. The former is rare species, which population is nowadays left only in the area of Subotica Sands, while the later is widespread all over Vojvodina, representing a characteristic species of steppe habitats. In addition to these taxa, *D. giganteiformis* subsp. *giganteiformis*, *D. giganteus* and *D. banaticus* are recorded in Vojvodina. During revision of herbarium material, presence of *D. giganteiformis* subsp. *cladovanus* was revealed on two localities of Deliblato Sands. Finally, owing to the pronounced morphological variability among analyzed taxa, an additional work towards clear definition of species and their morphological characteristics is strongly recommended.

Acknowledgements. This work has been supported by the Ministry of Education, Science and Technological Development, Republic of Serbia, under Grant 173030 and Provincial Secretariat for Higher Education and Scientific Research, under Grant APV114-451-2169/2016.

Flora of Danube River in vicinity of Tekija (Northeast Serbia): Taxonomical, ecological and phytogeographic analysis

Bolbotinović, Lj., Ranđelović, V., Jušković, M., Nikolić, D., Jenačković Gocić, D.

Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

* *ljiljana.bolbotinovic@pmf.edu.rs*

Aquatic and occasionally flooded habitats in Orşova Basin at the right bank of the Danube River were studied in 2018 in order to determine their floristic diversity. A total of 123 taxa were identified (2 species of class Polypodiopsida, 89 species of class Magnoliopsida and 34 species of class Liliopsida), pertaining to 50 families and 99 genera. The highest number of taxa is recorded within the following families: Compositae (15), Poaceae (15), Lamiaceae (7), Polygonaceae (5), Salicaceae (5) and Fabaceae (5). The species-richest genera were *Potamogeton* (*P. lucens*, *P. nodosus*, *P. perfoliatus* and *P. crispus*) and *Persicaria* (*P. maculosa*, *P. dubia*, *P. lapathifolia* and *P. hydropiper*). Flora of the investigated area has a hemicryptophytic character (25.20%) with significant contribution of therophytes (20.32%) and hydrophytes (14.63%). The phytogeographic analysis has shown that most species (44) have Eurasian type of distribution. It was determined that 16 taxa (13%) were included in the list of invasive species of Serbia, while most of them (12 species) have a North American origin. Among the recorded taxa, one species (*Trapa natans*) belongs to the group of Near Threatened species while 38 species are classified as Least Concern according to the European Red List of vascular plants.

Ecological differentiation of marshland communities recorded in the area of Central Balkan Peninsula

Jenačković Gocić, D., Jušković, M., Nikolić, D., Ranđelović, V.

Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

* *draganaj@pmf.ni.ac.rs*

In order to determine the degree of ecological differentiation between the communities of *Phragmito-Magnocaricetea* vegetation class, Non-metric Multidimensional Scaling Analysis (NMDS) was performed according to Ellenberg's indicator values for climatic and edaphic environmental factors. NMDS was carried out with the dataset composed of 762 relevés, some of them from literature sources and others collected during the field research in period 2012-2014. Results of NMDS have shown that edaphic factors have stronger influence on ecological differentiation of marshland communities than the climatic factors. *Caricetum gracillis*, *Caricetum ripariae* and *Caricetum acutiformis* prefer the driest marshland habitats while *Butometum umbellati*, *Typhetum latifoliae* and *Typhetum angustifoliae* show affinities to the habitats with the highest degree of humidity. Substrates characterized by high pH values are suitable for development of *Phragmitetum australis* and *Typhetum domingensis*, while growth of *Caricetum rostrato-vesicariae*, *Equisetetum limosi* and *Caricetum paniculatae* is supported by habitats rich in H^+ ions. Ecological affinities to nutrient-poor habitats were shown by only a few of the studied communities – *Caricetum vulpinae*, *Glycerietum fluitantis*, *Glycerietum notatae* and *Bolboschoenetum glauci*. High content of nutrients in substrates is favorable for development of *Cladietum marisci* and *Oenantho aquaticae-Rorippetum amphibiae*. In order to achieve better understanding of the syntaxonomic relationships within the *Phragmito-Magnocaricetea* class it is necessary to collect more data on ecological preferences of marshland communities.

Allio guttate-Limonietum gmelinii - new halophytic association in South Serbia

Zlatković, I.D.[1]*, Jenačković Gocić, D.[2], Ranđelović, V.[2]

[1]College of Agriculture and Food Technology, Prokuplje, Ćirila i Metodija 1, 18400 Prokuplje, Serbia.

[2]Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia.

* *gajevicivana@yahoo.com*

The phytocoenological research of halophytic vegetation at salt areas of South Serbia has shown presence of a new association *Allio guttate-Limonietum gmelinii*. This plant association was recorded at Lalinac and Lepaja salt areas at the altitude of 200-300 m above sea level, on carbonate soil type or solonetz. Seasonal dynamics were monitored in this association throughout the vegetation season, resulting in a list of 77 species. The characteristic and dominant species in this association are *Allium guttatum* and *Limonium gmellini*. Other typical halophytes in this association include *Puccinelia distans, Hordeum geniculatum, Podospermum canum* and *Lepidium perfoliatum*. At Lepaja salt area, species *Helminthia echinoides* was also recorded in significant numbers. Due to presence of agricultural plots in the immediate vicinity, a large number of weed species was recorded in this association. As species *Allium guttatum* has a small range with specific habitat demands, it is necessary to implement strictly defined conservation measures in order to preserve its populations.

Acknowledgement. This study was supported by the Ministry of Science and Technological Development of the Republic of Serbia (Project No. 173030).

Distribution and ecological preferences of *Noccaea kovatsii* in Serbia

Mišljenović, T.[1], Jovanović, S.[1], Kuzmanović, N.[1], Niketić, M.[2], Jakovljević, K.[1]

[1]Institute of Botany and Botanical Garden, Faculty of Biology, University of Belgrade, Takovska 43, 11000 Belgrade, Serbia

[2]Natural History Museum, Njegoševa 51, 11000 Belgrade, Serbia

* *tomica.m@bio.bg.ac.rs*

Noccaea kovatsii is a pseudometallophyte distributed in the Carpathians and the Balkan peninsula, known to (hyper)accumulate Ni, Zn and Cd. The aim of this study was to summarize the data on the distribution and ecological preferences of this species in Serbia. Based on the analysis of herbarium collections, literature data and field surveys the presence of *N. kovatsii* in Serbia was noted in 53 10x10 km UTM squares. The species was found on different geological substrates, metalliferous and non-metalliferous, in the altitude range from 240–2275 m a.s.l. Mean annual temperature of the sites varied from 1.0 to 11.7°C, with annual precipitation from 565 to 1092mm. Physico-chemical analyses of soils from 15 sites were performed, and it was determined that *N. kovatsii* was found on different types of loamy soils - from silty clay loam to sandy loam, acidic to moderately alkaline, moderately to well supplied with nitrogen. Occurrences of *N. kovatsii* were noted in various types of habitats including grasslands, pastures, deciduous and coniferous forests, but quite frequently the species was found on road embankments and road shoulders. High ecological plasticity of *N. kovatsii* makes it a suitable model for future studies and potential application in phytotechnology, primarily phytoremediation.

Acknowledgement. The Ministry of Education, Science and Technological Development of the Republic of Serbia supported this research through Grant 173030.

New contributions to the flora of the RN Macedonia

Matevski, V., Kostadinovski, M., Ćušterevska R.

St Cyril and Methodius University, Faculty of Natural sciences and mathematics, Institute of biology, Arhimedova 3, Mk 1000 Skopje,

* *vlado.matevski@yahoo.com*

The paper presents new data on the horology of the 10 rare and insufficiently known taxa on the territory of the RN Macedonia. The are the following: *Anthemis auriculata* Boiss. (Kavadarci: Mrzen), *Chaenorhinum rubrifolium* (DC.) Fourr. (Prilep: v. Debreshte), *Coronilla coronata* L. (Galichica), *Hippuris vulgaris* L.(Kratovo: v. Stracin-Suvo Ezero), *Neottia ovata (L.) Bluff & Fingerh. (*Mavrovo: Nikiforovo), *Odontites glutinosa* (M. Bieb.) Bentham (Prilep: Debreshte), *Parietaria lusitanica* L. (Mariovo: v. Grunishte), *Phalaroides arundinacea* (L.) Rauschert (Makedonski Brod: v. Suvodol), *Polygonatum verticillatum* (L.) All. (Bitola: Mariovo, Nidze Mt - Lubnica; v. Gradeshnica, Pette Cheshmi), *Rhynchocorys elephas* (L.) Grisebach (Kavadarci: Alshar). Some of these data refer to the distribution of certain plant species that have already processed in the edition "Flora of the Republic of Macedonia" (*Coronilla coronata* L., *Hippuris vulgaris* L., *Parietaria lusitanica* L.) while the other data refer to the species of some families (*Anthemis auriculata* Boiss., *Chaenorhinum rubrifolium* (DC.) Fourr., *Odontites glutinosa* (M. Bieb.) Bentham, *Rhynchocorys elephas* (L.) Grisebach, *Polygonatum verticillatum* (L.) All., *Neottia ovata (L.) Bluff & Fingerh., Phalaroides arundinacea* (L.) Rauschert),that will be subject to processing in the next volumes of this edition.

The bryophyte flora of Loven park in the city of Sofia, Bulgaria

Natcheva, R.[1], Gospodinov, G.[1,2]

[1]Department of Plant and Fungal Diversity and Resources, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 23 Acad. Georgi Bonchev str., Sofia, Bulgaria,

[2]Department of Plant Physiology and Molecular Biology, University of Plovdiv, 21 Tsar Asen Asen st. BG-4000 Plovdiv, Bulgaria

* *renimoss@bio.bas.bg*

This study reveals the bryophyte diversity in Loven Park, one of the largest parks in Sofia, Bulgaria. This is the first investigation of bryophyte flora of the park. The area of the park was studied by the transect method in 2017 and 2019. Thirty-one species of mosses and five species of liverworts were recorded. Of them two are of conservation importance. One of the species is new for Sofia floristic region. Despite its relatively long history as a forested area (more than 100 years), the bryophyte diversity of Loven park is low. The main reasons are, air and soil pollution, relatively uniform landscape and microrelief, few microhabitats, very dense understory layer of shrubs and saplings, and the invasion of ivy (*Hedera helix*) on soil and tree trunks.

Acknowledgements. This study is held within the project „Investigation of the flora and vegetation: diversity, distribution, biosystematics, dynamics and conservation, Phase II”.

Spontaneous flora of the Vraca Memorial Park (Sarajevo, Bosnia and Herzegovina)

Sarajlić, N.[1], Jogan, N.[2], Ranđelović, V.[1], Murtić, S.[3]

[1]Dept. of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

[2]Dept. of Biology BF UL, Večna pot 111, SI-1000 Ljubljana, Slovenia

[3]Dept. of Plant Production, Faculty of Agricultural and Food Sciences, University of Sarajevo, Zmaja od Bosne 8, 71000 Sarajevo, Bosnia and Herzegovina

* *nermina.sarajlic@ptice.ba*

The Vraca Memorial Park was built in 1980-1981 around the old Austro-Hungarian fortress located above the city of Sarajevo, on northwestern slopes of Trebević mountain slightly above 600 m asl. It covers an area of approximately 8 ha. The southwestern part of the park is mostly covered by seminatural forest, central part of the range mostly paved, and northeastern is covered by partly ornamental forest and some grassland patches. Despite being declared a National Monument of Bosnia and Herzegovina in 2005, the Park is neglected and ruined, which allowed diverse subspontaneous vegetation to develop. The paper presents the results of systematic research and analysis of the spontaneous vascular flora of the Vraca Memorial Park. A total of 280 species of 182 genera and 67 families were recorded. With 37 species, Poaceae were the most abundant, followed by Asteraceae (incl. Cichoriaceae) with 29, and Fabaceae and Rosaceae (23 species each). Numerous seedlings of shrubs and trees planted for ornamental purposes were observed, as well as the presence of two protected Orchidaceae species. The analyses of life forms, chorology, origin, and time of first record in the area, and comparison between Vraca Memorial Park and complete flora of Sarajevo will be presented.

13th Symposium on the Flora of Southeastern Serbia and Neighboring Regions

Stara planina Mt. 20th-23th June, 2019

Nature protection and Environment

INTRODUCTORY LECTURE

Internationally important plants in Serbia

Stojanović, V.

Institute for Nature Conservation of Serbia, Dr Ivana Ribara 91, 11 000 Belgrade, Serbia

* *verica.stojanovic@zzps.rs*

The number of plant species protected by national legislation in Serbia is 1187 (1128 vascular plants and 58 bryophytes). In the four internationally important documents according to which plant species and their habitats are being protected, i.e. the cross-border traffic and trade of which are being regulated, there are 161 plant species of international importance that are registered on the territory of Serbia, which are listed in the Appendices of the Habitats Directive (66), the Bern Convention (50), CITES (79) and the EU Wildlife Trade Regulation (83).

In the process of collecting data on this "policy species" until 2014, the Institute for Nature Conservation of Serbia has established the following: 9 species of plants can be found only at one site, 3 are extinct, 5 are likely to have been extinct, 2 have unclear taxonomic status, five have not been confirmed to grow on the territory of the Republic of Serbia. Based on the results of the first phase of the projects "The Establishment of an ecological network on the territory of the Republic of Serbia" and "Drafting of the Red book of flora, fauna and fungi of the Republic of Serbia", which were submitted to the Institute by the Faculty of Biology, the University of Belgrade in 2016, the data on "policy species" in Serbia have been updated and will be presented in this paper.

ORAL PRESENTATION

Google Street View – a useful tool in roadside invasive plants research

Tmušić, G., Anačkov, G.

Department of Biology and Ecology, Faculty of Science, University of Novi Sad, Trg Dositeja Obradovića 2, Novi Sad, Serbia

* *goran.tmusic@dbe.uns.ac.rs*

Road networks act as corridors for spreading of invasive alien plants and roadside may serve for their establishment and naturalization, especially if such plants are intentionally planted, as in case of an invasive tree of heaven in Serbia. We suggest Google Street View (GSV) as a free web service in providing accurate distribution data on invasive plants, spatially and temporally constrained by road network coverage and period of image acquisition. For this purpose, after 80 working hours and 1500 km of the roads in Serbia covered using GSV, we georeferenced 1092 findings, each followed by the image. Single tree defines one finding, the threshold for the minimal distance between each finding was set to 20 m and the same rule was applied in case of dense populations. By analyzing the number of findings within the different road classes, state roads classes IB (37%) and IIA (35%) include a majority of findings, followed by class IIB (24%) and lastly highways - IA including only 4% of findings. In a comparison of GSV approach with a hypothetical car survey, by averaging a speed of 50 km/h, the suggested methodology is a more cost-efficient alternative with great potential for other invasive plants and urban vegetation surveys as well.

The forthcoming first UNESCO Natural World Heritage site in the Republic of Serbia – Preparing the next extension of „The Ancient and Primeval Beech Forests of the Carpathians and Other Regions of Europe"

Ostojić, D., Krsteski, B., Jovanović, I.

Institute for Nature Conservation of Serbia, Dr Ivana Ribara 91, 11070 Belgrade, Serbia

* *ivana.jovanovic@zzps.rs*

European beech (*Fagus sylvatica*) is one of the main edificatory species in the Temperate Broad-leaf Forest Biome. This autochthonous European species originated in Tertiary Period and has withstood alternating glacial periods before entering the expansion phase after the last Ice Age, thus forming the most important natural forest ecosystems in Europe and in Serbia. To ensure the preservation of Beech gene pool and ecosystem diversity, renewal and expansion of Beech forests, the UNESCO protected this uniquely European phenomenon in 2007 by inscribing it on the World Heritage list as the „Primeval Beech Forests of the Carpathians", a trans-boundary serial property of ten components in Slovakia and Ukraine. After two latter extensions in 2011 and 2017, this Natural World Heritage site, currently named „The Ancient and Primeval Beech Forests of the Carpathians and Other Regions of Europe", consists of 78 components, preserving the last remnants of ancient and primeval Beech forests in 12 European countries. The third and final extension is currently being prepared with the goal of completing an overall picture of post-glacial Beech re-colonization process. This paper presents the work done so far to include several selected components of exceptional and exemplary Serbian Beech forests in the next extension, which would result in the first UNESCO World Heritage property in the category of Natural Heritage for the Republic of Serbia, strengthening the protection of individual sites and increasing awareness on their natural values.

The state, concept and perspectives of protection of the natural resource Šargan-Mokra Gora

Ostojić, D.[1], Dragišić, A.[1], Jović, D.[1], Stojanović, V.[1], Zlatković, B.[2], Nikolić, V.[1], Radaković, M.[1], Sekulić, N.[1], Bjedov, V.[1], Petković, A.[1]

[1]Institute for Nature Conservation of Serbia, Dr Ivana Ribara 91 11070 Belgrade, Serbia

[2] Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

**dragana.ostojic@zzps.rs*

The area of Šargan-Mokra Gora is located between mountains Tara and Zlatibor, in the municipality of Užice in southwest Serbia. The research has shown that the area of Šargan-Mokra Gora is one of the most interesting phytogeographic areas of southwestern Serbia, with all outstanding natural values, based on which and following the proposal of the Institute for Nature Conservation of Serbia it was designated as protected natural area in the category of Landscapes of Outstanding Features in 2005, while in 2008 this area gained the status of Nature Park. After a 10 year period of protection there was an audit of the status of the whole protected area with special emphasis on natural values and specific features of the added part of protected area. This paper presents the results of the latest research and defines the concept of protection, which has comprised all the specific traits of the originally protected area, as well as surfaces that became part of Nature Park upon the audit. The surface on which protection is implemented has been increased by about 70% compared to the originally protected surface, with the aim of better conservation, protection, rehabilitation and revitalization of the area in order to achieve a higher degree of sustainable development and proper management of the protected area.

Mapping and monitoring of wetlands using remote sensing in Tara national park, Serbia

Sekulić, D.[1], Kuzmanović, N.[1], Lakušić, D.[1], Lazarević, P.[1], Kovačević, J.[2], Šinžar-Sekulić, J.[1]

[1]University of Belgrade, Faculty of Biology, Department of Ecology and Geography of Plants, Institute of Botany and Botanical Garden „Jevremovac", Takovska 43, 11000 Belgrade, Serbia

[2]*University of Belgrade – Faculty of Civil Engineering, Department of Geodesy and Geoinformatics, Bul. kralja Aleksandra 73, 11000 Belgrade, Serbia*

** E3003_2017@stud.bio.bg.ac.rs*

Wetlands are important components of many mountain ecosystems across the globe. They provide many benefits including water storage, pastures, nutrient sinks and transformation, and carbon storage. A rapidly changing environment with land use and climate as the most dynamic components causes new challenges for nature conservation and management of protected areas. This study aims to estimate the advantages and limitations of remote sensing for discrimination and classification of different wetland habitat types, as well as the usage of this method in nature conservation and protection of this highly fragile habitat type. We used remote sensing techniques and satellite imagery combined with field survey data for mapping wetlands in Tara National Park in western Serbia. At the sites Krnja Jela and Jarevac a total number of 42 findings were collected, geo-referenced and assigned to 13 different habitat types in order to validate and calibrate the remote sensing procedure. Except field data, topographical features, environmental characteristics and other digital data layers (GIS) were included.

Are ameliorative canals of the Backa loess plateau providing ecological corridors for steppe fragments?

Szabados, K., Perić, R., Panjković, B., Dragaš, K.

Institute for Nature Conservation of Vojvodina Province, Radnicka 20a, 21000Novi Sad, Serbia

* *klara.szabados@pzzp.rs*

Pannonian loess steppes belong to the most endangered habitat types of the region. Remains of steppe-meadow habitat mosaics, hosting valuable populations of floristic rarities, survived in the loess valleys at Backa loess plateau. As a result of conservation assessment, ten spatial units were proposed for legal protection. Nine of them situated within the catchment area of the Krivaja watercourse and have been altered by the construction of ameliorative canals and irrigation reservoirs. The vegetation strips of the hydrological network, recognised as ecological corridors for many species of agricultural landscape, provide the only spatial connection between the natural habitat complexes. Assessment of the corridor connectivity for steppic plants was carried out by spatial analysis of freely available satellite images and field survey (flora and vegetation research of 200m long transects) of different vegetation types. The result shows considerable degradation of grasslands both along the canal banks and within the small fragments of original habitats preserved along the canals. Valley sections with forest plantations act as barriers for grassland species. The most important factor decreasing the corridor connectivity is the spreading of invasive plant species, enhanced by the abandonment of pastures, grassland afforestation and canal maintenance practices.

Acknowledgement. Corridor survey was carried out as a part of Interreg IPA CBC 2017HR-RS135 project co-financed by EU (IPA) funds.

Eranthis hyemalis (L.) Salisb. - indicator species of climate change

Panjković, B., Perić, R., Milenić, B.

Institute for Nature Conservation of Vojvodina Province, Radnička 20a, 21 101 Novi Sad, Serbia

* *biljana.panjkovic@pzzp.rs*

Winter aconite (*Eranthis hyemalis*) is an critically endangered and strictly protected species with only few records in Serbia. It grows on humus-rich, moderately fertile, well-drained soils in full sun or part shade. The early flowering, before another spring species, short vegetation period and summer dormancy reflects its submediterranean origin and accompanying climate with most favourable conditions for plant development during the humid winter. Its life cycle is typical for many other mediterranean geophytes and is limiting factor of distribution in continental areas where this species grows in adequate edaphic and climatic conditions. Flowering cycle and distribution pattern of winter aconite were studied in the SNR „Bagremara“. Observations were carried out between 1996 and 2018. In the conditions of Bagremara ,flowering of winter aconite plants started at the middle of January and lasted until the midle of March which is not in contrast with average data in other countries. Start of flowering period depends on the air temperature values during the winter months and the averages of annual air temperatures. This data are compared with official weather and climate informations from nearby weather station at Bač. Shifting in the start of flowering towards the earlier periods of winter as well as gradual expanding of its area of occupancy suggests that connection with higher values of average temperatures during last decade should be possibly explained in the context of climatic change and shifting mediterranean climate zone. In the long term this could reflect positively on the population status of this species in Srbia.

Drosera rotundifolia L. (Droseraceae), endangered carnivorous plant species in the flora of Serbia - state of populations and phytocoenological affilation in the area of the Vlasina plateau

Beatović, M., Jenačković Gocić, D., Nikolić, D., Ranđelović, V.

University of Niš, Faculty of Sciences and Mathematics, Departmant of Biology and Ecology, Višegradska 33, Niš, Serbia

** vladar@pmf.ni.ac.rs*

Results of investigation of endangered carnivorous plant species in flora of Serbia *Drosera rotundifolia,* state of populations and phytocenological affiliation in the Vlasina plateau are presented. In this area, *D. rotundifolia* grows on habitats in communities with different *Sphagnum* species - *Drosero-Caricetum stellulatae, Caricetum godenowii*, *Sphagno-Equisetetum fluviatilis* and *Caricetum limosae*; or in communities with moss *Polytrichum gracile* - *Polytricho gracile-Droseretum rotundifoliae*. Based on the results of the research, it can be concluded that this species, according to the current knowledge, is represented in 9 areas in which it is building populations that are relatively numerous, but due to the negative effect of the anthropogenic factor and the habitat drying, the existence is threatened and characterized as endangered (EN). The most effective protection measure for *D. rotundifolia* is the protection of its habitats against the activity of anthropogenic factors.

Acknowledgements. The Ministry of Education, Science and Technological Development of the Republic of Serbia has supported this research under Grant 173030.

Biological indication of air quality in the urban area of Bosilegrad (Southeastern Serbia) by use lichens

Stamenković, S.[1], Ristić, S.[2], Aleksić, G.[1], Marković, M.[1], Djekić T.[3]

[1]Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

[2]Faculty of applied sciences, University "Union - Nikola Tesla", Niš, Serbia

[3]Department of Geography, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *sslavisa@pmf.ni.ac.rs*

Air pollution detection in Bosilegrad has not been done yet. In this work different lichens species have been used as a bioindicators to establish different air pollution levels. At 26 investigated points 23 lichen species from 15 genera have been found. Using the Index of Atmospheric Purity (IAP) it has been found that there are 2 different air pollution zones in Bosilegrad: "lichen desert", and "struggle zone". The most sensitive lichen taxa in Bosilegrad are *Pleurosticta acetabulum, Melanohalea exasperata, Melanohalea exasperatula, Melanelixia subaurifera,* and the most tolerant are *Phaeophyscia orbicularis, Physcia adscendens, Physcia aipolia,Physconia enteroxantha* and *Xanthoria parietina.*

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, grant number: OI 171025.

Traditional pig herding as suitable habitat management of endangered wetland species

Kiš, A.[1], Szabados K.[1], Demeter, L.[2], Biró, M.[2], Perić, R.[1], Marinkov, J.[3], Molnár, Z.[2]

[1]Institute for Nature Conservation of Vojvodina Province, Radnička 20a, Novi Sad, Serbia

[2]MTA Centre for Ecological Research, Klebelsberg K. út 3, Tihany, Hungary

[3]University of Novi Sad, Faculty of Sciences, Department of Biology and Ecology, Trg Dositeja Obradovića 2, Novi Sad, Serbia

* *alen.kis@pzzp.rs*

Managing protected areas within cultural landscapes requires deep knowledge of traditional land-use practices that have contributed to the preservation of natural values. This case study shows the positive effects of pig herding on the survival of rare plant species in the Bosut forest-wetland floodplain area (Posavina, Serbia). The presence of 43 plant taxa of national and international importance has been identified, 45% of which inhabit wetlands. They are threatened by changes in the water regime that accelerates wetland succession. Our results show that approx. half of the marshes are overgrown by shrubs or dense sedge communities. The traditional pig herding is still practiced in some localities. Comparing the flora of sites with different grazing intensities, we found that disturbances provided by pig grazing and uprooting prevents wetland succession and provides unique microhabitats, ensuring the survival of floral rarities such as *Marsilea quadrifolia*, *Hottonia palustris* and *Ludwigia palustris*. The practice also leads to forest habitats' diversification by altering patterns of shrub layer, litter and soil openness. Considering high costs of mechanical removal of woody vegetation, encouraging traditional pig herding by local farmers seems to be optimal habitat management.

Acknowledgements. This research was supported partly by the projects NKFIH K 119478 and GINOP-2.3.2-15-2016-00019.

The diversity of macrophyte communities in the Drina River floodplain (the Middle Danube Basin, Serbia)

Damnjanović, B.[1,2], Novković, M.[2], Radulović, S.[2], Cvijanović, D.[2]

[1]Higher Medical and Business-Technological School of Applied Studies Šabac, Hajduk Veljkova 10, 15000 Šabac, Serbia

[2]University of Novi Sad, Faculty of Sciences, Department of Biology and Ecology, Trg Dositeja Obradovića 2, 21000 Novi Sad, Serbia

* *bdamnjanovic@live.com*

The Drina River floodplain has been subjected to the intensive gravel excavation in the recent decade. Newly created gravel pit lakes along the floodplain provide a huge opportunity for conservation management of aquatic habitats in the entire river basin catchment area. The aim of this study was to determine the aquatic vegetation of the Drina River floodplain (the Middle Danube Basin Serbia). Data matrix was created from 561 sample quadrats, collected during the summer months of 2015, 2016 and 2018 at 18 gravel pit lakes and 4 fluvial lakes. The datasets were analyzed using PAST 3.24 software, by Classical Multivariate Clustering and the Bray-Curtis Similarity Index. The cluster analysis revealed 15 aquatic vegetation groups (VG): VG1 *Ceratophyllum demersum*, VG2 *Ceratophyllum demersum-Valisneria spiralis*, VG3 *Chara contraria*, VG4 *Chara globularis*, VG5 *Elodea canadensis*, VG6 *Elodea nuttallii*, VG7 *Najas marina*, VG8 *Najas minor*, VG9 *Nitellopsis obtusa*, VG10 *Nuphar lutea*, VG11 *Potamogeton nodosus*, VG12 *Potamogeton natans*, VG13*Potamogeton pectinatus*, VG14 *Typha latifolia*. Constant and dominant species were identified for each VG. Eight macrophyte vegetation assemblages were found to be of high conservation interest for the region of Serbia.

Assessment of cerium-oxide (CeO_2) nanoparticle ecotoxicity using non-biting midge *Chironomus riparius* (Diptera, Chironomidae)

Savić-Zdravković, D.[1], Milošević, Dj.[1], Stanković, J.[1], Đurđević, A.[1], Duran, H.[2], Uluer, E.[2], Matić, S.[3], Stanić, S.[3], Jovanović, B.[4]

[1]Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

[2]Department of Materials Science and Nanotechnology Engineering TOBB University of Economics and Technology, Söğütözü Cad. 43, 06560 Ankara, Turkey

[3]Department of Biology and Ecology, Faculty of Science, University of Kragujevac, Radoja Domanovića 12, Kragujevac, Serbia

[4]Department of Natural Resource Management and Ecology, Iowa State University, Ames, IA, USA

* *dimitrija.savic@pmf.edu.rs*

The toxicity of Cerium-oxide nanoparticles (nano-CeO_2) on freshwater midge *Chironomus riparius*, Meigen, was assessed by observing several biomarkers. The experiments were designed using measured concentrations of nano-CeO_2 in the sediment, according to the OECD guidelines for testing of chemicals, in the laboratory setup. The full characterization of the CeO_2 nanoparticles was made and the concentrations of 2.5, 25, 250 and 2500 mg of nano-CeO_2 per kg of sediment were tested. The increase of nano-CeO_2 content in the chironomid larvae was observed when its content was increased in the sediments (Spearman rho test rho=0.73, $p<0.01$). The toxicity was not detected at the developmental level, causing no observable effects on life traits. At the lower biological level, toxicity was detected through significant DNA damage in the midges exposed to higher nano-CeO_2 levels (one-way ANOVA $p < 0.05$). In addition, investigated oxidative stress parameters showed no significant differences between the treatments. There is a need for further investigation in order to understand causal relationships between molecular and higher-level responses to nano-CeO_2 exposure. Nevertheless, obtained results indicate that *C. riparius* could be used as bioindicator, providing valuable information for nano-CeO_2 risk assessment freshwaters and environmental protection planning.

Acknowledgements. This work was financed by the Ministry of Education, Science and Technological Development, Republic of Serbia, Grant No. III43002

Impact of physicochemical factors on macroinvertebrate communities in springs in Southern Serbia

Aleksić, M.

Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *milicaaleksić94@yahoo.com*

This paper presents an analysis of 10 springs belonging to different levels of capping. The goal of the study was to determine the impact of physicochemical factors: flow/discharge, temperature, oxygen concentration, oxygen saturation, pH and conductivity, on qualitative and quantitative composition of macroinvertebrate communities.The CCA analysis has shown that factors with the greatest impact on composition of these communities include pH, oxygen concentration, water temperature and conductivity. According to Shannon-Weaver index, the greatest diversity was recorded at Spring 9 (1.6) and the smallest at Spring 5 (0.41). Spring 9 is situated in an open habitat within a rural settlement and is capped in form of a tube, while Spring 5 is in a forest. According to Cluster Analysis, communities in springs were grouped according to the open/closed nature of their habitats, as forest communities were clearly distinct from those in open areas. The average values of family diversity were higher in open habitats (0.94) than in forest habitats (0.88). The greatest diversity (average value of diversity was 0.91) and number of individuals (average number of recorded individuals was 125) were recorded in uncapped springs lacking anthropogenic impact.

POSTER PRESENTATION

Habitat types inventory in the area of Nature Park Golija in 2018

Đurović, S.[1,2], Vukojičić, S.[1], Kabaš, E.[1], Veljić, M.[1], Kuzmanović, N.[1], Pantović, J.[1], Sekulić, D.[1], Lazarević, P.[1]

[1]University of Belgrade, Faculty of Biology, Takovska 43, 11000 Belgrade, Serbia,

[2]University of Niš, Faculty of Agriculture, Kosančićeva 4, 37000 Kruševac

* *sdjurovic@bio.bg.ac.rs*

Golija is one of the highest mountains in west Serbia, with the highest peak Jankov kamen (1833 m). It is one of the ecosystem diversity centres on the Balkan peninsula. Large areas are covered with old forest complexes, but there are also spacious meadows and pastures. Also, mires, as especially fragile ecosystems, can be found in spruce forest zone. During 2018, from June to September, we made an inventory of mires, small wetlands, grasslands and lands dominated by forbs, mosses or lichens and inland sparsely vegetated habitats on 286 sites in order to give better insight into the condition of non-forest habitats within the park which should serve as a basis for making decisions, working with other agencies and the public as well as for the long-term protection of the park ecosystems. Forty-nine different types of non-forest habitats have been registered, including one habitat that requires a new description. Habitats were classified using Serbian national classification system. Distribution maps for investigated habitats were made. Dominant and characteristic taxa vouchers were deposited in Herbarium BEOU.

Inventory of protected plant species in Nature Park Golija recorded in 2018

Vukojičić, S.[1], Đurović, S.[1,2], Kabaš, E.[1], Veljić, M.[1], Kuzmanović, N.[1], Pantović, J.[1], Sekulić, D.[1], Lazarević, P.[1]

1University of Belgrade, Faculty of Biology, Takovska 43, 11000 Belgrade, Serbia,

2University of Niš, Faculty of Agriculture, Kosančićeva 4, 37000 Kruševac

* *sneza@bio.bg.ac.rs*

As one of the highest mountains in west Serbia harbouring great ecosystem diversity, Mountain Golija is also one of the species diversity centres on the Balkan Peninsula. Over 800 taxa of vascular plants were recorded during floristic investigations in the last 60 years. Among them are some endemic and relict, as well as rare and endangered species protected by the law. We made an inventory of protected plant species in Nature Park Golija, declared in 2001, covering 75.183 ha of the mountain, in order to give better insight into the abundance of the protected plant species populations within the park which should serve as a basis for making decisions in long-term protection. Out of 43 protected vascular plant taxa recorded in previous floristic investigations of Mountain Golija, 12 were confirmed. *Calluna vulgaris*, relict species, and *Pastinaca hirsuta*, endemic species, were recorded for Golija for the first time during our investigations. Twenty-six briophytes significant for protection were also recorded, including the first record of *Grimmia lisae* for Mountain Golija. Distribution maps were made for all recorded species following habitat characteristics, including accompanying plant species.

Monitoring of three critically endangered plant species in Western Stara Planina Mts, Bulgaria

Vladimirov, V.[1,2], Velev, N.[1]

[1]Department of Plant and Fungal Diversity and Resources, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Acad. Georgi Bonchev St., bl. 23, 1113 Sofia, Bulgaria

[2]Faculty of Forestry, University of Forestry, 10 Kliment Ohridski Blvd., 1797 Sofia, Bulgaria

* *vladimir_dv@abv.bg*

Stara Planina Mts (Balkan Range) is the longest mountain range in Bulgaria. It is among the richest in plant species regions of the country, with numerous plants of conservation concern. The aim of the poster is to report the results from the monitoring of *Lathyrus palustris* (Fabaceae), *Plantago maxima* (Plantaginaceae) and*Swertia punctata* (Gentianaceae). They are represented with single populations in the country, and thus, 'Critically endangered' at national level. *Lathyrus palustris* and*P. maxima* occur in damp to wet meadows south of the village of Buchin Prohod, Kosinbrod Municipality. *Swertia punctata* occurs by river Barza under peak Midzhur, above Gorni Lom village, Chuprene Municipality. The populations are restricted to very small areas, comprising a few hundred individuals each. The monitoring during the past decade shows the populations are in a relatively stable state, with only slight increase in the number of individuals in *S. punctata*. The poster presents the monitoring design and results and provides data about the habitat and populations. The threat factors are discussed and some recommendations for the long-term conservation of the species are proposed.

Acknowledgements. Financial support of the Bulgarian Enterprise for Management of Environmental Protection Activities (Contract no. 11233/ 10 August 2016) is gratefully acknowledged.

The sad story of *Lycopodiella inundata* in Bulgaria or what (not) to monitor in strongly clonal plants

Ivanova, D., Natcheva, R.

Department of Plant and Fungal Diversity and Resources, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 23 Acad. Georgi Bonchev str., Sofia, Bulgaria

* *dani@bio.bas.bg*

In this study we focus on the problems posed by the clonal growth of the Marsh Clubmoss (*Lycopodiella inundata*) in Bulgaria. It is Critically Endangered at the national level. The species is an extremely weak competitor. In Bulgaria it is known from three sites but only two support viable populations. The site at the Rhodopi Mts suffered a drastic disturbance within the monitoring period. After drainage, the state of the population of *L. inundata* quickly deteriorated. The site at Milevska Mts remained stable without traces of disturbance or major changes. We report the results of the monitoring conducted at two sites for five and three years, respectively, in the period 2011-2018, for the need of the National System for Biodiversity Monitoring. Due to the strongly clonal growth and the inability to define separate individuals, the monitoring unit was a reproductive shoot. The results indicate that this number fluctuates within the study period but it did not reflect the change of hydrological regime and population deterioration in the Rhodopi Mts. Therefore the number of reproductive shoots is not a good measure for population state. We suggest alternative methods for monitoring of L. inundata and similar species with creeping, diffuse mat-forming habit.

Acknowledgements. The financial support provided by the Bulgarian Enterprise for management of environmental protection activities (Contract no. 11233/10 August 2016) is gratefully acknowledged.

State of the only population in the world of the Bulgarian endemic *Achillea thracica* Velen. (Asteraceae)

Bancheva, S. Delcheva, M.

Institute of Biodiversity and Ecosystem research, Bulgarian Academy of Sciences, Acad. G. Bonchev Str., 23, 1113-Sofia, Bulgaria

sbancheva@yahoo.com

The Bulgarian endemic *Achillea thracica* Velen. (Asteraceae) is one of the rarest species not only in Bulgarian flora but also in the world. The species is protected by the Bulgarian Biodiversity Act, included in the list of IUCN, the Berne Convention and the Red Book of Bulgaria in the category "Critically endangered". *A. thracica* grows on dry grassy places along roads, shrubs and forest meadows in the xerotherm oak belt. In the past, the species was known from two localities in central Bulgaria, but until today survived a single population located in the village of Manole, Plovdiv Region, along temporary roads in arable fields. The population occupies an area of about 2.5 hectares and is highly fragmented. The individuals are arranged in groups. The main threatening factors are ploughing field boundaries and enactment of "black" routes. The site was monitored during 2010-2018. In the autumn of 2019 were carried out restoration activities aimed at assisting the propagation of the species by planting seeds previously collected from the locality.

Acknowledgments. Financial support by the Enterprise for the Management of Environmental Protection Activities of the Ministry of Environment and Waters of Bulgaria, project ‘Conservation of rare and endangered plant species in Bulgaria through implementation of activities from established action plans’ is gratefully acknowledged.

Trace elements contents and accumulation in soils and five plant species of the genus *Viola* L. sect. *Melanium*, from the ultramafic and non-ultramafic substrates of Serbia and Bosnia & Herzegovina

Tomović, G.[1], Đurović, S.[1,2], Buzurović, U.[3], Niketić, M.[3], Milanović, Đ.[4], Mihailović, N.[5], Jakovljević, K.[1]

[1]Institute of Botany and Botanical Garden, Faculty of Biology, University of Belgrade, Takovska 43, 11000 Belgrade, Serbia

[2]Faculty of Agriculture in Kruševac, University of Niš, Kosančićeva 4, 37000 Kruševac

[3]Natural History Museum, Njegoševa 51, 11000 Belgrade, Serbia

[4]Faculty of Forestry, University of Banja Luka, Bulevar Vojvode Stepe Stepanovića 75A, 78000 Banja Luka Bosnia and Herzegovina

[5]Institute for the Application of Nuclear Energy – INEP, University of Belgrade, Banatska 31b, 11080 Belgrade, Serbia

* *gtomovic@bio.bg.ac.rs*

This study investigated five species of the genus *Viola* L. section Melanium Ging. from 13 ultramafic outcrops and two non-ultramafic (limestone and dolomitic) from Serbia and Bosnia & Herzegovina. Concentrations of P_2O_5, K_2O, Ca, Mg, Fe, Mn, Ni, Zn, Cu, Cr, Co, Cd and Pb in plant roots and shoots, and their corresponding soils are presented. To assess accumulative potential of these *Viola* species, bioconcentration, accumulation and translocation factors were calculated. Factor analysis was used in order to identify the sources of heavy metals in soils. Five studied *Viola* species growing on 13 different localities illustrated large differences in heavy metals uptake, translocation and accumulation. This survey suggests that all three populations of *V. kopaonikensis* Pančić ex Tomović & Niketić from the ultramafics of Serbia, as well as three populations of *V. beckiana* F. Fiala ex Beck from the ultramafics of Bosnia & Herzegovina emerge as Ni strong accumulators (up to 266 mg kg-1 and 713 mg kg-1 Ni in their shoots respectively) and could be used for phytoextraction purposes. Populations of *V. tricolor* L. from the ultramafics of Serbia acted as root-accumulators, considering their potential to accumulate medium amounts of Ni (up to 402 mg kg-1) in their roots.

Acknowledgments. The Ministry of Education, Science and Technological Development of the Republic of Serbia supported this research through Grant 173030 “Plant biodiversity of Serbia and the Balkans – assessment, sustainable use and protection”.

Radionuclides contamination in soil and plant samples of *Teucrium montanum* L. (Lamiaceae) from serpentinite and calcareous habitats in Serbia

Stanković, M.[1], Zlatić, N.[1], Krstić, D.[2]

[1]Department of Biology and Ecology, Faculty of Science, University of Kragujevac, Radoja Domanovića 12, Kragujevac, Serbia

[2]Department of Physics, Faculty of Science, University of Kragujevac, Radoja Domanovića 12, Kragujevac, Serbia

* *mstankovic@kg.ac.rs*

The purpose of this comparative analysis is the determination of the total content of natural and artificial radionuclides in soil samples and aboveground plant parts of*Teucrium montanum* L. (Lamiaceae) sampled from 20 different localities on serpentinite and calcareous habitats on the territory of Serbia. The activity concentrations of^{40}K, ^{226}Ra, ^{232}Th (natural radionuclides) and ^{137}Cs (artificial radionuclide) in soil and plant samples were measured with high purity germanium (HPGe) detector and expressed as Bq kg^{-1}. The calculated activity concentrations of ^{40}K, ^{226}Ra, ^{232}Th and ^{137}Cs in soil samples from serpentinite/calcareous habitats are in range: 39.6-91.0/59.3-1018.8, 1.7-5.5/4.3-52.4, 2.4-10.9/5.9-72.9 and 57.2-844.9/29.6-701.5 Bq kg^{-1}, respectively. Appropriate activity concentrations of ^{40}K, ^{226}Ra, ^{232}Th and^{137}Cs in plant samples are in range: 152.9-445.9/228.0- 521.4, n.d.-1.2/0.6-5.6, n.d./0.2-0.9 and 1.0-46.4/1.7-7.0 Bq kg^{-1}, respectively. The obtained values showed that the quantities of certain radionuclides ^{40}K, ^{226}Ra, ^{232}Th in the soil and plant material from the calcareous habitats were greater in comparison with the values for the serpentinite habitats, while quantities for the ^{137}Cs is greater in the soil and plant material from the serpentinite habitats. Results indicate that in addition to the macro- and micronutrient as well as heavy metal content and water regime, serpentinite substrate is distinguished by its specificity in radionuclides contamination in the soil and plant samples compared to calcareous substrate.

Does *Tussilago farfara* (hyper)accumulate metals from post flotation tailing sites in Serbia?

Jakovljević K[1], Mišljenović T[1], Savović J[2], Kuzmanović M[3], Ranđelović D[4], Mihailović N[5], Jovanović S[1]

[1]University of Belgrade, Faculty of Biology, Institute of Botany and Botanical Garden, Takovska 43, Belgrade 11000, Serbia

[2]University of Belgrade, Vinca Institute of Nuclear Sciences, Mike Petrovića Alasa 12-14, Belgrade 11000, Serbia

[3]University of Belgrade, Faculty of Physical Chemistry, Studentski trg 12-16, Belgrade 11000, Serbia

[4]Institute for Technology of Nuclear and other Mineral Raw Materials, Bulevar Franš d'Eperea 86, Belgrade 11000, Serbia

[5]University of Belgrade, Institute for the Application of Nuclear Energy – INEP, Banatska 31b, Belgrade 11080, Serbia

* *kjakovljevic@bio.bg.ac.rs*

The aim of this study was to explore accumulation capacity of *Tussilago farfara* colonizing active and abandoned mine tailings in comparison to the accession from an unpolluted site. Physical characteristics of substrates and concentrations of Ca, Mg, Fe, S, Al, Pb, Zn, Cu, Cd, Mn, As, Sb, Ag, Ti, and Sr in substrates and plants were analyzed. Elemental concentrations varied widely across the studied sites, with the highest concentrations of several microelements found in the flotation tailings from Veliki Majdan mine, characterized by very intensive mining activities (7,880 for Pb, 5,850 for Zn, 9,100 for As, 500 for Sb, 1,240 for Cu and 41 mg kg^{-1} for Cd). Translocation of these elements from roots to the shoots in plants from Veliki Majdan was low, as part of the defense strategy to protect the photosynthetically active tissues. The opposite was noted in the sample from Stolice tailings, with higher concentrations of toxic elements (As, Sb, and Zn) in the shoots in comparison to the roots. Even though concentrations of studied elements were below the hyperaccumulation threshold, and *T. farfara*would not be suitable for their phytoextraction, it has an important role in the initial phases of revegetation of highly contaminated sites.

Acknowledgements. The Ministry of Education, Science and Technological Development of the Republic of Serbia supported this research through Grants 173030, 176016 and 172019

Trace elements profiles of the psedometallophyte *Plantago holosteum* from ultramafic and non-ultramafic sites in Serbia and Montenegro

Jakovljević, K.[1], Mišljenović, T.[1], Mihailović, N.[2], Jovanović, S.[1], Tomović, G.[1]

[1]University of Belgrade, Faculty of Biology, Institute of Botany and Botanical Garden, Takovska 43, Belgrade 11000, Serbia

[2]University of Belgrade, Institute for the Application of Nuclear Energy – INEP, Banatska 31b, Belgrade 11080, Serbia

* *kjakovljevic@bio.bg.ac.rs*

The aim of this study was to compare chemical profiles of the pseudometallophyte *Plantago holosteum* Scop. from 7 ultramafic and 3 non-ultramafic sites in Serbia and Montenegro. Concentrations of selected micro- and macroelements in plant tissues and corresponding soils were analyzed. Significant differences in concentrations of Mg, Ca, Ni and Cr were recorded in the soils as well as in the roots and shoots from ultramafic and non-ultramafic sites. Accumulation factors (AF = shoot/soil$_{available}$element concentration) for Ni were lower in ultramafic accessions in comparison to the non-ultramafic ones, as a defense strategy to prevent the aboveground tissues from the toxicity of Ni in excess. The highest concentration of Ni (> 100 ppm) was found in the shoots from Tuzinje and this population can be considered as Ni accumulator. Concentrations of Ni at all studied sites were fairly below the hyperaccumulation threshold (1000 ppm). Particularly elevated concentrations of Cu and Zn were found in the shoot samples from Suvo Rudište, the abandoned iron-copper mine in Mt. Kopaonik (142 and 110 ppm, respectively). Metal tolerance of *P. holosteum*is primarily related to the strategy of metal exclusion, allowing this species to colonize ultramafic soils and substrates anthropogenically contaminated with high metal concentrations.

Acknowledgements. The Ministry of Education, Science and Technological Development of the Republic of Serbia supported this research through Grant 173030.

Content of lead in selected species of mushrooms from Southeastern Serbia

Dimitrijević, M., Mitić, V., Nikolić, J., Ćirić, S., Stojanović, G., Stankov Jovanović, V.

Department of Chemistry, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *marija.dimitrijevic@pmf.edu.rs*

Mushrooms are considered functional food because of their chemical and nutritional properties and they are consumed for their therapeutic properties and preventing disease. Mushrooms that form ectomycorrhizae are specially adapted to absorb chemical elements from the mineral particles of the soil, so they can serve as natural indicators of pollution. Lead toxicity is an important environmental disease and its effects on the human body are devastating. There is almost no function in the human body which is not affected by lead toxicity. The aim of this study was to evaluate the contamination of eight edible wild species of mushrooms (*Polyporus septosporus, Butyriboletus fechtneri, Xerocomellus chrysenteron, Butyriboletus regius, Russula virescens, Imperator rhodopurpureus, Rubroboletus rhodoxanthus* and *Macrolepiota procera*) collected from non-contaminated zones by lead. Concentration of lead was evaluated by ICP-MS, after microwave digestion. The highest Pb level was observed in *X. chrysenteron* (2.59 mg/kg) and the lowest value, which was ten times lesser, was found in *B. regius* (0.29 mg/kg). Imperator rhodopurpureus and *M. procera* showed similar values for lead (0.61 – 0.66 mg/kg), respectively. The acceptable daily intake of lead is 1.5–1.74 mg weekly for an individual of 60 kg bw. Based on concentrations of Pb found in this research, consumption of 300-g mushrooms will provide 0.008–0.07 mg of lead so examined mushrooms are considered safe and unpolluted.

Acknowledgements: The research was supported by the Serbian Ministry of Education, Science and Technology Development (Grants No 172047 and 172051).

Bioaccumulation potential of species *Juncus articulatus* L.

Branković, S.[1], Grbović, F.[1]*, Topuzović, M.[1], Glišić, R.[1], Đelić, G.[1], Simić, Z.[2], Đekić, V.[3]

[1]University of Kragujevac, Faculty of Science, Department of Biology and Ecology, Radoja Domanovića 12, 34000 Kragujevac, Serbia

[2]University of Kragujevac, Faculty of Science, Department of Chemistry, Radoja Domanovića 12, 34000 Kragujevac, Serbia

[3]Center for Small Grains, Save Kovačevića 31, 34000 Kragujevac, Serbia

**filip.grbovic@pmf.kg.ac.rs*

Exposure to elevated metal levels in soil lead to metal tolerance in some plant species. *Juncus* L. species grows on salty marshes or poorly drained soils, and also can be found on mine pits and tailings. The aim of this study was to determine the concentrations of 10 metals (Ca, Mg, Fe, Mn, Cu, Zn, Ni, Cr, Pb, and Cd) in plant *Juncus articulatus* L. growing on the mine pit and the flotation of the mine "Rudnik" in central Serbia. Flam atomic absorption spectrophotometer (FAAS) was used for analyzing metal elements content in soil and plant parts. Obtained results showed that concentrations of Cr, Pb and Cd in the investigated soil were above the maximum allowable concentrations of substances in the soil, and above remediation values according to regulations of the Republic of Serbia. This study showed that the mean values of the concentrations of the investigated elements in *J. articulatus* (whole plant) decreased in the following order: Fe>Ca>Mg>Mn>Zn>Cu>Cr>Ni>Pb>Cd. Analysis of the accumulation potential of various plant parts of investigated species showed that Mn, Ni, Mg, Ca, Fe, Zn, Cr are accumulating in the roots, while Mg and Cu are more accumulating in inflorescence of *J. articulatus.*

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant III41010).

Concurrent accumulation of Ni(II) and Pb(II) ions by aquatic macrophyte *Pistia Stratiotes*

Anđelković, T.[1], Anđelković, D.[1], Kostić I.[1], Branković, M.[1], Zlatković, B.[2]

[1]Department of Chemistry, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

[2]Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *ivana.chem@outlook.com*

In this paper, aquatic macrophyte *Pistia Stratiotes* was used for the simultaneously removal of Ni(II) and Pb(II) ions from water. The experiment was performed for different concentrations of metals for 30 days. Tanks with 15 pieces of *Pistia Stratiotes* (taken from Ostrovica, Serbia) consisted water solutions with the same concentration of nutrients, KH_2PO_4 (30 µmol/L) and NH_4NO_3 (120 µmol/L) and different concentrations of Ni(II) and Pb(II) ions. Comparison of accumulation were performed by 5 times higher concentration of ions (10 and 50 µmol/L). Results obtained from the first tank, without adding of investigated ions, showed that native plants pre-contained small amount of Ni(II), in average 3.1 µg/g, while Pb(II) ions were not detected. Obtained results showed that in tank with Ni(II) concentration of 50 µmol/L and Pb(II) concentration of 10 µmol/L, amount of determined Ni(II) was 514.7 µg/g while amount of determined Pb(II) was 11.3 µg/g. In the opposite case when concentration of Pb(II) was five times higher than concentration of Ni(II), amount of determined Ni(II) was 118.5 µg/g while amount of determined Pb(II) was 111.5 µg/g. By comparing to total amount of metal ions, in both cases about 11.7% of Ni(II) and 1.5% of Pb(II) was removed.

Investigation of *Pistia Stratiotes* potential for removing Cd(II) ions from water

Anđelković, T.[1], Anđelković, D.[1], Kostić I.[1], Branković, M.[1], Zlatković, B.[2]

[1]Department of Chemistry, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

[2]Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *ivana.chem@outlook.com*

Macrophytes shows high affinity for removal of metal ions and as kind of biosorbent material that are biodegradable and easy to grow, supporting wide ranges of pH and temperature, has an increasing interest in investigation of removing of metal ions. The aim of this study was to investigate potential of macrophyte*Pistia stratiotes* in Cd(II) ion removal. Plants were taken from Ostrovica (Serbia) and grown in three tanks, with three different concentrations (0.0, 10.0 and 50.0 µmol/L) of Cd(II) and with the same concentration of nutrients, KH_2PO_4 (30 µmol/L) and NH_4NO_3 (120 µmol/L). Results obtained from the first tank, that did not contain Cd(II), showed that native plants pre-contained small amount of Cd(II), in average 3.2 µg/g. Results obtained from second tank that contained Cd(II) in concentration 10.0 µmol/L, showed that plants contained Cd(II) in average 114.8 µg/g, while plants that were exposed to higher amount of Cd(II), contained in average 520.1 µg/g, what corresponds with five times higher concentration of Cd(II) in water. The overall results indicate that *Pistia stratiotes* shows significant removal potential for Cd(II).

Acknowledgement. This work was partially supported by the Ministry for Education, Science and Technological Development of the Republic of Serbia (Grant no. III 41018 and TR 31060).

An overview of invasive woody plant species in the protected natural areas of Belgrade (Serbia)

Jovanović, S.[1*], Šinžar-Sekulić, J.[1], Mišljenović, T.[1], Glišić, M.[2], Mataruga, Z.[3], Jakovljević, K.[1]

[1]University of Belgrade, Faculty of Biology, Institute of Botany and Botanical Garden, Belgrade 11000, Serbia

[2]Higher agricultural school of vocational studies in Šabac, Šabac 15000, Serbia

[3]University of Belgrade, Institute for Biological Research"Siniša Stanković", Belgrade 11060, Serbia

* *sjov@bio.bg.ac.rs*

The distribution of invasive woody species was studied in 6 protected natural areas within the city of Belgrade, namely Ada Ciganlija, Avala, Banjička šuma, Bojčinska šuma, Kosmaj and Miljakovačka šuma. In total, 12 invasive, or potentially invasive woody species were noted and mapped within the studied areas: *Acer negundo*, *A. saccharinum*, *Ailanthus altissima*, *Amorpha fruticosa*, *Broussonettia papyrifera*, *Fraxinus americana*,*Gleditsia triacanthos*, *Juglans nigra*, *Mahonia aquifolium*, *Prunus serotina*, *Rhus typhina* and *Robinia pseudoacacia*. The distribution of these species was analyzed in regard to the proximity to the city center, to test the hypothesis that the invasive species richness increases towards the more urbanized sites. The number of studied invasive species per site, as well as their density were examined in relation to the period of introduction and the size of the protected area. Having in mind that the population density of immediate surroundings of the protected areas is a very good predictor of alien species number, including invasive ones, the relations between these factors were also analyzed. Based on the obtained results, the susceptibility of the studied sites to the spread of the invasive species was assessed. In conclusion, a detailed invasive tree species management plan was proposed for the studied sites.

Acknowledgements. The Ministry of Education, Science and Technological Development of the Republic of Serbia supported this research through Grant 173030

A hero or a villain? Invasive *Ambrosia artemisiifolia* on sites with different levels of antropogenic pollution in Serbia

Mišljenović, T.[1], Jakovljević, K.[1], Savović, J.[2], Kuzmanović, M.[3], Ranđelović, D.[4], Mihailović, M.[5], Jovanović, S.[1]

[1]University of Belgrade, Faculty of Biology, Institute of Botany and Botanical Garden, Takovska 43, Belgrade, Serbia

[2]University of Belgrade, Vinča Institute of Nuclear Sciences, Mike Petrovića Alasa 12-14, Vinča, Belgrade, Serbia

[3]University of Belgrade, Faculty of Physical Chemistry, Studentski trg 12-16, Belgrade, Serbia

[4]Institute for Technology of Nuclear and other Mineral Raw Materials, Bulevar Franše d` Eperea 86, Belgrade, Serbia

[5]University of Belgrade, Institute for the Application of Nuclear Energy – INEP, Banatska 31b, Belgrade, Serbia

* *tomica.m@bio.bg.ac.rs*

Common ragweed (*Ambrosia artemisiifolia*), a monoecious annual plant native to North America was introduced to Europe and is considered invasive in the majority of the European countries, including Serbia. It inhabits riverbanks, agricultural fields, various types of ruderal sites and industrial waste sites, such as post flotation tailings and fly ash deposits. The aim of this study was to asses the strategies of metal(oid) tolerance of *A. artemisiifolia* from 5 sites in Serbia with different levels of anthropogenic pollution. The samples of soils and plants were collected from road embankments at Mt. Tara and Mt. Maljen, post flotation tailing site of the Stolice antimony mine, fly ash deposits of the Kostolac power plant, as well as from the coal separation ponds in Baljevac (Raška). Physical characteristics of substrates and concentrations of Ca, Mg, Fe, S, Al, Pb, Zn, Cu, Cd, Mn, As, Sb, Ag, Ti, and Sr in substrates and plants were analyzed. Even though *A. artemisiifolia* is a highly invasive species in Serbia, its spontaneous growth at highly polluted and disturbed sites can, to a certain extent, prevent the soil erosion and initially slow down metal leaching in the environment until suitable remediation measures are applied at the site.

Acknowledgements. The Ministry of Education, Science and Technological Development of the Republic of Serbia supported this research through Grants 173030, 176016 and 172019.

Astragalus dasyanthus (Fabaceae) – a rare species in the Bulgarian Flora and its conservation

Stoyanov, S., Goranova, V.

Department of Plant and Fungal Diversity and Resources, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Acad. Georgi Bonchev St., bl. 23, 1113 Sofia, Bulgaria

* *tjankata@abv.bg*

Astragalus dasyanthus Pall. is one of the rarest representatives of genus *Astragalus* in Bulgaria and one of the rarest plants of the Bulgarian flora. Because of its high conservation value it is protected by Bulgarian Biodiversity Act and included in the Bulgarian Red Data Book (Vol. 1, Plants and Fungi, 2015) with category "Critically Endangered". Currently in Bulgaria are known three localities: two in North Bulgaria (Danube Plain) and one in Southwest Bulgaria (Valley of River Struma). In North Bulgaria the species is ecologically related with the loess zone, wheretakes part in the habitat Pannonic loess steppic grasslands (6250). This habitat, included in Directive 92/43/EEC (Conservation of natural habitats and of wild fauna and flora), is one of the most vulnerable and rarest in Bulgaria. As a result of the long-term monitoring (2010–2014, 2017–2018) data on the basic parameters of the populations of *Astragalus dasyanthus* were collected and analyzed, which makes it possible to make an updated assessment of their condition. Major threats and adverse impacts on the species and its habitats have been identified. In order of the *in situ* conservation of *Astragalus dasyanthus* and its habitats, the three localities were declared as Protected Sites.

Acknowledgements. The financial support provided by the Bulgarian Enterprise for management of environmental protection activities (Contract no. 11233/ 10 August 2016) is gratefully acknowledged.

Bupleurum boissieri and *B. pauciradiatum* (Apiaceae) – recently discovered new species to the Balkans and their protection in Bulgaria

Stoyanov, S., Goranova, V.

Department of Plant and Fungal Diversity and Resources, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Acad. Georgi Bonchev St., bl. 23, 1113 Sofia, Bulgaria

* *tjankata@abv.bg*

Bupleurum uechtritzianum, described from Bulgaria in 2010, was synonymized with *B. boissieri*. *Bupleurum boissieri*, so far known for Turkey (Asia Minor), Syria and Georgia, first becomes recognized for the Balkans (Northeast Bulgaria and Romanian Dobrogea). Currently in Bulgaria are known four localities of this species: one in Northeast Bulgaria (Valley of Rusenski Lom River) and three in the historical region of Dobrogea (Frangensko Plateau, area around Balchik town and cape Kaliakra). Part of the locality near Ostritsa village (Ruse district) was declared as a Protected Site in 2013. *Bupleurum pauciradiatum* are presented in Bulgaria with a single extremely small population. It occupies an area of 10 ha and has a fragmented structure with 4–5 small patches. It is located about 500 meters northwest of the Bolata Bay of Bulgarian Black Sea coast. Part of the locality falls into the Kaliakra Reserve and Stepite Protected Site. The entire population is within Natura 2000 Protected Zone Kaliakra Complex (BG0000573). *Bupleurum boissieri* and *B. pauciradiatum* takes part mainly in the habitat type 62C0 Ponto-Sarmatic steppes, one of the rarest and most vulnerable European habitatsof Directive 92/43/EEC (1992). Major threats to it are recreation and construction of wind power stations.

Acknowledgements. The financial support provided by the Bulgarian Enterprise for management of environmental protection activities (Contract no. 11233/ 10 August 2016) is gratefully acknowledged.

Soil seed bank of invasive weed species in some protected areas of AP Vojvodina

Konstantinović, B., Popov, M., Samardžić, N., Šabović S.

University of Novi Sad, Faculty of Agriculture, Department of Environmental and Plant Protection, Trg Dositeja Obradovića 8,21000 Novi Sad, Serbia

* *milena.popov@polj.uns.ac.rs*

Studies of the soil seed banks of invasive plant species can provide valuable insight into the long-term implications of plant invasions. The aim of the research was to determinate soil seed reserves of invasive weed species in two protected areas – Special Nature Reserve "Selevenjske pustare" and Landscape of Outstanding Features "Subotička peščara". Forty-eight soil samples were taken at the depth of 0-10 cm in spring 2018. They were rinsed by water through the system of copper sieves of which the last was 0.25cm in diameter. Identifying the seeds and determining their quantity was carried out with microscopes and determiners. Soil samples taken at Special Nature Reserve "Selevenjske pustare" contained seeds of 41 weed species in total from which 12 were identified as invasive weed species: Amaranthus retroflexus, Asclepias syriaca, Matricaria discoidea, Robinia pseudoacacia, Celtis occidentalis, Veronica persica, Setaria italica, Lolium multiflorum, Datura stramonium, Fraxinus pennsylvanica, Portulaca oleracea and Ambrosia artemisiifolia. Soil samples from Landscape of Outstanding Features "Subotička peščara" contained seeds of 7 invasive and 32 non-invasive weed species. At both localities, Amaranthus retroflexus and Portulaca oleracea was the weed species with the highest number of selected seeds from the samples. There is a crucial need to develop weed seed bank research in order to control the spreading of invasive weeds.

Acknowledgments. This study was the result of the project HUSRB / 1602/12/0132 - 5.7.3.

On the reproductive biology of balkan endemic *Alkanna primuliflora* (Boraginaceae)

Nikolova, R.[1], Yankova-Tsvetkova, E.[1], Semerdjieva, I.[2]

[1]Department of Plant and Fungal Diversity, Division of Flora and Vegetation, Institute of Biodiversity and Ecosystem Research, BAS, 2, Gagarin Str., 1113 Sofia, Bulgaria

[2]Department of Botany and Agrometeorology, Faculty of Agronomy, Agricultural University – Plovdiv, 12 Mendeleev Str., 4000, Plovdiv, Bulgaria

* *e_jankova@abv.bg*

To avoid extinction endangered and endemic species must ensure a viable population size that can be maintained through reproduction, therefore the reproductive success in these plants is of fundamental importance. This study is aimed to revealing the peculiarities of structures and processes in the male and female generative sphere of Balkan endemic *Alkanna primuliflora* in connection with the realization of the reproductive potencial that influences the character and size of population of the species. For this purpose, buds and flowers from three natural Bulgarian populations (Breznitsa village, in the valley of Struma river; in the Rodhopa mountain, near the town of Asenovgrad and in the Djendem tepe area, in the town of Plovdiv) were collected and processed according to the Classical Paraffin Methods, and the main features of reproductive sphere were established: tetrasporangiate anthers which wall develops after Dicotyledonous-type, consisting of epidermis, fibrous endothecium, one ephemeral middle layer and glandular tapetum; two-celled mature pollen; anatropous, tenuinnucellate ovule; *Polygonum*-type embryo sac; Asterd-type embryo; normal course of the processes of formation of male and female gametophytes, presence of proterandry; absence of apomixis. The revealed state of reproductive structures and processes in *A. primuliflora* provides to the species a high reproductive potential.

Acknowledgements. The authors are grateful for the financial support provided by the "Program for young scientists and post-doctoral students" of the Bulgarian Academy of Sciences

Wildlife conservation and local folklore

Nikolić, M.[1,2], Cvetković, J.[1,2], Savić-Zdravković, D.[1,2], Conić, J.[1,2], Ilić, M.[1,2], Marković, S.1,2, Vučković, A.[1,2], Macura, B.[3], Crnobrnja-Isailović, J.[1,2,4]

[1]Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

[2]Biological Society "Dr. Sava Petrović", Višegradska 33, Niš, Serbia

[3]Stockholm Environment Institute, Linnengatan 87d, Sweden

[4]Institute for Biological Research „Siniša Stanković", Department of Evolutionary Biology, University of Belgrade, Despota Stefana 142, 11060 Belgrade, Serbia

e-mail: zerocool.axl@gmail.com

Local resource users can affect the implementation of conservation measures positively or negatively therefore being a powerful conservation factor. Present local folk beliefs, religion and mythology contribute vastly to the formation of attitudes and opinions of the locals towards nature and wildlife. For the purpose of this research, the methodology of surveying enabled the effective collection of information on the attitudes and knowledge of the locals related to the people's attitude towards wildlife. Surveying was conducted in a total of four locations (100 respondents each) in the underdeveloped municipalities of Serbia: Donji Milanovac and Kladovo in the eastern, and Leskovac and Nis in southern Serbia. The Mann-Whitney test of the obtained results showed that respondents from the localities in eastern Serbia are much more superstitious than respondents in southern Serbia ($P = 0.002$). Also, the same test has confirmed that residents living near protected areas are much more superstitious than residents living outside protected territory ($P = 0.034$). Many international documents in the field of nature protection state the education of the population as a necessary step in the protection of biodiversity, therefore continuous education of the population both in protected areas and outside their borders is necessary.

Acknowledgments. This research was conducted with the financial support of The Rufford Foundation financed project 18761-1 and 22238-2. We would like to thank the biological society "Dr. Sava Petrović" members for participating in the research.

13th Symposium on the Flora of Southeastern Serbia and Neighboring Regions

Stara planina Mt. 20th-23th June, 2019

Genetics, selection and biotechnology

ORAL PRESENTATION

Using morphology and anatomy to locate candidate genes for wheat yield components

Quarrie, S.[1], Rančić, D.[2], Dodig, D.[3], Czyczylo-Mysza, I.[4], Habash, D.[5]

[1]Faculty of Biology, University of Belgrade, Studentski trg 16, 11000 Belgrade, Serbia

[2]Faculty of Agriculture, University of Belgrade, Nemanjina 6, 11080 Zemun, Serbia

[3]Maize Research Institute, Slobodana Bajica 1, 11185 Zemun Polje, Serbia

[4]Department of Biotechnology, Polish Academy of Sciences The Franciszek Górski Institute of Plant Physiology, Kraków, Poland

[5]Securewheat, St Albans, AL3 UK

* *steve.quarrie@gmail.com*

Recent publication of the hexaploid wheat genome sequence has transformed opportunities to identify and test candidate genes regulating agronomic traits in wheat. A doubled haploid population of bread wheat from the cross Chinese Spring x SQ1 (a breeding line), mapped with over 450 markers, was used to study the genetic control of nitrogen and carbon partitioning and mobilisation during grain filling. This identified a region on chromosome 5B, centred on marker locus Xpsp3037, regulating several traits associated with organ size at both anthesis and grain dough stage, with SQ1 alleles increasing organ size. Other work with this mapping population showed consistent effects at Xpsp3037 on increasing grain size, biomass per stem, flag leaf width, but reducing flag leaf length. Increased leaf width was associated with SQ1 alleles giving more vascular bundles across the leaf. Anatomical data on stem sections showed significant SQ1 allele effects at this locus giving wider stems and wall thickness, more xylem area per stem cross-section, more parenchyma cells and more phloem area in larger bundles per section. Candidate genes within 5 megabases of Xpsp3037 included several transcription factors and genes affecting cell division and growth, including TB2/DP1/HVA22, demonstrating the value of stem anatomical data.

Acknowledgements. Part of this work was funded by an EU-FPV project 'SUSTAIN' QLK5-CT-2001-01461 to SQ and DH. Work by DR, DD and ICM was partly funded through the project "Grains of small grains - physiological, biochemical and anatomical basis of drought resistance" (2016-2019) by Serbian and Polish Academies of Sciences.

Ex-situ conservation, phytochemical screening and genetic diversity in several *Hypericum* species from Romania and the Balkans

Coste, A.[1], Deliu, C.[1], Şuteu, D.[1], Băcilă, I.[1], Halmagyi, A.[1], Gille, E.[2], Postolache, D.[3], Butiuc Keul, A.[4], Oniga, I.[5], Loureiro, J.[6], Zlatković, B.[7]

[1]Department of Experimental Biology and Biochemistry, Institute of Biological Research, Republicii 48, 400015, Cluj-Napoca, branch of National Institute of Research and Development for Biological Sciences (NIRDBS), Bucharest, România

[2]Stejarul Biological Research Centre, Alexandru cel Bun 6, 610004, Piatra Neamţ, branch of National Institute of Research and Development for Biological Sciences (NIRDBS), Bucharest, România

[3]National Institute for Research and Development in Forestry "Marin Drăcea", Cluj-Napoca Research Station, 400275 Cluj-Napoca, România

[4]Department of Molecular Biology and Biotechnology, Faculty of Biology and Geology, Babeş-Bolyai University, Kogălniceanu 1, 400084 Cluj-Napoca, România

[5]Faculty of Pharmacy, "Iuliu Haţieganu" University of Medicine and Pharmacy, Ion Creangă 12, 400010, Cluj-Napoca, România

[6]CFE, Centre for Functional Ecology – Science for People & the Planet, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas 3000-456, Coimbra, Portugal

[7]Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

* *ana.coste@icbcluj.ro*

Hypericum genus, currently considered to include over 500 species, is distributed globally, as well as in the Balkan Peninsula. Species of the genus *Hypericum* contain a broad range of valuable compounds with proven antidepressant and anticancer activities. However, about 75% of these species are yet unexplored. The Balkans exhibit an outstanding level of biodiversity, comprising many bioactivity rich *Hypericum* species distributed in the wild including several unexplored endemic and endangered species. Hence, our research was focused mainly on phytochemical screening and introduction of unexplored Romanian *Hypericum* species into in vitro

culture, optimization of elicitation measures, screening of their bioactivities and long-term cryostorage. In Romania, 12 native *Hypericum* species occur. Among these we studied two *Hypericum* species found in Transylvania: *H. richeri* ssp. *transsilvanicum* Čelak, a Romanian Carpathian endemic and *H. umbellatum* A. Kern, a rare and endangered Daco-Balkan species, along with other valuable *Hypericum* species from the same region: *H. hirsutum* and *H. maculatum*. Here, we'll report new data regarding the biosynthetic potential of in vitro grown rare and endemic Transylvanian species, as well as the analysis of ploidy level and molecular characterization of wild plants and/or accessions of *H. perforatum*, *H. maculatum* and the Balkan endemic species, *H. rumeliacum*.

Acknowledgements. This work was partially supported by a grant of the Ministry of Research and Innovation through Program 1 - Development of the National R&D System, Subprogram 1.2 - Institutional Performance - Projects for Excellence Financing in RDI, ctr. no. 22PFE/2018 and partially by the core program PN2019-2022 - BIODIVERS 3, through the project BIOSERV, project code 19270201, contract nr. 25N/2019.

Micropropagation of *Micromeria juliana* (L.) Benth. ex Rchb. (Lamiaceae) through nodal explants

Tošić, S., Stevanović, J., Mitić, M., Zlatković, B., Stanisavljević, M., Stojičić, D.

Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *stanisavljevic.milica@yahoo.com*

The species of the Lamiaceae family usually contain biologically active substances for which they are used in folk medicine, in the pharmaceutical, food and cosmetic industry. *Micromeria juliana*, belonging to this family, is interesting for studying the production, accumulation and metabolism of significant secondary metabolites. Sufficient amount of biological material can be provided by using tissue culture methods *in vitro*. The aim of this paper is to establish protocol for the regeneration of *M. juliana* plants using nodal explants on a nutrient medium with different growth regulators. The greatest number of axillary buds was formed in explants grown on MS nutrient medium with 1 μM kinetine. The explants grown on the medium without the growth regulators as well as on the medium with auxin were spontaneously rooting.

POSTER PRESENTATION

Antioxidant properties of fresh sour cherry (*Prunus cerasus* L.) fruits from Serbia

Prvulović, D., Peić Tukuljac, M., Barać, G., Miodragović, M., Ljubojević, M., Ognjanov, V.

Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, Novi Sad, Serbia

* *dejanp@polj.uns.ac.rs*

Sour cherries are good sources of phytochemicals and natural antioxidants. The aim of this research was to broaden current knowledge of chemical characteristics of sour cherry fruits cultivated in Serbia. Four cultivars of Serbian origin were investigated in this study: Fruškogorska, Futoška, Majurka and Prima. Fruits were harvested at full maturity and kept refrigerated. One gram of fresh edible parts in three replications of each sample was extracted in 10 mL of 70% (v/v) methanol by maceration overnight. After 24h extracts were centrifuged and filtered and used for further biochemical analysis. Total phenolics (TP), total tannins (TT), total flavonoids (TF) and total anthocyanins (TA) contents were determined spectrophotometrically. The antioxidant capacity of fruit's extracts was evaluated by three different assays: DPPH (2,2-diphenyl-1-picrylhydrazyl), ABTS (2,2'-azino-bis(3-ethylbenzothiazoline -6-sulphonic acid) and FRAP (ferric-reducing antioxidant power). The significant differences in the TP, TT, TF and TA contents and antioxidant activity of fruits were observed. The results obtained in this work showed that fruits of Futoška cultivar posses significantly lower content of all measured phenolic compounds, as well as, lower antioxidant activity. Fruits of cultivar Fruškogorska exhibited higher antioxidant capacity than any other cultivar in DPPH and ABTS assays.

Acknowledgement. The research presented in this article is part of project No. TR-31038 financially supported by Ministry of Education, Science and Technological Development of the Republic of Serbia.

Development of genomic resources for neglected and endemic tree species in the Balkans using Next Generation Sequencing technologies

Postolache, D.[1], Zhelev, P.[2], Popescu, F.[1]

[1]National Institute for Research and Development in Forestry "Marin Drăcea", 077190 Voluntari, Romania

[2]University of Forestry, 1797 Sofia, Bulgaria

* *dragospostolache@yahoo.com*

The Balkan Peninsula is considered one of the largest European glacial refugia. However, the genetic diversity of several endemic and neglected tree species in the Balkans remains poorly understood (e.g. *Carpinus orientalis, Ostrya carpinifolia, Quercus hartwissiana; Q. protoroburoides; Q. thracica*). One of constrain to explore genetic diversity and adaptive potential represents the scattered DNA sequence data available in molecular data repositories (e.g NCBI, EMBL-EBI). The advent of Next Generation Sequencing technologies (NGS) and the commercial availability of NGS platforms (e.g. Ion Torrent, lllumina), will permit to generate a massive amount of DNA sequence data at a lower costs and at an unprecedented rate. Our aim is to develop genomic resources for several endemic and neglected tree species in the Balkans that will be used not only to estimate genetic diversity but also to describe adaptive potential of tree species.

Acknowledgments. The research is supported by national program (BIOSERV) of the Ministry of Research and Innovation from Romania.

Changes in sclerenchyma cell walls related to stem twining in *Dioscorea balcanica*

Simonović Radosavljević, J.[1], Mitrović, A.Lj.[1], Bogdanović Pristov J.[1], Radotić, K.[1], Janošević, D.[2]

[1]Institute for Multidisciplinary Research, University of Belgrade, Kneza Višeslava 1, 11000 Belgrade, Serbia

[2]University of Belgrade, Institute of Botany and Botanical Garden „Jevremovac“, Faculty of Biology, Takovska 43, Belgrade, Serbia

* *jasna@imsi.rs*

Dioscorea balcanica Košanin, family Dioscoreaceae, is an endemic, endangered liana species and a Tertiary relict of Balkan Peninsula. Gelatinous fibers, specialized sclerenchyma cells and well-known components of tension wood, are responsible for stem twining in liana plants. The aim of this investigation was to determine changes in sclerenchyma cell walls correlated with the twining process in liana plants. Our results showed that the differences in cell walls of sclerenchyma cells between straight and twisted internodes are not visible by light microscopy, but they are visible by SEM microscopy. In twisted internodes, cell walls of sclerenchyma cells in the region of contact with the support (‘‘tension’’ side of twisted internodes) appear smooth on the cross sections, suggesting cellulose microfibrils oriented almost parallel to the fiber axis. In contrast, cell walls of the entire ring of sclerenchyma cells in straight internodes, as well as cell walls of sclerenchyma cells on the “opposite” side of twisted internodes, appear jagged on the cross sections, suggesting cellulose microfibrils oriented at very high microfibril angle to the fiber axis. This result suggests that gelatinous fibers in *D. balcanica* stem have lignified G-layer, and thus could contribute to the understanding of ‘‘late lignification of the G-layer’’.

Acknowledgements: This work was supported by: the grants 173017, III45012 and 173015 of the Ministry of education and science of the Republic of Serbia

Structural characterisation and orientation of cell wall polymers in *Arabidopsis thaliana* stem

Simonović Radosavljević, J.[1], Stevanić, J.[2], Đikanović, D.[1], Mitrović, A.Lj.[1], Salmén, L.[2], Radotić, K.[1]

1 Institute for multidisciplinary research,University of Belgrade, Kneza Višeslava 1, 11000 Belgrade, Serbia

2 RISE/Innventia AB, Drottning Kristinas väg 61, SE-114 86 Stockholm, Sweden

* *jasna@imsi.rs*

Plant cell walls are composed of a framework of cellulose microfibrils that are interconnected with heteropolysaccharides (lignin, hemicelluloses) in a specific manner. Plant cell walls form a large part of the plant body and define its characteristics. Structural organisation of the cell wall and related polymers is important for both mechanical properties of plants and chemical reactions occurring in the wall space, especially in the response to stress.By using imaging FTIR microscopy, run in transmission mode and at different polarisation modes (from 0° to 90°), it is possible to follow the chemical variability and the orientation of cell wall polymers (cellulose, hemicelluloses and lignin) of the *Arabidopsis thaliana* stem. The polarised FTIR measurements indicated that both xylan and lignin have parallel orientation with regard to the orientation of cellulose. It is believed that this structuring of lignin in the S_2 layer of the cell wall might be a result of the spatial constraints within the cell wall, occuring due to the previous deposition of cellulose/hemicellulose in a strongly oriented assembly.

Acknowledgements. This work was supported by Ministry of Education, Science and Technological development of Republic Serbia (Project #173017, 45012) and COST Action FP0802.

Transferring spotted-wing drosophila from natural environment to laboratory conditions: our first experiences

Cvetković, V.J., Dimitrijević, J., Cvetanović, A., Mitrović, T., Jovanović, N., Stanković, S.S., Žikić, V.

Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

* *biovlada@yahoo.com*

Spotted-wing drosophila, *Drosophila suzukii* (Matsumura, 1931) is a fruit fly species which has been reported as an invasive fruit pest, particularly for raspberry, blackberry and other berry fruits. The damage that they cause in fruit plantations imply need for its control, especially because these flies as an allochthonous species are more aggressive and dangerous for domestic fruits in our country. It is easier to observe and perform research on drosophila flies in controlled laboratory conditions what imply need for *D. suzukii* culturing. Aim of our pilot study was to transfer *D. suzukii* from environment to laboratory and to set a fly culture. We set the culture of *D. suzukii* flies obtained from infested raspberries that were collected from plantation near Lebane town in Serbia. Preliminary analysis shows that standard laboratory conditions and standard cornmeal-based feeding medium, which were regularly used for *D. melanogaster* laboratory stock maintenance, is not optimal for *D. suzukii* culturing. This was expected and it is in accordance with available literature data. Fine tuning of laboratory conditions and ingredients concentration in feeding medium is needed to ensure optimal conditions for *D. suzukii* culturing.

Genetic variation of camelina (*Camelina sativa* (L.) Crantz) estimated using SRAP (sequence-related amplified polymorphism) markers

Nagl, N., Marjanović Jeromela, A., Mitrović, P.

Institute of field and vegetable crops, Maksima Gorkog 30, Novi Sad, Serbia

* *nevena.nagl@ifvcns.ns.ac.rs*

Camelina (*Camelina sativa* (L.) Crantz), commonly known as false flax, is a diploid oilseed plant in the family *Brassicaceae*. It is a native European species which was cultivated until 19th century when it was replaced by more productive oil crops like oilseed rape and sunflower. Lately, interest in camelina has been revived because of its exceptional level of omega-3 essential fatty acids, favorable agronomic characteristics, and its potential as a low-input source of biofuel. The phenotypic diversity within camelina has been limitedly quantified, but there is even less information considering the use of molecular markers for genetic characterization. The objective of study was to use SRAP markers in assessing the genetic relatedness *C. sativa* accessions of different geographic origin. The SRAP is technique based on amplification of two primers, designed to preferentially amplify exonic and intronic regions and create polymorphisms that depend on variation of the length of amplicons. Due to its good reproducibility, high efficiency and low cost, it is very useful method for genetic diversity analysis. Variability among 20 accessions of camelina was estimated using 25 SRAP primer combinations. Estimation of variance components among the accessions, genetic variation and cluster analysis will be presented as well.

Genetic diversity of Macedonian sweet cherry (*Prunus avium* L.) using simple sequence repeats

Barać, G.[1], Gjamovski, V.[2], Kiprijanovski, M.[3], Ognjanov, V.[1], Dulić, J.[1], Milović, M.[1]

[1]University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia

[2]Cyril and Methodius University, Institute of Agriculture, Skopje 1000, Republic of North Macedonia

[3]Cyril and Methodius University, Faculty of Agricultural Sciences and Food, Skopje 1000, Republic of North Macedonia

* *goranb@polj.uns.ac.rs*

Sweet cherry is one of the most important fruit crops grown in the Ohrid region. The assortment in this region is primarily based on autochthonous genotypes and many of the cultivars that are grown have big economic and agronomic value. The origin of these cultivars is unknown and their characterization was performed using morphological characteristics following IPGRI and UPOV descriptors. The goal of the research was to determine the genetic diversity among autochthonous sweet cherry genotypes grown in Macedonia and Ohrid region using SSR markers and to compare them with cultivars grown worldwide. Plant material consists of 6 autochthonous sweet cherry cultivars (Ohridska crna, Ohridska crvena krcka, Ohridska dolga siska, Ohridska brza, Bela docna and Dalbazlija) and 8 standard cultivars. High genetic diversity level was observed between all analyzed genotypes. Using set of 15 SSR markers we were able to distinguish all genotypes with exception ofOhridska dolga siska and Germersdorfer. Cluster analysis grouped all autochthonous cultivars as well as cultivars Germersdorfer and Sweetheart. These results can implicate potential origin of Macedonian sweet cherry germplasm.

Acknowledgements. The research presented in this article is part of project No. TR-31038 financially supported by Ministry of Education, Science and Technological Development of the Republic of Serbia

Genome size diversity of *Orchis* spp. from the Fruška gora mountain, Serbia

Dulić, J., Ljubojević, M., Barać, G., Ognjanov, V.

Department of Fruit growing, Viticulture, Horticulture and Landscape architecture, Faculty of Agriculture, University of Novi Sad, Dositej Obradović sq. 8, 21000 Novi Sad, Serbia

** jovana.dulic@polj.uns.ac.rs*

Family *Orchidaceae*, with more than 160-fold variation and with the greatest genome size range, currently presents the most diverse angiosperm family. Although orchids do not possess species with the smallest or largest genome, the range of the genome size makes them the most variable angiosperm family. 32 species of terrestrial orchids were recorded on the Fruška gora mountain, northern Serbia. The aim of this study was to estimate the genome size of terrestrial orchid species belonging to genus *Orchis* located on the Fruška gora mountain. Sampling included 3 orchid species (*Orchis mascula, Orchis militaris, Orchis purpurea*) from 5 natural populations. Young, fully developed leaves were sampled during the April 2017. Diploid genome sizes (2C-values) were estimated by DNA flow cytometry and a simplified two-step protocol using Otto buffers. Significant difference in genome size between species and localities was observed. The genome sizes varied between species from 23,11 pg for *Orchis mascula* to 38,70 pg for *Orchis militaris*. Also, a small difference between genome sizes was observed among populations within *Orchis purpurea* species. Presented research indicates great genome size diversity, and points to the high need for further research on genome size and ploidy level of terrestrial orchids on the Fruška Gora mountain.

Comparison of two different gelling agents influence on micropropagation of *Prunus* sp. Rootstock

Dulić, J., Ognjanov, V., Ljubojević, M., Barać, G., Milović, M., Narandžić, T.

Department of Fruit growing, Viticulture, Horticulture and Landscape architecture, Faculty of Agriculture, University of Novi Sad, Dositej Obradović sq. 8, 21000 Novi Sad, Serbia

* *jovana.dulic@polj.uns.ac.rs*

Micropropagation is a widely used method for multiplication of standard rootstocks as well as for the selection of new rootstocks. To enhance successful and viable plant production, it is necessary to establish appropriate nutrition media, plant regulators, gelling agents and other components. The aim of this study was to examine the influence of two different gelling agents (Phytagel and Agar) on *in vitro* multiplication and rooting of *Prunus*sp. rootstocks included in the sweet and sour cherry breeding program. The research included two selections of *Prunus fruticosa* (SV1, SV2), one selection of *Prunus cerasus* (OV/OS) and Gisela 6 as a standard rootstock. Shoot tips obtained in May 2018 were used for *in vitro* culture establishment. After three weeks in the initiation medium, explants were placed on the medium for multiplication where the influence of gelling agents was tested. Significant influence of Phytagel on the number and height of multiplicated shoots was observed in all selections as well as in Gisela 6. Also, the strongest root development in terms of rooting percentage, root number and total root height for Gisela 6 and SV1 was achieved on the medium gelled with Phytagel (2,2 g/l).

Acknowledgements. The research presented in this article is a part of the project No. TR-31038 financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

The dependence of freshwater microalgae biomass production on the source of nitrogen in media

Stanković, N., Joković, N., Vitorović, J., Đorđević, Lj., Mihajilov-Krstev, T.

Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *nikola.stankovic@pmf.edu.rs*

Microalgae represent a significant raw material in biotechnology due to their high percentage of carbon hydrates, proteins, lipids and other metabolites they synthetize. In this study we tested two microalgal isolates from water samples of Vlasina and Bovan lake, identified as Closterium sp. and *Coccomyxa* sp, in order to examine how nitrogen sources affect their growth. Both isolates were grown on media with different nitrogen sources: ammonium ferric citrate, sodium nitrate and a mixture of these two compounds. The growth of microalgae and nitrogen absorption from the media was determined by spectrophotometric method. After a 30-day growth, the produced biomass was determined by a gravimetric method. Both isolates have shown a good growth on the medium with ammonium ferric citrate as the only nitrogen source, as well as on the medium with a mixture of ammonium ferric citrate and sodium nitrate. The results of chemical analysis of medium samples on which the microalgae grew have shown that both isolates do not absorb nitrates from medium for growth, but it instead uses ammonia ion as the source of nitrogen. The biomass yield after a month of growth was the biggest on the medium which contained ammonium ferric citrate and sodium nitrate.

Acknowledgment. This research was supported by the Ministry of Education Science and Technological Development of the Republic of Serbia [grant number III 45001].

Development of low-cost culture media for *Chlorella* sp. cultivation on the base of inorganic fertilizer

Stanković, N., Joković, N., Đorđević, Lj., Vitorović, J., Vujić, J., Mihajilov-Krstev, T.

Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *nikola.stankovic@pmf.edu.rs*

Microalgae are dominant primary producers in aquatic ecosystems, and their biomass is an essential biological resource. This work investigates simple low cost cultivation of freshwater microalga in order to gain great biomass. Consequently, in this study influence of two different culture media on the growth of *Chlorella* sp. was evaluated. Microalgae were placed in a batch culture during 28 days, in saline solution enriched with inorganic agricultural NPK fertilizer (SS-NPK) to compare the growth with the same strain cultured in aqueous solution of synthetic medium BG 11. The initial inocula (2 x 10^5 cells/ml) and cultivation conditions were the same: photoperiod day light ratio 16:8 hours, aerated during light period, light intensity 2000 lux under cool while LED light, pH 7.5. Slightly greater biomass, which was determined gravimetrically, was obtained in SS-NPK comparing to BG 11 medium. Culture medium made of saline solution enriched by inorganic fertilizer (NPK) was adequate and may replace the commercial medium BG 11 for the cultivation of microalgae *Chlorella* sp. resulting in high biomass and low cost.

Acknowledgment. This research was supported by the Ministry of Education Science and Technological Development of the Republic of Serbia [grant number III 45001].

Effect of auxins on root formation in *Hypericum barbat*um Jacq. *in vitro* plantlets

Krstikj, M., Tusevski, O., Gadzovska Simic, S., Cvetanovska, L.

Department of Plant Physiology, Institute of Biology, Faculty of Natural Sciences and Mathematics, University „Ss. Cyril and Methodius“, Archimedova str. 3, 1000 Skopje, Macedonia

** mkrstikj1@gmail.com*

This study evaluated the effect of auxins indole-3-acetic acid (IAA) and indole-3-butyric acid (IBA) on root formation of *Hypericum barbatum* Jacq. *in vitro* plantlets. The rooting capacity of *H. barbatum in vitro* plantlets was studied upon treatment with different concentrations of IAA and IBA (0.1, 0.5 and 1.0mg·L). Control plantlets were rooted on hormone-free medium. The regeneration potential of *in vitro* plantlets was analyzed through their fresh biomass and index of compactness, as well for frequency of root formation, number of roots and root length. Plantlets cultivated on 1mg·L^{-1} IAA exhibited the highest values for root frequency and root number, while 1 mg·L^{-1} IBA was the most effective for root elongation. In contrast, control plantlets demonstrated a maximum accumulation of fresh biomass (1.4g) compared to auxin-treated plantlets (0.2-1.1 g). The auxin-treated plantlets showed 1.6-fold increased index of compactness in comparison to control. Present results suggested that high concentrations of IAA and IBA could be proposed for efficient regeneration of *H. barbatum in vitro* plantlets. This is the first report on a rapid regeneration system of *H. barbatum* in *in vitro* conditions and provides a solid base for further application of conservation strategies.

Drosophila larvae exposed to H_2O_2 as a model of acute oxidative stress for the examination of plants antioxidative potential

Spasov, K., Stepić, M., Vitorović, J., Cvetković, V., Jovanović, N., Dimitrijević, J., Stanković, N., Mitrović, T., Joković, N.

Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

* *jovana.dimitrijevic1@pmf.edu.rs*

Fruit flies (*Drosophila melanogaster*) are a good experimental model for examining the effects of various chemical compounds on the oxidative stress parameters. The concentration of reduced glutathione (GSH) and malondialdehyde (MDA) as the non-enzymatic biochemical parameters, as well as the activity of catalase enzyme, were determined in larvae exposed to various concentrations of hydrogen peroxide (6%, 8%, 10%) in order to determine which concentration causes acute stress in Drosophila larvae and thus make them an adequate model for testing antioxidant properties of various compounds. MDA concentrations were significantly increased in larvae treated with 6% and 10% hydrogen peroxide compared to untreated larvae, while the GSH concentration was slightly reduced in larvae treated with 6% hydrogen peroxide, but significantly increased in larvae treated with 8% and 10% hydrogen peroxide. Catalase activity was slightly reduced in all treated groups. Antioxidant properties of Hemp (*Cannabis sativa* L.) seed oil as well as natural antioxidant vitamin C were tested in the second part of the experiment and obtained results didn't clearly show the difference between groups (treatment with 1% H_2O_2, 1% H_2O_2,+ different concentrations of hemp seed oil and 1% H_2O_2+ vitamin C) which indicated the need for additional testing within the model. The results of this study show that hydrogen peroxide could be used for inducing acute stress in the larvae of fruit flies but additional biochemical parameters should be examined to give a more obvious picture of stress that would facilitate the monitoring of the effects of antioxidants.

13th Symposium on the Flora of Southeastern Serbia and Neighboring Regions

Stara planina Mt. 20th-23th June, 2019

Useful plants

ORAL PRESENTATION

Basil in ethnomedicine and modern scientific trends

Tošić, S., Stanisavljević, M., Stojičić, D.

Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *stanisavljevic.milica@yahoo.com*

Plants have been a very important source of medicinal products since the earliest times. One of the very important plant species is basil (*Ocimum basilicum* L.), which has broad utilitarian value and all plant organs may be used. Basil is an aromatic and medicinal plant used in traditional medicine for treatment of diverse ailments, including fever, stomachache, throat ache, cough, tooth pain and neurological disorders. Due to the broad use of basil in phytopharmacy, cosmetics and culinary arts, both plantation farming and preservation of natural populations are considered highly important. Basil is also commonly used in religious rituals. The biological activity is based on numerous secondary metabolites, including polyphenols, flavonoids and terpenes. The essential oils are characterized by very pleasant smell and antioxidant, antimicrobial, fungicidal, antiviral and insecticide effects. Due to the medicinal properties of basil, it is a subject of intensive research in fields of phytomedicine and phytopharmacy. In order to achieve the highest possible biomass yield and enable more efficient exploitation of the antioxidant and phytochemical potential, numerous biotechnological studies are directed toward researching correlation between various environmental conditions and the processes of plant growth and development, as well as the biosynthesis of desired biomolecules. The climatic changes and the expansion of impact of abiotic and biotic stress factors reveal the need for selection of stress-resistant and stress-tolerant genotypes. The economic importance and broad spectrum of uses imply the need for further research on pharmacological and toxicological effects, in order to provide safer and more efficient use of basil.

Acknowledgements. This work was funded by the Serbian Academy of Sciences and Arts, branch in Nis, (project: Field research of the oral tradition of southeastern Serbia, no. 0-20-18).

POSTER PRESENTATION

Reproductive potential, metabolic and genetic profile, in *in situ* and *ex situ* conditions, of medicinal plants species from the bulgarian flora with resource deficit – scientific base for their cultivation

Yankova-Tsvetkova, E.[1], Berkov, S.[1], Stanilova, M.[1], Yurukova-Grancharova, P.[1], Vitkova, A.[1], Nikolova M.[1], Zhelev, P.[1], Stoyanov, S.[1], Vladimirov, V.[1], Aneva, I.[1], Kozhurahova, A.[1], Traykova, B.[1], Ilinkin, V.[1], Nikolova, R.[1], Stefanova, T.[1], Dimitrova, M.[1], Semerdjieva, I.[2], Zheljazkov, V.[2]

[1]Department of Plant and Fungal Diversity, Division of Flora and Vegetation, Institute of Biodiversity and Ecosystem Research, BAS, 2, Gagarin Str., 1113 Sofia, Bulgaria

[2]Department of Botany and Agrometeorology, Faculty of Agronomy, Agricultural University – Plovdiv, 12 Mendeleev Str., 4000, Plovdiv, Bulgaria

* *e_jankova@abv.bg*

Bulgaria has a great resource potential of medicinal plants species and occupies one of the first places in Europe in export of medicinal and aromatic plants. In recent years, due to the intensive exploitation of their natural habitats, the resources of medicinal plants in the country decreased. This lead to the necessity of special measures to ensure favourable conditions for their reproduction and sustainable development. In 2018, started to develop a research project funded by the National Science Fund aimed on exploring the possibilities for cultivation of four valuable medicinal plants with resource deficit and conservation value for the Bulgarian flora: *Alkanna tinctoria, Helichrysum arenarium, Primula veris, Arctostaphylos uva-ursi,* in order to provide a raw material from them and preserving their natural populations. The research strategy includes monitoring, embryological, phytochemical, genetic and biotechnological research, and the team consists of scientists from two research organizations, Institute of Biodiversity and Ecosystem Research at BAS and Agrarian University, Plovdiv It is expected that fundamental scientific data will be obtained for the target species; to complement their biological characteristics and create base for their future growing in culture, and in the long term their genetic fund will be preserved for the Bulgarian flora.

Acknowledgements: The authors are grateful for the financial support provided by the National Science Fund (Grant КП-06-Н26/6/13.12.2018).

The content of macro, micro and toxic elements in the extracts of black locust flowers

Boškov, I.A.[1], Savić, I.M.[1], Spalović, B.[2], Štrbac, N.[2], Savić-Gajić, I.M.[1].

[1]Faculty of Technology, University of Nis, Bulevar oslobodjenja 124, 16000 Leskovac, Republic of Serbia,

[2]Technical Faculty, University of Belgrade, Vojske Jugoslavije 12, 19210 Bor, Republic of Serbia

**e-mail: vana.savic@yahoo.com*

The aim was to investigate the influence of solvent polarity on the content of microelements, macroelements and toxic metals in the extracts of black locust flowers (*Robiniae pseudoacaciae flos*) by inductively coupled plasma optical emission spectrometry. The extracts were prepared using water, ethanol, 50% (v/v) ethanol, methanol and 50% (v/v) methanol. The extractions were performed under reflux at the temperature of 60 °C for 35 min. The dominant macroelement was K in the extract. The smallest content of K (150.69 mg/100 g dry weight) was noticed in the ethanolic extract, while the highest content (1187.5 mg/100 g dry weight) was found in the aqeous extract. The presence of microelements B and Al were confirmed in the extracts. The highest content of Al (242.46 mg/100 g dry weight) and B (39.02 mg/100 g dry weight) were determined in the ethanolic and methanolic extracts, respectively. This content of Al is due to its high concentration in the soil. In the aqueous extracts, the content of Al and B were lower than the detection limit. The presence of macro, micro and toxic elements in the extracts was determined because the tea of black locust is consumed and can affect human health.

Acknowledgment. The authors acknowledge the financial support for this study by Grant No. TR-34012 from the Ministry of Education, Science and Technological Development of the Republic of Serbia. Ivana Boskov is a recipient of scholarship from the Ministry of Education, Science and Technological Development of the Republic of Serbia.

Inhibitory effect of origano essential oil on lipid oxidation in cooked pork chops

Ivić M., Jokanović, M., Tomović, V., Škaljac, S., Šojić, B.

Faculty of Technology Novi Sad, University of Novi Sad, Bulevar cara Lazara 1, Novi Sad, Serbia,

* *sojic@tf.uns.ac.rs*

During cooking develops meat aroma, enhances meat tenderness and achieves a palatable and safe product by inactivation of pathogenic microorganisms. However, cooking promotes lipid oxidation causing flavour deterioration, rancidity, altered nutrient value or possible formation of toxic compounds. Antioxidants originating from plants could be incorporated into the meat products and therefore inhibit lipid oxidation. The aim of this study was to evaluate lipid oxidation as affected by the addition of origano essential oil. Origano essential oil (OEO) was applied through marination by immersing pork chops overnight. Thereafter, pork chops were vacuum-packaged in pouches and cooked in a water bath at 80 °C until reached 72 °C in the centre of the sample. OEO at level of 30 µl 100 g^{-1} meat reduced ($P<0.05$) TBARS (thiobarbituric acid reactive substances) values, both in raw and cooked pork chops. Applied essential oil lowered the TBARS value to a value of 40% of that found in the raw control samples, while the TBARS value in cooked samples pretreated with OEO was lowered to a value of 18% of that found in control samples. The results demonstrated strong potential of origano essential oil as natural antioxidant in raw and cooked pork chops.

Acknowledgments. This research was financially supported by the Ministry of Education, Science and Technological Development, Republic of Serbia, project No TR31032.

Antioxidant activity of winter savory (*Satureja montana* L.) supercritical extract in cooked pork sausages

Šojić, B., Tomović, V., Pavlić, B., Zeković, Z., Jokanović, M., Škaljac, S., Ivić, M.

University of Novi Sad, Faculty of Technology Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia

* *sojic@tf.uns.ac.rs*

The effect of winter savory (*Satureja montana* L.) supercritical extract (SFE) on pH value, Thiobarbituric acid-reactive substance (TBARS) value and flavour of cooked pork sausages during 30 days of storage was examined. Cooked pork sausages were created in local industrial plant. Supercritical fluid extraction with carbon-dioxide was used for isolation of lipid extracts. SFE was added to the sausage batter at concentration of 0.010 µL/g (SFE1), 0.025 µL/g (SFE2), 0.050 µL/g (SFE3), 0.075 µL/g (SFE4) and 0.100 µL/g (SFE5). Sausages produced without SFE was assigned as control (C). The addition of SFE had no significant ($p>0.05$) effect on pH values. All five concentrations of SFE significantly ($p<0.05$) affected to reduction of TBARS values. Additionally, at the end of storage (30th day), the TBARS test shown alterations between the treatments in the following order: C>SFE1≥SFE2≥SFE3≥SE4>SFE5. The addition of SFE (≤0.075 µL/g) had no negative impact on flavor. It can be concluded that winter savory supercritical extract (SFE), could be successfully applied as natural plant antioxidant in cooked pork sausages. Another advantage achieved by SFE was recovery of solvent-free extract which exhibited high bioactivity suggesting that it could be considered as adequate alternative to synthetic additives.

Acknowledgments. This research was financially supported by the Ministry of Education, Science and Technological Development, Republic of Serbia, project No TR31032 and TR31013.

Antipseudomonal activity of *Satureja montana* L. essential oil and its synergistic potential with ciprofloxacin

Pejčić, M., Stojanović-Radić, Z., Dimitrijević, M., Janković, A.

Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *milicapejcic1991@gmail.com*

Pseudomonas aeruginosa is a Gram-negative, biofilm producing pathogenic bacteria which causes numerous diseases, characterized by increasing resistance to antibiotics. *Satureja montana* L. is an aromatic plant widely used in traditional medicine, whose essential oil possess various biological activities including high antimicrobial potential. The aim of this study was to evaluate the antimicrobial activity of the *S. montana* essential oil applied alone or in combination with antibiotic ciprofloxacin, as well as its antibiofilm potential against fourteen *P. aeruginosa* clinical isolates. The obtained results showed inhibitory activity at concentrations from 1.25-10.00 mg/ml. The oil achieved a high synergistic interaction with ciprofloxacin in 8 isolates and additive interaction in 3 isolates. Observed results for antibiofilm assays showed a reduction of biofilm production up to 93.6% (oil applied at the beginning of the cultivation period). Promising results were also obtained when the oil was applied to the mature biofilms, where a reduction of 23.4-88.5% was measured. The results presented in this work suggest that obtained oil can be considered as adjuvant therapy in the treatment of chronical infections caused by *P. aeruginosa*.

Acknowledgments. This work was funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Project No. 172061)

Effects of different priming methods on seed germination and early growth of basil (*Ocimum basilicum* L.)

Kanjevac, M., Jakovljević, D., Bojović*, B.

Department of Biology and Ecology, Faculty of Science, University of Kragujevac, Radoja Domanovića No 12, Kragujevac, Serbia

* *biljanab@kg.ac.rs*

Seed priming is a pre-sowing strategy for improvement of seedling development which generally enhances germination rate and plant performance through the modulation of pre-germination metabolic activity prior to emergence of the radicle. In addition, this is potentially an important mechanism of induced resistance in plants against abiotic stress tolerance. In this study, different pre-sowing methods (hydro priming (H_2O), hormo priming (GA_3 and IAA), organic priming (ascorbic acid), halo priming (KNO_3 and $MgSO_4$), hemo priming (H_2O_2) and botanical priming (leaf extract of *Urtica dioica* L.)) were evaluated on seeds from *Ocimum basilicum*L. (basil) through the establishments of seed quality parameters (germination percentage, root and shoot length, seedling yield and vigour index). The seeds were primed in appropriate solution for the duration of 12 hours, then dried and placed in appropriate conditions for germination. Non-priming seeds were regarded as a control. Results demonstrated that among tested solutions, treatment with KNO_3 recorded as best priming method since improved all investigated parameters of basil seedling development. This halo priming is followed by ascorbic acid, extract of *U. dioica*, H_2O_2, and GA_3, respectively. Germination of basil seeds and further seedling development could be improvement by application of pre-sowing methods prior to germination.

Different smells of "Oregano" in South East European countries: The case of *Origanum vulgare* L.

Mertzanidis, D.[1], Koureas, D.[1,2], Assimopoulou, A.N.[3], Kokkini, S.[1]

[1]Laboratory of Systematic Botany and Phytogeography, School of Biology, Aristotle University of Thessaloniki, Thessaloniki, Greece

[2]Naturalis Biodiversity Center, 2300RA, Leiden, the Netherlands

[3]Organic Chemistry Laboratory, School of Chemical Engineering, Aristotle University of Thessaloniki, Thessaloniki, Greece

* *dmertzanidis@bio.auth.gr*

The common name "oregano" is attributed to several species of Lamiaceae family but also in members of other families. Among them, *Origanum vulgare* L. seems to be the most widely used for food flavoring by European consumers. Smell-intensity [essential oil (EO) content] and smell-type (EO composition) is considered in comparison to its distribution in SE European countries [Albania, Bulgaria, Greece, and Former Yugoslavia (North Macedonia, Serbia, Slovenia and Kosovo)]. Data are extracted from published information given in three scientific databases (Scopus, Web of Science and Google Scholar), regarding the EOs of native *O. vulgare* plants for the past 24 years (1993-2017). A total number of 108 individual samples of *O. vulgare* geographically scattered in the area have been found, with the majority of them (c. 70%) originated from Greece and Albania. Plants from those areas have a sharp - [EO content up to 8,8mL $100g^{-1}$ dry weight (mean= 3,26%)] oregano type - smell [dominant compounds carvacrol and / or thymol]. On the other hand, *O. vulgare* plants grown northwards to Mt Voras and Rhodope mountain range have a weaker [EO content up to 2,9% (mean= 0,72%)] and diversified smell [due to a variety of monoterpenes and sesquiterpenes].

Acknowledgements. This research has been supported by the project "Upgrading the Plant Capital (PlantUp)" (MIS 5002803) which is implemented under the Action "Reinforcement of the Research and Innovation Infrastructure", funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014–2020) and co–financed by Greece and the European Union (European Regional Development Fund)

Differences in local flora are reflected to the traditional medicine: The case of *Hypericum* in two geographically distant areas of Greece

Keki, M.[1], Poulaki, S.[1], Kokkini, S.[1,2]

[1]Postgraduate Studies Program "Conservation of Biodiversity and Sustainable Exploitation of Native Plants", School of Biology, Aristotle University of Thessaloniki, GR 541 24 Thessaloniki, Greece;

[2]Lab of Systematic Botany & Phytogeography, Department of Botany, School of Biology, Aristotle University of Thessaloniki, GR 541 24, Thessaloniki, Greece

* *mariakeki@bio.auth.gr*

In almost every ethnobotanical research in the Balkans, taxa of the genus *Hypericum* L. are present and frequently mentioned as taxa of high value. The most commonly mentioned taxon is *Hypericum perforatum* L., but in some cases other taxa are also mentioned for similar uses. The genus is represented in the flora of Greece by over 40 taxa. The aim of this study is to (i) investigate which *Hypericum* taxa are used as traditional medicine and in two geographically distant regions of Greece, (ii) trace information of home-made preparations, and (iii) record their therapeutically applications. This study was carried out in 12 villages and small cities, located in North Central Greece (Municipality of Edessa) and Eastern Peloponnese (Municipality of Epidaurus). For the collection and evaluation of ethnobotanical information, semi-structured interviews with native people were used. To record which taxa were present in the areas the time of the collections by the locals, *Hypericum* plants were collected and taxonomically identified. Due to differences in topography and climate but also in the cultural heritage of the two areas, differences are recorded in the taxa used as well as in the way of their therapeutically uses.

Diversity of scientific and common plant names: The case of *Hypericum* in the Balkan region

Poulaki, S.[1], Keki, M.[1], Kokkini, S.[1,2]

[1]Postgraduate Studies Program "Conservation of Biodiversity and Sustainable Exploitation of Native Plants", School of Biology, Aristotle University of Thessaloniki, GR 541 24 Thessaloniki, Greece

[2]Lab of Systematic Botany & Phytogeography, Department of Botany, School of Biology, Aristotle University of Thessaloniki, GR 541 24, Thessaloniki, Greece

* *skpoulaki@bio.auth.gr*

The genus *Hypericum* L. is represented in the Balkan flora by over 70 taxa, members of 16 sections locally or widely spread throughout the whole Balkan peninsula. Members of the genus are widely used in the traditional medicine all over Balkans. Among them, *H. perforatum* native and widespread in that area, is the most frequent mentioned in the several ethnobotanical publications from countries of SE Europe. Besides the variety of common names attributed locally to *H. perforatum* and its infraspecific taxa, it is registered and sold as "St. John's wort" in North Europe and USA. In an attempt to reveal the *Hypericum* diversity in the Balkan flora in biological and cultural terms, a research project has been started aiming to the collection and combine information from the (i) standard floras, taxonomic revisions and nomenclature notes, (ii) published information for the common names attributed locally in *Hypericum* plants in the Balkan countries (included Turkey), and (iii) our recent information from local markets and interviews with people of Greek villages. The results to date suggest that much more than one common name is attributed to a single *Hypericum* taxon and that a single taxon may be recognized by a variety of names.

13th Symposium on the Flora of Southeastern Serbia and Neighboring Regions

Stara planina Mt. 20th-23th June, 2019

Phytochemistry and Phytotherapy

ORAL PRESENTATION

Antioxidant activity of black pepper (*Piper nigrum* L.), cubeb (*Piper cubeba* L.) and allspice (*Pimenta dioica* (L.) Merr) extracts

Stanojević, Lj., Milenković, A.*, Cvetković, D., Stanojević, J., Babić, M.

Faculty of Technology, Leskovac, University of Niš, Bulevar Oslobodjenja 124, Leskovac, Serbia

* *aleksandra.milenkovic@student.ni.ac.rs*

Antioxidant activity of ethanolic extracts, obtained from black pepper (*Piper nigrum* L.), cubeb (*Piper cubeba* L.) and allspice (*Pimenta dioica* (L.) Merr) fructus, by reflux extraction in solvomodulus 1:10 m/v during 120 minutes, was examined in this work. Total phenols content was determined by Folin-Ciocalteu method, while total flavonoids content was determined by AlCl3 method. The antioxidant activity of ethanolic extracts was determined spectrophotometrically by DPPH assay. The highest content of total phenols (273.29 mgGAE/g of dry extract) and total flavonoids (22.21 mgRE/g of dry extract) was determined in the allspice extract. The minimal concentrations of allspice, black pepper and cubeb extracts, required for neutralization of 50% of initial DPPH radical concentration (EC50 value) were 0.011 mg/ml; 0.104 mg/ml and 0.378 mg/ml, respectively. A good correlation was found between total phenols and total flavonoids content in extracts and EC50 values (R2 = 0.549 and R2 = 0.993, respectively). The obtained results show that isolated extracts are a good source of natural antioxidants, as well as potential alternative to synthetic antioxidants. It is assumed that phenols and flavonoids areresponsible forantioxidant activity, which opens up a new topic for further research.

Acknowledgment. This work is part of the research project "Plant and synthetic bioactive products of new generation," no. TR 34012, financed by the Ministry of Education, Science and Technological Development of Republic of Serbia.

Chemical composition and antimicrobial activity of black pepper (*Piper nigrum* L.), cubeb (*Piper cubeba* L.) and allspice (*Pimenta dioica* (L.) Merr) essential oils

Milenković, A.[1]*, Stojanović-Radić, Z.[2], Pejčić, M.[2], Stanojević, Lj.[1], Stanojević, J.[1]

[1]Faculty of Technology in Leskovac, University of Niš, Bulevar Oslobođenja 124, Leskovac, Serbia

[2]Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *aleksandra.milenkovic@student.ni.ac.rs*

The essential oils from black pepper, cubeb and allspice fructus were obtained by Clevenger-type hydrodistillation using hydromodulus 1:10 m/v during 180 minutes. The qualitative and quantitative composition of the oils was determined by GC-MS and GC-FID spectrometry. Their activity against reference strains and isolates of human intestinal pathogens: *Bacillus cereus*, *Candida albicans* and *Salmonella enterica* were investigated using the microdilution method. Minimum inhibitory (MIC) and minimum microbicidal concentrations (MMC) were determined for all samples. The isolated pepper essential oils inhibited the growth of all tested microorganisms, with allspice essential oil showing the lowest MIC value. The major components in black pepper essential oil were (E)-caryophyllene (33.6%), limonene (19.1%) and β-pinene (11.2%); in cubeb oil: γ-cadinene (13%), β-cubebene (12.1%), α-copaene (11.7%) and δ-cadinene (7.2%) and in allspice oil: eugenol (48.5%) and methyl eugenol (35%). The tested samples of essential oils did not show a bactericidal effect on *Bacillus cereus* strains. It is assumed that there is a correlation between the chemical structures of the most abundant compounds in the essential oils and their antimicrobial activity, which could be a good basis for further research. The results obtained indicate that investigated essential oils are a good source of natural antimicrobial agents with potential application in food and pharmaceutical industries.

Acknowledgments. This work is part of the research project "Plant and synthetic bioactive products of new generation," no. TR 34012, financed by the Ministry of Education, Science and Technological Development of Republic of Serbia.

Phenolic compounds are involved in desiccation tolerance of endemic resurrection species *Ramonda serbica* Panc.

Vidović M, Morina F, Milić-Komić S, Veljovic-Jovanovic S

Institute for Multidisciplinary Research, Department of Life Science, University of Belgrade, KnezaViseslava 1, 11030 Belgrade, Serbia

**marija@imsi.rs*

Balkanic endemic plant species, *Ramonda serbica*, belongs to a small group of resurrection plants, since it is able to survive in an almost completely dehydrated state for months, and to fully recover metabolic functions upon watering. During drought and rehydration, reactive oxygen species increase presents an additional treat. In accordance, the increase of activities of the antioxidative enzymes, such as several superoxide dismutases and polyphenol oxidases in the critical first few hours of rehydration of *R. serbica* leaves was reported [1,2]. In fully hydrated leaves, the most abundant soluble phenolics were hydroxybenzoic acids (HBAs: p-hydroxybenzoic, protocatechuic, and syringic acid) and catechin. Among hydroxycinnamic acids (HCAs), caffeic acid was the major one, beside ferulic and chlorogenic acids. In addition, four flavonoids: apigenin, luteolin, cyanidin and delphinidin were identified as glycosides. Although *R. serbica* settles exclusively north-facing steep rocky sides, in the shade of the surrounding forest canopy, with reduced solar irradiance, 5-d-exposure to supplemental UV-B radiation significantly enhanced amounts of HBA derivatives and anthocyanins (2.6 and 5.7 folds, respectively), whereas flavon glycosides and most of HCA derivatives were unaffected. The physiological aspect of this UV-B stimulative effect, as well as the role of phenolic metabolism in cellular desiccation survival has to be explained.

Acknowledgment. This research was supported by the Ministry of Education and Science, Republic of Serbia. (Project No. III 43010).

Antibacterial activity of *Frangula alnus* extracts against *Staphylococcus aureus* strains forming biofilm

Mitić-Ćulafić D.[1], Đukanović, S.[1], Cvetković, S.[1], Kekić, D.[2], Perić, M.[1], Knežević-Vukčević, J.[1], Nikolić, B.[1]

[1]University of Belgrade-Faculty of Biology, Studentski trg 16, Belgrade, Serbia

[2]University of Belgrade-Faculty of Medicine, dr Subotića 1, Belgrade, Serbia

* *mdragana@bio.bg.ac.rs*

Antimicrobial resistant bacteria are the causes of numerous clinical problems worldwide. Control of infections acquired in hospitals and communities caused by multi-drug resistant bacteria has become a major problem worldwide. *Staphylococcus aureus* is one of the leading causes of human infections of different tissues. It forms biofilm, which plays a critical role in the persistence of chronic infections due to ability to tolerate antimicrobial agents. The search for new antimicrobials among medicinal plants has gradually increased around the world. Therefore, the aim was to estimate antibacterial/antibiofilm activity of *Frangula alnus* extracts towards six *S. aureus* strains. Results obtained showed that the ethyl-acetate extract (EtOAc) exhibited higher antimicrobial activity then aqua and ethanol ones. The minimal inhibitory concentrations of EtOAc were determined for all tested strains, ranging from 25 to 500 µg mL^{-1}. It repressed biofilm formation and showed inhibitory potential against preformed biofilms in concentration ranges 675-1000 µg mL^{-1} and 125-1000 µg mL^{-1}, respectively. Thus, the use of *F. alnus* as antimicrobial medicinal herb is justified and encourages further study in order to develop new antimicrobial drugs.

Acknowledgements. This work was supported by the Ministry of Science of Republic of Serbia, Project No. 172058.

Anticandidal activity of *Satureja montana* and *Thymus vulgaris* essential oils: synergistic potential and anti-virulence efficacy

Dimitrijević, M., Stojanović-Radić, Z., Pejčić, M., Dinčev, S.

[1]Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *dimitrijevicmarina92@yahoo.com*

Satureja montana L. (fam. *Lamiaceae*) is a perennial shrub which grows wild in southern Europe, the Caucasus, and northern Africa. It is a well-known aromatic plant, frequently used as traditional medicinal herb and spice. *Thymus vulgaris* (thyme) is used in folk medicine for its expectorant, antitussive, antibroncholitic, antispasmodic, anthelmintic, carminative and diuretic properties. Antimicrobial activities of the savory and thyme essential oils were individually evaluated against twelve *Candida* strains, using a broth-microdilution method. Growth inhibition, time-kill curve analysis and inhibition of germ tube formation were evaluated. In this study, the synergistic activity of the mentioned essential oils was investigated, as well as the potential anti-biofilm activity against various *Candida* isolates. The oil of *S. montana* exhibited higher antimicrobial activity than the thyme oil. Obtained MICs varied among the strains, but the oil of *S. montana* generally exhibited high anticandidal potential (0.312-1.250 mg/ml). When the oils were applied in combination, a high synergistic effect was observed. Both oils significantly decreased the biofilm formation in all investigated *Candida* strains and also completely inhibited germ tube formation after 2 h and 4 h. The observed anti-virulence activities demonstrated the high potential of these two oils as natural anticandidal agents.

Acknowledgments. This work was funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Project No. 172061)

Dietary polyphenolics in soybean wild relatives (*Glycine soja* Sieb. & Zucc.)

Malenčić, Đ.[1], Šućur, J.[1], Torović, Lj.[2], Đorđević, V.[3], Miladinović, J.[3]

[1]Faculty of Agriculture, University of Novi Sad, Trg D. Obradovića 8, 21000 Novi Sad, Serbia

[2]Faculty of Medicine, University of Novi Sad, Hajduk Veljkova 3, 21000 Novi Sad, Serbia

[3]Institute of Field and Vegetable Crops, M. Gorkog 30, 21000 Novi Sad, Serbia

* *malencic@polj.uns.ac.rs*

Soluble free polyphenols, PVPP-bound tannins, total flavonoids, isoflavones, anthocyanins and proanthocyanidins content, as well as the DPPH- and ABTS-radical scavenging capability of the *Glycine soya* were analyzed. The seeds of soybean wild relatives (genotypes Amur, Primorje and Habarovsk) originate from russian Far East (Manchuria). It is the closest living relative of soybean (*Glycine max*). One commercial cultivar (Atlas) was analyzed as well, for comparison reason. All specimens were grown at the Institute for Field and Vegetable Crops, Novi Sad. The most significant difference between wild and commercial soybean seeds was established in proanthocyanidin content; it varied from 2.76 (Atlas) up to 101.11 mg catehin g-1 d.s. (Habarovsk). Also, the values for anthocyanins content in wild relatives was 2 to 5-fold higher compared to Atlas. HPLC analysis showed that the most represented anthocyanins were cyanidin- and delphinidin-3-glucosides. Due to high levels of natural antioxidants of polyphenolic origin, the values for DPPH- and ABTS-radical scavenging activities were 15 to 40-fold higher in wild relatives. According to results obtained genotype Amur stands out. The obtained data should enable the selection of the wild genotypes rich in biologically active compounds that could further be processed into functional food, but also for the breeding purposes.

New insights into biological potential of *Juniperus communis* L. var. *saxatilis* Pall. from Stara Planina Mt: *in vitro* cytotoxic and antimicrobial effect

Nikolić, B.[1], Vasilijević, B.[1], Knežević-Vukčević, J.[1], Orčić, D.[2], Ćirić, A.[3], Džamić, A.[1], Anačkov, G.[2], Rajčević, N.[1], Mitić-Ćulafić, D.[1]

[1]University of Belgrade-Faculty of Biology, Studentski trg 16, 11000 Belgrade, Serbia

[2]Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia

[3]University of Belgrade-Institute for Biological Research "Siniša Stanković", Bulevar Despota Stefana 142, 11000 Belgrade, Serbia

* *biljanan@bio.bg.ac.rs*

Plant material, collected in July 2014 near the peak Babin Zub, was used to prepare essential oil (EO) and post-distillation waste (PDW). GC-MS determined α-pinen as dominant EO constituent, while LC-MS/MS pointed at rutin and quinic acid as the most abundant in PDW. Strong antioxidativity of PDW was determined in DPPH (IC_{50} 5.27µg/mL) assay. Cytotoxicity against carcinoma cells of lung (A549) and colon (HT-29 and HCT116), and normal fibroblasts (MRC-5), pointed at remarkably higher effectivity of EO (IC_{50} range 69-160µg/mL). Binary mixtures of EO/PDW with doxorubicin induced clear synergism, being more pronounced in cancer A549 cells than in normal fibroblasts. Microdilution assay performed on selected fungal and bacterial strains showed that PDW induced moderate antimicrobial effect against fungi (MICs and MFCs ranging between 118-900µg/mL) and *Listeria monocytogenes* (MIC/MBC were 390/740 µg/mL). Combinations of EO/PDW with selected antibiotics induced synergistic antilisterial activity in checkerboard assay. High selectivity of PDW against fungi and *L. monocytogenes* was determined in respect to all used cells. In *in vitro* adhesion-inhibition assay PDW reduced adhesion of *L. monocytogenes* to colon cells (29-62% inhibition). Obtained results indicated that *J. communis* EO could be recommended for further anticancer study, while PDW should be considered as potential antimicrobial.

Acknowledgements. This work was supported by the Ministry of Science of Republic of Serbia, Project No. 172058.

Should we use teas or tinctures made of aromatic plants from Lamiaceae family for health-boosting?

Oalđe, M.*, Vuković-Gačić, B., Alimpić Aradski, A., Kolarević, S., Marin, P.D., Duletić-Laušević, S.

Institute of Botany and Botanical Garden "Jevremovac", University of Belgrade, Faculty of Biology, Studentski trg 16, Belgrade, Serbia

* *marianao@bio.bg.ac.rs*

Eighteen Lamiaceae species originating from Serbia which possess medicinal properties were selected for this research. The study was carried out in order to obtain data on different aspects of antioxidant activities of the selected species. Their ethanolic and aqueous extracts were subjected to the analysis of the content of total phenolics, phenolic acids, flavonoids and flavonols, as well as antioxidant, cytotoxic, antigenotoxic and genoprotective effects using a number of standard methods and tests performed both *in vitro* and *in situ*. Among the investigated species, both aqueous and ethanolic extracts of *Melissa officinalis*, *Mentha × piperita* and*Origanum vulgare* showed the greatest potential overall. *Salvia officinalis*, *Sideritis scardica* and *Teucrium montanum* extracts showed significant results when tested for their *in situ* bioactivities. When comparing the *in vitro*and *in situ* experiments, it can be noticed that they are more or less equal. Generally, slightly higher activities were found when ethanolic extracts were used, which might suggest that tinctures are more potent for health-boosting than teas. In summary, this study indicates the accurate application and usage of the investigated plants as teas and tinctures.

Acknowledgements. The authors are grateful to the Ministry of Education, Science and Technological Development of the Republic of Serbia for financial support (Projects No. 173029 and 172058).

The possibility of medicinal plants application in diabetes therapy – antioxidant and antihyperglycemic potential

Salaj, N., Srđenović Čonić, B., Bojić, J., Jeremić, K., Hitl, M., Gavarić, N., Božin, B.

[1]Department of Pharmacy, Faculty of Medicine, University of Novi Sad, Hajduk Veljkova 3, Novi Sad, Serbia

* *NEBOJSA.SALAJ@mf.uns.ac.rs*

Traditional medicinal plants are used as an additional form of type 2 diabetes therapy in which oxidative stress is one of the progression factors. The aim of the research was preliminary chemical characterization and evaluation of the antioxidant and antihyperglycemic potential of aqueous extracts of tea mixture marketed as remedy for treatment of diabetes, and its individual herbal components. The *in vitro* antioxidant activity was estimated by application of DPPH-, OH-, NO- and FRAP-tests. Preliminary chemical profiling of the extracts included quantification of total phenolics and flavonoids, while antihypereglycemic potential was estimated through determination of inhibition potential of α-amylase and α-glucosidase. The highest content of total phenolics and flavonoids was characteristic for *Phaseoli legumen* and correlated with strong antioxidant potential. The greatest anti-α-amylase potential was characteristic for *Betulae folium* and *Phaseoli legumen* extracts, while the greatest anti-α-glucosidase potential has been recorded for the *Olivae folium* extract. High ratio (40%) of*Olivae folium* and *Phaseoli legumen* in the tea mixture leads to the conclusion that these drugs mostly contribute to its antioxidant and anti-hyperglycemic effects.

Chemotaxonomy of genus *Hypericum* – *Drosocarpium* section. Samples originating from central part of Balkan Peninsula

Kladar, N.[1,2], Salaj, N.[1], Srđenović Čonić, B.[1,2], Hitl, M.[1], Gavarić, N.[1,2], Anačkov, G.[3], Božin, B.[1,2]

[1]University of Novi Sad, Faculty of Medicine, Department of Pharmacy, Hajduk Veljkova 3, Novi Sad, Serbia

[2]University of Novi Sad, Faculty of Medicine, Center for Medical and Pharmaceutical Investigations and Quality Control, Hajduk Veljkova 3, Novi Sad, Republic of Serbia

[3]University of Novi Sad, Faculty of Sciences, Department of Biology and Ecology, Trg Dositeja Obradovića 3, Novi Sad, Serbia

* *nebojsa.kladar@mf.uns.ac.rs*

The *Hypericum* genus includes around 500 widely distributed species classified into 36 sections. Numerous attempts were made in order to identify specific chemotaxonomic markers which would be of significance for infrageneric classification of species, but this resulted only in partial success. The aim of the present study was detailed chemical characterization of *Drosocarpium* section representatives of *Hypericum* genus. Total of 65 samples representing nine different taxa were collected at several localities in central part of Balkan Peninsula and characterized by HPLC-DAD method. The obtained chemical profiles describing the amounts of hypericin, hyperforin and flavonoids (or their glycosides) were evaluated by methods of multivariate statistics. The results showed that the selected compounds have the potential to distinguish certain taxa from other, but this contribution is still limited since no complete separation of taxa was recorded. Hypericin and hyperforin were the compounds which mostly affected the discrimination of samples. This confirms their importance as chemotaxonomic markers of the genus and gives a reason to hypothesize that some other compounds belonging to classes of naphtodianthrones or phloroglucinols might represent a key for intra-sectional classification of *Drosocarpium* species.

Acknowledgements. Project of the Ministry of Education, Science and Technological Development, Republic of Serbia (Grant No 172058) „The biologically active natural products as potential sources of new medicines and dietary supplements“ supported this research.

Effects of *Satureja montana* L. essential oil against *Klebsiella pneumoniae* clinical isolates: anti-virulence and synergistic potential

Pejčić, M., Stojanović-Radić, Z., Dimitrijević, M., Stojković, O.

Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *milicapejcic1991@gmail.com*

Klebsiella pneumoniae is a Gram-negative pathogen usually associated with pneumonia, urinary tract, and nosocomial infections. The virulence of *K. pneumoniae* strains is related to its capability to form a capsule and/or biofilm. Therefore, the aim of the present study was to evaluate the antibacterial, anti-virulence and synergistic potential of *Satureja montana* essential oil against *K. pneumoniae* isolates. Antimicrobial efficacy of the essential oil was investigated by determining the minimal inhibitory concentrations (MICs) using the microdilution method. Obtained MICs were further used to study a potential synergistic interaction of the oil and antibiotic ciprofloxacin. The anti-virulence activity of the essential oil was tested by on biofilm production and degradation of mature biofilms, as well as on the formation of the capsule. The results showed a high antibacterial potential (1.5-5.00 mg/ml) of the tested oil and synergistic effect in combination with the ciprofloxacin. The biofilm experiments demonstrated a high oil's activity by inhibiting up to 80.14% of the biofilm production. The reduction of 12.16-71.5% was measured after application of oil to mature biofilm. In the presence of oil, changes in the formation of the capsule were not observed. Therefore savory oil presents a promising supporting agent for the treatment of persistent infections caused by Klebsiella strains.

Acknowledgments. This work was funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Project No. 172061)

Antibiofilm activity of *Verbascum pinnatifidum* Vahl. ethanolic extracts

Göse, M.[1], Hacioğlu Doğru, N.[2]

[1]Graduate School of Natural and Applied Sciences, Çanakkale Onsekiz Mart University, Çanakkale, Turkey

[2]Department of Biology, Faculty of Arts and Sciences, Çanakkale Onsekiz Mart University, Çanakkale, Turkey

* *nurcihan.n@gmail.com*

Microbial biofilms pose health risks in clinical environments, food industry and drinking water systems. Microorganisms within biofilms more resistant to antibiotics and chemical agents than planktonic cells in suspension. New alternatives for controlling infections have been proposed focusing on the therapeutic properties of medicinal plants and their antibiofilm avtivities. Here, we investigated *in vitro* antibiofilm activities of ethanolic extract of *Verbascum pinnatifium* Vahl. Antibiofilm activities of the ethanolic extract were determined for *Escherichia coli* NRRL B-3704, *Pseudomonas aeruginosa* ATCC 27853, *Proteus vulgaris* ATCC 13315, *Acinetobacter baumanii*ATCC 19606, *Bacillus subtilis* ATCC 6633, *Staphylococcus aureus* ATCC 25923, *S. haemolyticus* ATCC 43252 and Candida *albicans* ATCC 10231 test microorganismsbased on crystal violet binding assay. The highest antibiofilm activity against biofilm formed by *B. subtilis* ATCC 6633 and *S. haemolyticus* ATCC 43252 at lowest MIC value 2.5 µg/mL and 10 µg/mL, respectively. The current findings indicated that biofilm forming of bacteria could be potentially be managed using *V. pinnatifium* plant extracts.

Acknowledgments. This investigation is a part of Master thesis of Mehmet GÖSE. This study was financially supported by the Çanakkale Onsekiz Mart University Scientific Research Projects Coordination Unit, Turkey (FYL-2018-2693).

First insight into essential oil variability of *Juniperus sabina* var. *balkanensis* from Serbia

Rajčević, N., Janaćković, P., Dodoš, T., Marin, P.D.

University of Belgrade - Faculty of Biology, Institute of Botany and Botanical Garden "Jevremovac", Department of Morphology and Systematics of Plants, Studentski trg 16, 11000 Belgrade, Serbia

* *nemanja@bio.bg.ac.rs*

Juniperus sabina L. is a smooth leaf-margined prostrate juniper growing in Eurasia - from Spain through the south of Europe and Kazakhstan to western China, Mongolia and Siberia. Because of the very fragmented natural range, there is a significant difference between distant populations. Until recently, two varieties, aside from the typical *J. sabina*, have been recognised - *J. sabina* var. *arenaria* (E.H. Wilson) Farjon and *J. sabina* var. *davurica* (Pall.) Farjon. However, recent research of molecular markers has yielded another possible variety - *J. sabina* var. *balkanensis* R.P.Adams, with distribution range in the Balkan Peninsula. The object of this research was to look into leaf essential oil variability of a population from Serbia. The essential oil was obtained from 20 individuals from Resavska gorge using hydrodistillation. The composition was analysed by GC/MS and GC/FID. In the leaf essential oil between 62 and 84 compounds were identified, representing 98.5% of the total oil content. The oil was dominated by oxygenated terpenes. Monoterpenes (56.5%) dominated the essential oil profile, followed by diterpenes (18.4%). In most samples, *trans*-sabinyl acetate was the dominant compound, while sabinene was dominant in only 10% of the samples.

Acknowledgements. This work was supported by Serbian Ministry of Education, Research and Technological Development (Grant No. 173029).

POSTER PRESENTATION

Heavy metals in *Morchella esculenta* mushrooms from Serbia

Mitić, V.*, Stankov Jovanović, V., Cvetković, J., Dimitrijević, M., Zlatanović, I., Stojanović, G.

Department of Chemistry, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *violetamitic@yahoo.com*

Mushrooms have been a food supplement in various cultures, being cultivated and eaten for their delicacy and beneficial effect on health. *Morchella esculenta*, is a species of fungus in the Morchellaceae family of the Ascomycota. including polysaccharides, proteins, all important vitamins, trace elements, dietary fibers and aromatic compounds. It is one of the most important and economically beneficial wild species of mushroom characterized bynutritional and medicinal values. Due to the impact of heavy metals on the metabolism it is important to determine their concentration in food. Therefore, the aim of this research was to determine the concentration of heavy metals in *M. esculenta*. The most abound heavy metals were essential metals which play an important role in biological systems (Fe 136.655, Zn 85.361 and Cu 51.027 μg/g d.w). The contents of Cr, Cd, Ni and Mn were 1.297, 1.339, 2.669, 8.779 μg/g d.w, respectively. The lowest concentration (0.404 μg/g d.w) was determined for Ag. Concentrations of As and Ga were under the detection limit of the used method. Our results are in the range of previously published results or lower than them.

Acknowledgements. The authors are grateful to the Ministry of Education, Science and Technological Development for financial support through the grant within frame of basic research, No 172047 and 172051.

Antioxidant systems of three invasive ragweeds from the Vojvodina province: *Ambrosia artemisiifolia*, *A. trifida* and *Iva xanthifolia*

Kiprovski, B.[1], Malenčić, Đ.[2]*, Luković, J.[3], Boža, P.[3]

[1]Institute of Field and Vegetable Crops, Maksima Gorkog 30, 21000 Novi Sad, Serbia

[2]Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia

[3]Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 2, 21000 Novi Sad, Serbia

* *malencic@polj.uns.ac.rs*

The combination of reproductive success with high stress tolerance (through osmotic adjustment and antioxidants) is essential for invasion success, particularly in stressful environments in the frame of global change.Antioxidant capacity could be a possible marker of adaptation to variable environmental conditions, since change in amount of antioxidants represents one of the first responses to various environmental stimuli. Among investigated ragweeds, I. xanthifolia leaves had more pronounced guaiacol-peroxidase (GPx) activity (2.5- to 9.7-fold) than *A. artemisiifolia* and *A. trifida*. *A. artemisiifolia* and *I. xanthifolia* leaves have similar reduced glutathione (GSH) content (13.05 µmol g-1 fr. w.), while A. trifida had 1.3-fold lower GSH concentration. However, superoxide-dismutase (SOD) activity was invariable in all investigated plants (234.1-247.5 U g-1 fr. w.). The highest content of total phenolics, tannins, flavonoids and proanthocyanidins were detected in *A. trifida* leaves (up to 3.7-fold the amount of the others). According to antioxidant activity (O2.-, .OH and DPPH-scavenging tests), investigated ragweed species could be presented in a scale: *A. trifida* > *I. xanthifolia* > *A. artemisiifolia*. Accumulation of non-enzymatic antioxidants and lower content of GSH point to different oxidative stress avoidance strategies of *A. trifida* when compared to *A. artemisiifolia* and *I. xanthifolia* within the same environmental conditions.

Composition and antimicrobial activity of lavender, *Lavandula angustifolia* Mill. (Lamiaceae) essential oil against standard strains and wound isolates of bacteria

Marčetić, M.[1], Obradović, M.[1], Tomić, E.[1], Teovanović, A.[2], Lakušić, B.[3], Božić, D.[2]

[1]Department of Pharmacognosy, University of Belgrade-Faculty of Pharmacy, V. Stepe 450, Belgrade, Serbia

[2]Department of Microbiology and Imunnology, University of Belgrade-Faculty of Pharmacy, V. Stepe 450, Belgrade, Serbia

[3]Department of Botany, University of Belgrade-Faculty of Pharmacy, V. Stepe 450, Belgrade, Serbia

* *mirjana.marcetic@pharmacy.bg.ac.rs*

Lavender flower and essential oil are traditionally used for relief of mild mental stress and to aid sleep. *Staphylococcus* spp. are part of skin microbiota and frequent contaminants of the wounds. The aim of the study was to investigate the composition and antimicrobial activity of lavender oils on standard strains of bacteria, wound isolates of *Staphylococcus epidermidis* and *S. aureus* and also the activity of the oil in the combination with gentamicin. The essential oils were analysed by GC-FID/GC-MS. Sensitivity of seven standard bacterial strains and eight wound isolates of staphylococci were examined by disk-diffusion or broth-microdilution method. The dominant components in the essential oils of lavender flower were: linalool, linalyl acetate and camphor and in oil of leaves and stems borneol, 1,8-cineol and camphor. The essential oil of lavender inhibited the growth of laboratory bacterial strains (MIC 0.125 – 1 mg/ml). The best activity (0.125 mg/ml) was obtained with commercial samples that contained higher content of camphor and borneol. The essential oil of lavender flower (2%) inhibited the growth of multiresistant wound isolates of staphylococci. Significant synergistic effects against *Staphylococcus* spp. were observed in combinations of subinhibitory concentrations of essential oils (15.6 – 31.2 μg/ml) and gentamicine (0.06 – 0.25 μg/ml).

Acknowledgements. This work was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Project No. 173021).

Composition of the essential oil of *Satureja kitaibelii* Wierzb. ex Heuff.

Stanisavljević, D.M.[1], Đorđević, S.M.[2], Zlatković, I.D.[1], Ranđelović, N.V.[3], Veličković, D.T.[1]

[1]College of Agriculture and Food Technology, 1 Ćirila i Metodija St, Prokuplje, Serbia

[2]Institute for Medicinal Plant Research "Dr Josif Pančić", 1 Tadeuša Košćuška St, Belgrade, Serbia

[3]University of Niš, Faculty of Sciences and Mathematics, 33 Višegradska St, Niš, Serbia

* *draganastanisavljevic72@gmail.com*

Satureja kitaibelii Wierzb. ex Heuff. (according to Silic a species, according to the Flora of Europe a subspecies of *S. montana* L. ssp. *kitaibelii* (Wierzb.) P.W. Ball, and according to the Flora of Serbia a variety of *S. montana* var. *kitaibelii* Wierzb, is a perennial plant which is a low-growing shrub of 30-50 cm in height with well-developed root system. The over ground part of S. kitaibelii in the phenological phase of the blooming were gathered from the region of the municipality of Niš (locality Mt. Suva planina, 1317 m.a.s.l.). Essential oil was isolated by hydrodistillation in apparatus according to Clevenger under Ph. Eur. Qualitative and quantitative analysis of chemical composition of the essential oil was carried out using GC/FID and GC/MS. The number of registered and identified components in essential oil was 27. Monoterpenes were dominating (72.9%) in comparison to sesquiterpenes (27.2%). The main component in essential oil was trans-geraniol (36.1%). Apart from dominating trans-geraniol, there were also sesquiterpenes, γ-muurolene (8.9%) and trans-caryophyllene (4.7%). The content of isolates is important in the contest of their use in medicinal purposes, in industry as raw material, and in cookery where the quality of products highly depends on chemical content of isolates.

Acknowledgements. The Ministry of Education, Science and Technological Development of the Republic of Serbia supported this study through the projects no. 172047 and 46001.

Comparative study of the chemical composition of *Acinos alpinus* essential oil and methanolic extract

Golubović, T.[1], Kitić, D.[2], Stojanović G.[3], Zlatković, B.[4]

[1]Faculty of Occupational Safety, University of Niš, Čarnojevića 10 a, Niš, Serbia

[2]Department of Pharmacy, Faculty of Medicine, University of Niš, Bulevar Zorana Đinđića 81, Niš, Serbia

[3]Department of Chemistry, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

[4]Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *acinos2002@gmail.com*

The essential oil from aerial parts of *Acinos alpinus* (L.) Moench was analysed by GC and GC/MS. Forty-eight constituents were identified, representing 93.3% of the oil. The major component was thymol (13.0%). Furthermore, the presence of α-terphinyl acetate (8.3%), borneol (6.7%) and β-caryophyllene oxide (5.7%) were noted as additional significant constituents. The oxygenated monoterpenes were the most abundant compounds (62.7%). Among sesquiterpenes (30.6%), oxygenated sesquiterpenes were present with 20.1% and sesquiterpene hydrocarbons with 10.5%. The qualitative and quantitative analysis of the methanolic extract, performed by GC and GC/MS indicated that the most abundant compounds in *Acinos alpinus* methanolic extract were thymol (31.5%), borneol (14.6%) and spathulenole (14.6%). The contents of germacrene D (9.6%), caryophyllene oxide (9.1%) and hexadecanoic acid (8.4%) were significant. The main group of compounds was monoterpenes (49.3%), among them oxygenated monoterpenes were present in the highest percentage (48.3%). As far as sesquiterpenes (37.4%) are concerned, substantial part belongs to oxygenated fraction (25.8%). Metanol extract of *Acinos alpinus* as well as essential oil may be considered as a potential sources of thymol.

Acknowledgements. This research was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grants No. OI 172047 and No. III 41018).

Antioxidant activity of *Cistus salviifolius* and *C. creticus* extracts

Jelena S. Matejić, J.S.[1], Žarković, L.D.[2], Marković, M.G.[1], Jovanović, M.S.[1], Zlatković, B.K.[3], Marin, P.D.[2], Džamić, A.M.[2]

[1]University of Niš, Department of Physics and Biology with human genetics, Faculty of Medicine, Bulevar dr Zorana Đinđića 81, 18000 Niš, Serbia

[2]University of Belgrade, Faculty of Biology, Institute of Botany and Botanical Garden "Jevremovac", Studentski trg 16, 11000 Belgrade, Serbia

[3]University of Niš, Department of Biology and Ecology, Faculty of Science and Mathematics, Višegradska 33, 18000 Niš, Serbia

* *jekamatejic@gmail.com*

The present study describes the antioxidant capacity of the ethanolic and ethyl acetate extracts obtained from the aerial parts of *Cistus salviifolius* L. and *C. creticus* L. Plant material was collected in Greek islands Skopelos and Crete. The extracts were prepared using ultrasonic assisted extraction, with 70% ethanol and ethyl acetate. Spectrophotometric methods were used for measuring the antioxidant potential through DPPH, ABTS and β-carotene assays. Antioxidant activity of ethanol extract from *C. salviifolius* was better than those obtained for ethyl acetate extract. In DPPH, ABTS and β-carotene tests, results expressed as IC50 showed IC50 0.111 mg/ml, IC50 0.188 mg/ml and IC50 0.485 mg/ml, respectively. The ethanolic extract from *C. creticus* also showed higher antioxidant potential in relation to the ethyl acetate extract, with the obtained values in DPPH assay IC50 0.184 mg/ml; in ABTS assay IC50 0.221 mg/ml; and in β-carotene IC50 0.365 mg/ml. Ethanolic extract of *C. salviifolius* and *C. creticus* showed good antioxidant activity. Due to the ability to neutralize free radicals, ethanolic extracts of analyzed *Cistus* taxa represent a potential agents for the prevention of diseases caused by oxidative stress.

Acknowledgments. The authors are grateful to the Ministry of Education, Science and Technological Development of the Republic of Serbia for financial support (Grant No. 173029).

Influence of the Time of Maceration on Phenolic Composition of Wines Produced from the Indigenous Variety Prokupac

Nikolić-Milojević, N.Lj.[1], Mošić, I.S.[2], Davidović, D.N.[3], Karabegović, I.T.[4], Lazić, M.L.[4], Nikolić, N.Č.[4], Veličković, D.T.[3]

[1]Status doo, 65a Vase Albanca St, Svrljig, Serbia

[2]Aromatika doo, Jadranska St, Niš, Serbia

[3]College of Agriculture and Food Technology, 1 Ćirila i Metodija St, 18400 Prokuplje, Serbia

[4]Faculty of Technology, University of Niš, 128 Bulevar oslobođenja St, Leskovac, Serbia

* *dvelickovic7@ptt.rs*

The influence of the time of maceration on phenolic composition of wine produced from the indigenous variety Prokupac was studied in this paper. A large number of factors affect the degree of extraction: maceration time, temperature, pumping-over, application of pectolytic enzymes and sulfating, etc. The time of maceration affects phenolic composition of produced white, rosé and red wine. White wine was produced from free run, without maceration. In the production of rosé wine, cool-temperature extraction prior to fermentation in 2-hour period was used, while for the production of red wine, maceration was carried out at 15-20˚C for 2 weeks.

With the increase of the time of maceration, the concentration of total phenolic compounds also increases, whereby, the lowest content was detected in white wine (565.4 mg/L GAE). The phenolic content in red wine was almost 2.5 times higher when the time of maceration was extended to 14 days (1433.8 mg/L GAE). A significant increase in total flavonoides content was detected: 153.4 mg/L CE (white wine), 179.3 mg/L CE (rosé wine), and 1205.0 mg/L CE (red wine). The total flavonoid share in total phenolic content of the wine increases with the increase of the time of maceration and its value is as follows: 27.1 % (white wine), 34.3 % (rosé wine) and 84.0 % (red wine).

Acknowledgements. This study was funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Project No. 172047).

DNA-protective effect of methanol extracts of various plant organs of *Nepeta cataria*

MihovićN.[1], Matić, S.[2]*, Mladenović, M.[1], Stanković, N.[1], Stanić, S.[2], VukoviĆ, N.[1]

[1]University of Kragujevac, Faculty of Science, Department of Chemistry, P.O. Box 60, 34000 Kragujevac, Serbia

[2]University of Kragujevac, Faculty of Science, Department of Biology and Ecology, P.O. Box 60, 34000 Kragujevac, Serbia

* *sanjamatic@kg.ac.rs*

Many plant extracts have been shown to exert a number of biological properties. In the present study in vivo antigenotoxic potential of stem, flower and leaves extracts of *Nepeta cataria* L. (Miljevici village, Serbia, altitude 920 m, 43º22'07"N, 19º35'25"E, Jun 2014) was evaluated against carbon tetrachloride (CCl4)-induced DNA damages in liver of albino Wistar rats using the comet assay. Extracts of stem, flower and leaves of *N. cataria* at doses of 50, 100, and 200 mg/kg body weight were orally administered to Wistar rats once daily for 5 days before they were treated with CCl4. A significant increase of DNA damage in the liver occurred after CCl4 administration was significantly lowered by treatment with the extracts of N. cataria. Administration of different doses of *N. cataria* flowers extract prior to CCl4 led to a significant reduction in DNA damage when compared to the group treated only with CCl4 with percentage reduction above 50%. The present study has demonstrated that *N. cataria* stem, flower and leave extracts possess antigenotoxic effect.

Acknowledgments. This work was supported by the Ministry of Education, Science and Technological Development, Republic of Serbia, Grants No. III43004 and III41010.

Chemical analysis and cytotoxity of *Rumex balcanicus* Rech.F. (Polygonaceae)

Arsenijević, J.[1], Stanojković, T.[2], Ranđelović, R.[3], Kundaković-Vasović, T.[1]

[1]Department of Pharmacognosy, University of Belgrade-Faculty of Pharmacy, Vojvode Stepe 450, Belgrade, Serbia

[2]Institute of Oncology and Radiology of Serbia, Pasterova 14, Belgrade, Serbia

[3]Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, Serbia

* *tatjana.kundakovic@pharmacy.bg.ac.rs*

Rumex balcanicus Rech.f. (Polygonaceae) is an endemic species that inhabits central parts of Serbia and Kosovo. The genus *Rumex* is characterizied by the accumulation of anthraquinones, naphthalene-1,8-diols, flavonoids and stilbenoids. Aerial parts of *R. balcanicus*, collected on Vlasina Lake (Serbia) in 2014, were used to determine the chemical composition and cytotoxic activity. Cyclohexane, dichloromethane, methanol and aqueous extracts were prepared and tested using MTT-test, against human epithelial cervical cancer cells (HeLa), human colon carcinoma cell line (LS174), human non-small cell lung cancer cells (A549) and healthy MRC-5 human embryonic lung fibroblast cell line. Methanol and aqueous extracts were analyzed using LC-MS. In tested extracts, caffeic acid derivates and flavonol derivatives were identified. The main components in both extracts were rutin, miquelianin, quercitrin and quercetin 3-O-acetyl-rhamnoside. Caffeic acid and its glycosides were also present in analyzed extracts. Aqueous extracts had no cytotoxicity against tested cell lines, while cyclohexane, dichlormethane and methanol extracts were active against all tested cell lines with IC_{50} ranged from 116.48±3.26 μg/mL to 178.21±1.30 μg/mL. Due to the presence of flavonoids and exhibited cytotoxic effect, *R. balcanicus* herba could be interesting as a plant material for further pharmacological analysis and isolation of the anti-tumor compounds.

Acknowledgements. The authors are grateful to the Ministry of Education, Science and Technological Development of Serbia for financial support (Grants Nos 173021 and 34012).

Pharmacological activity of *Rumex balcanicus* Rech. F. (Polygonaceae)

Radović, J.[1], Milenković, M.[2], Ranđelović, V.[3], Kundaković-Vasović, T.[1]

[1]Department of Pharmacognosy, University of Belgrade-Faculty of Pharmacy, Vojvode Stepe 450, Belgrade, Serbia

[2]Department of Microbiology and Immunology, University of Belgrade-Faculty of Pharmacy, Vojvode Stepe 450, Belgrade, Serbia

[3]Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, Serbia

* *tatjana.kundakovic@pharmacy.bg.ac.rs*

Recent studies demonstrated that *Rumex* species exhibit various pharmacological activities, such as antiinflamatory, antioxidant, anticancer, antimicrobial, but there are almost no data on pharmacological activities of Balcan endemic species *Rumex balcanicus*. Thus, the aim was to examine antioxidant activity, using DPPH and FRAP method, antimicrobial activity via broth microdilution method and α-amylase inhibitory activity using DNS reagent of aqueous and methanol extracts of roots and aerial parts of *R. balcanicus*, collected on Vlasina Lake in 2014. All tested extracts exhibited high antioxidant activity which has been correlated with the high content of polyphenols. Aqueous extracts exhibited lower activity compared to methanol extracts. Methanol extract of*R. balcanicus* roots showed the highest activity, both in DPPH (IC_{50}= 9.57 µg/mL) and FRAP test (IC_{50}=3.98 µmol Fe/mg of extract), while aqueous extract of aerial parts showed the lowest activity (IC_{50}= 24.73 µg/mL; IC_{50}=2.11 µmol Fe/mg). Only methanol extract of aerial parts showed α-amylase inhibitory activity with IC_{50}=252 µg/mL. All extracts had low antimicrobial activity against almost all tested bacterial strains except against *Bacillus subtilis*. Positive results obtained in this study show that *R. balcanisus* contains potential as a new raw material and for the development of drugs efficient in treating diabetes.

Acknowledgements. The authors are grateful to the Ministry of Education, Science and Technological Development of Serbia for financial support (Grants Nos 173021 and 34012).

Chemical constituents of the essential oil from fresh aboveground parts of *Erigeron annuus* (L.) Pers. (Asteraceae) from southeastern Serbia

Nikolić, M.; Radulović, N.

Department of Chemistry, Faculty of Science and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

**: milica.nikolic.1990@gmail.com*

Erigeron annuus (L.) Pers. (Asteraceae), daisy fleabane, is a widespread herbaceous annual plant species, that represents an invasive weed in Serbia. It has been used in traditional medicine as a diuretic, as well as a treatment for diarrhea and kidney stones. Thus far, a number of researchers have analyzed the composition of the essential oil of this plant taxon, and these studies revealed a great variation in the content and identity of its volatile constituents. Hydrodistillation of the fresh inflorescence and leaf of *E. annuus*, collected at the beginning of the flowering phase from a wild-growing population in Serbia (Oblačina Lake, near Niš), yielded a small amount of greenish essential oil (0.105%, w/w). Detailed GC and GC-MS analysis of the obtained essential oil revealed polyacetylenes as one of the major chemical classes detected. The main constituents of the essential oil were found to be germacrene D (38.6%), (*Z*)-lachnophyllum ester (8-dihydromatricaria ester; 25.2%) and (*Z*,*Z*)-matricaria ester (3.7%). C_{10} polyacetylenes seem to be typical of Astereae, with matricaria ester-related compounds as the most widespread ones.

Acknowledgment. The authors acknowledge the Ministry of Education, Science and Technological Development of Serbia for financial support (project 172061).

The essential oil of *Pulicaria vulgaris* Gaertn. (Asteraceae): composition, and structural elucidation of a new bioactive presilphiperfolane diol

Mladenović, M.Z.[1], Radulović, N.S.[1], Stojanović, N.M.[2], Ranđelović, P.J.[3], Blagojević, P.D.[1]

[1]Department of Chemistry, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

[2]Faculty of Medicine, University of Niš, Bulevar dr Zorana Đinđića 81, Niš, Serbia

[3]Department of Physiology, Faculty of Medicine, University of Niš, Bulevar dr Zorana Đinđića 81, Niš, Serbia.

* *markohem87@gmail.com*

The genus *Pulicaria* (tribe Inuleae of the Compositae family) consists of *ca.* 100 species with a distribution from Europe to North Africa and Asia [1]. A number of compounds from *Pulicaria* species possess significant bioactivities, and they could be promising candidates for the development of potential drugs [1]. In the continuation of our investigations of the secondary metabolites of plant taxa from the Serbian flora, we have studied the chemical composition of *Pulicaria vulgaris* Gaertn. essential oil. *Pulicaria vulgaris* is a rare plant species, with golden-yellow flowers, growing on sandy, stony places. To the best of our knowledge, there are no previous studies on either the volatile or nonvolatile secondary metabolites of this species. Analyses by GC and GC/MS of an essential-oil sample obtained from air-dried aerial parts allowed the identification of 106 components (most of which were identified by at least two independent means). Sesquiterpenes constituted the most abundant compound class, representing 86.4% of the total essential oil. The bulk of the oil was comprised of two oxygenated sesquiterpenoids–*epi*-α-cadinol (23.3%) and presilphiperfolane-7,8-diol (46.4%). No plant species other than *P. vulgaris* are characterized by the presence of presilphiperfolane-7,8-diol. This fact may be of chemotaxonomic/biosynthetic significance.

Acknowledgments. This work was supported by the Ministry of Education, Science and Technological Development of Serbia [Project No. 172061].

Chemical composition and antimicrobial activity of diethyl ether and ethyl acetate extracts of *Artemisia scoparia* Waldst. et Kit.

Ickovski, J.D.[1], Stepić, K.D.[1], Petrović, G.M.[1], Đorđević, A.S.[1], Palić, I.R.[1], Stojanović, G.S.[1]

[1]Department of Chemistry, Faculty of Science and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

* *ivanpalic@yahoo.com*

Chemical composition of the essential oil of *Artemisia scoparia* was thoroughly studied by many researchers, while there are insufficient data about composition of the *A. scoparia* extracts. Volatiles of two different solvent extracts, diethyl ether (DE) and ethyl acetate (EE), were analyzed by GC and GC/MS. The number of identified components from DE was 127 (representing 93.8% of the total GC peak areas), while for EE extract that number was 10 (representing 97.5% of the total GC peak areas). In both, DE and EE, the main compound was scoparone (35.4%; 86.1%, respectively). Antimicrobial activity was tested against four bacterial strains (Gram-negative: *Escherichia coli* and *Salmonella abony*; Gram-positive: *Bacillus subtilis* and *Staphylococcus aureus*) and one fungal strain (*Candida albicans*), using disc-diffusion method. Both tested samples, DE and EE, were inactive against Gram-negative bacteria and they exhibited low activity against Gram-positive bacteria. In the case of antifungal testing, both of the examined extracts exhibit a high activity (inhibition zone was for DE 37 mm and for EE 32 mm)

Acknowledgments. Ministry of Education, Science and Technological Development of the Republic of Serbia [172047].

Cytotoxic and antimicrobial activity of selected *Hieracium* L. extracts and isolated sesquiterpene lactones

Milutinović, V.[1], Matić, I.[2], Grozdanić-Stanisavljević, N.[2], Stanojković, T.[2], Soković, M.[3], Ćirić, A.[3], Niketić, M.[4], Petrović, S.[1]

[1] Department of Pharmacognosy, University of Belgrade - Faculty of Pharmacy, Vojvode Stepe 450, 11221 Belgrade, Serbia

[2] Institute of Oncology and Radiology of Serbia, Pasterova 14, 11000 Belgrade, Serbia

[3] University of Belgrade, Institute for Biological Research "Siniša Stanković", Bulevar Despota Stefana 142, 11000 Belgrade, Serbia

[4]Natural History Museum, Njegoševa 51, 11000 Belgrade, Serbia

* *nadjagrozdanic@gmail.com*

Cytotoxic and antimicrobial activities were investigated for MeOH extracts of flowering aerial parts of *Hieracium calophyllum* R. Uechtr. (CAL), *H. coloriscapum* Rohlena & Zahn (COL), *H. pseudoschenkii* (Rohlena & Zahn) Niketić (PSE), *H. valdepilosum* Vill. s.l. (VAL) and *H. glabratum* Willd. (GLA), their two isolated sesquiterpene lactones 8-epiixerisamine A and crepiside E, as well as for CH_2Cl_2 extract of flowering aerial parts of *H. scheppigianum* Freyn (SCH). Crepiside E (IC_{50} = 46.00 µg/mL), COL (IC_{50} = 152.28 µg/mL) and SCH (IC_{50} = 148.12 µg/mL) showed the highest cytotoxic activity against HeLa cells in MTT test. The cytotoxic activity against LS174, A549, as well as against normal MRC-5 cells was significantly weaker. In microdilution test, crepiside E and 8-epiixerisamine A exhibited noteworthy antifungal effect against *Aspergillus ochraceus*, *Penicillium funiculosum*, *Candida albicans* and *C. krusei* (MIC = 0.15 - 0.4 mg/mL, MFC = 0.3 - 0.8 mg/mL). Among the extracts, the best antibacterial activity was shown by SCH and CAL against *Pseudomonas aeruginosa* (MIC = 1.68 and 2.52 mg/mL, MBC = 3.36 and 5.04 mg/mL), and the highest antifungal activity by SCH and VAL against *C. albicans* (MIC = 2.48 and 2.52 mg/mL, MFC = 4.96 and 5.04 mg/mL).

Acknowledgements. Ministry of Education, Science and Technological Development of the Republic of Serbia (Grants Nos. 173021, 175011, 173032).

Chemical composition and chemometric analysis of essential oils from four different *Citrus* species fruit

Sovrlić, M.[1], Arsenijević, J.[1], Novaković, S.[1], Kocović, A.[1], Tomović, J.[1], Rančić, A.[2]

[1]Faculty of Medical Sciences, University of Kragujevac, Department of Pharmacy, 34000 Kragujevac, Serbia.

[2]Institute of Public Health Kragujevac, 34000 Kragujevac, Serbia

* *sofke-ph@hotmail.com*

Fruits from *Citrus* species are used for centuries not only as food but also in perfume and beverage industry, in aromatherapy and as medication. Essential oils are one of the main ingredients of *Citrus* species fruits. Different citrus species have essential oils with different composition. Our goal was to investigate chemical composition of essential oils obtained from four different citrus species fruits. Essential oils were obtained by the steam distillation of peal (flavedo) of sweet orange (*Citrus sinensis*), mandarin (*Citrus reticulata*), lemon (*Citrus limon*) and lime (*Citrus aurantifolia*). Essential oils were analyzed by gas chromatography-mass spectrometry. There were 31 different compounds in all four essential oils. Two compounds, α-pinene and D-limonene, both monoterpenes were identified in all four essential oils and D-limonene was the most represented compound in all four analyzed essential oils in range between 47.5% in lime and 89.9% in sweet orange. Chemometric analysis included principal component analysis and hierarchical cluster analyses. Principal component analysis showed that there are three principal components which together explain 99.9% of variance. Hierarchical data analysis showed that there are two clusters in total. Parts of one cluster were lemon and lime essential oils and parts of the other one were sweet orange and mandarin essential oils. In conclusion, investigated essential oils differ and could be separated in two groups, although they originate from the same *Citrus* genus. Dominant component in all four essential oils is D-limonene.

Acknowledgements. This work was financially supported by Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant no. 172015).

Determination of chemical composition and antimicrobial, antioxidant and cytotoxic activities of lichen *Parmelia perlata*

Tomović, J.[1], Rančić, A.B.[1], Décor, R.[2], Vasiljević, P.[3], Manojlović, N.T.[1]*

[1]Department of Pharmacy, Faculty of Medicinal Sciences, University of Kragujevac, Svetozara Markovića 69, 34000 Kragujevac, Serbia

[2]B.C.T. consulting, Rue du 13 Aout 1956, 5000 Monastir, Tunisia

[3]Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

* *mtnedeljko@gmail.com*

The lichens synthesize a large number of secondary metabolites and most of these metabolites are unique to the lichen. The extracts of the lichens and their secondary metabolites exhibit a broad spectrum of biological activity (1). The aim of this study is to investigate the chemical composition of acetone and methanol extracts of the lichen *Parmelia perlata* and their antimicrobial, antioxidant, and anticancer activities. The phytochemical analysis of the extracts of *Parmelia perlata* lichen was determined by HPLC-UV method and FT-IC method. The predominant phenolic compounds in these extracts were salazinic acid and stictic acid. Besides these compounds, the tested extracts of these lichens contain atranorin and chloratranorin. The contents of total phenolics in the lichen extracts were in the range 89.26 to 94.26 mg GA/g. The lichen extracts showed comparable and strong antioxidant activity, exhibited higher DPPH and hydroxyl radical scavengings, chelating activity, and inhibitory activity towards lipid peroxidation. The lichen extracts demonstrated important antimicrobial activity against eight strains with MIC values from 19.53 to 312.5 μg/ml. Cytotoxic effects of lichens were tested against *Hep2c*, *RD* and *L2OB* cell lines the MTT method. Cytotoxic effects of *P. perlata* extracts toward three cancer cell lines were in the range from 76.33 to 147.17 µg/ml (IC_{50} values). The present study showed that tested extracts of lichen demonstrated an important antimicrobial, antioxidant and anticancer effects. That suggests that this lichen can be used as new sources of the natural antimicrobial agents, antioxidants and anticancer compounds.

Acknowledgments. This research was supported by the Ministry of Education and Science of Serbia, project number 172015.

HPLC profiles of *Umbilicaria crustulosa* and *U. cylindrica* extracts

Zlatanović, I.[1], Jovanović, O.[1], Zlatković, B.[2], Stojanović, G.[1]

[1]Department of Chemistry, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

[2] Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *ivana.z.988@gmail.com*

The aim of this study was to evaluate and compare HPLC profiles of acetone, ether, ethyl acetate and dichloromethane extracts of lichens *Umbilicaria crustulosa* and *U. cylindrica*. The main component of the acetone, ether and ethyl acetate extracts of *U. crustulosa* was gyrophoric acid (78%, 67.7% and 74.7%) followed by lecanoric acid (5.7, 11.9, 16.1%)), crustinic acid (2.8, 0.8, 2.6%) and a methyl-orsellinate (1.5, 8.6, 9.2%). Ether and ethyl acetate extracts of *U. cylindrica* contained norstictic acid (42.1% and 28.7%) as the main component followed by gyrophoric acid (23.5% and 17.8%) and salazinic acid (21.8% and 16.6%). On the other hand, in the acetone extract, gyrophoric acid was the main component (83.5%). Regarding the main components chemical composition of dichloromethane extracts was different comparing to acetone, ether and ethyl acetate extracts. Atranorin was the predominant component of both dichloromethane extracts (*U. crustulosa* 58.1%, *U. cylindrica* 53.2%). The obtained results indicate that a chemical composition is genetically determined since both samples were collected at the same site (E Serbia, Stara planina mountain, Babin zub, siliceous rocks, 1650 m, 43° 23' N, 22° 40' E) and the same time (May 2015).

Acknowledgments. The research was supported by the Serbian Ministry of Education, Science and Technology Development (Grant No. 172047).

Total phenol and flavonoid content, antioxidant and antitumor activity of *Rubus serpens* extracts

Veličković, I.[1], Grujić, S.[1], Žižak, Ž.[2] Marin, P.D.[1]

[1]University of Belgrade, Faculty of Biology, Institute of Botany and Botanical Garden „Jevremovac“, Studentski trg 16, 11000 Belgrade, Serbia

[2] Institute of Oncology and Radiology of Serbia, Pasterova 14, 11000 Belgrade, Serbia

* *ivona@bio.bg.ac.rs*

Rubus serpens is short plant with yellowish-green stems and leaves and rare white flowers. The aim of this study was to evaluate total phenol (TPC) and flavonoid (TFC) content in aqueous, ethanol and acetone leaf and fruit extracts, their antioxidant and antitumor properties. TPC and TFC were more abundant in leaf extracts, being the highest in acetone (338.31 mg GAE/g and 89.48 QE/g of d. w., respectively). The most promising antioxidant activity through three *in vitro* tests (DPPH, ABTS and FRAP) exhibited aqueous leaf extracts in contrast to aqueous fruit extract. Similarly, water and ethanol leaf extracts revealed antitumor properties on human carcinoma cell lines (HeLa, K562 and MDA-MB-453) by MTT assay. Additionally, treatment of HeLa cells for 24h with aqueous and ethanol leaf extracts induced typical morphological features of the late apoptosis (condensed nuclei) and increased number of cells in subG1 phase of cell cycle after 24h and particularly after 48h of incubation. The presented results indicate that *R. serpens* fruits and especially leaves are good source of biologically active compounds including phenols. Moreover, examined extracts possessed remarkable antioxidant and promising antitumor activity.

Acknowledgements: The authors are grateful to The Ministry of Education, Science and Technological Development for financial support of this work (Project No. 173029 and 175011).

Protoprophyrin ix photodegradation in methanol and methanol-lipid mixtures

Lazarević, A.[1], Petrović, S.[1], Stanojević, J.[1], Cvetković, D.[1], Cvijović, M.[2], Zvezdanović, J.[1]

1University of Nis, Faculty of Technology Leskovac

2University of Belgrade, Faculty of Medicine

* *acalazarevic92@hotmail.com*

Protoporphyrin IX (PPIX) is the last porphyrin intermediate in common for heme and chlorophyll biosynthesis. It normally does not accumulate in plants because highly photosensitizing - phototoxic nature. Recently were presented some herbicides causing accumulation of PPIX as phototoxic agent when illuminated by visible light. Therefore, PPIX photostability determination can be useful in applications studies as photosensitizing agent. For this study, two methanol solutions were used, with PPIX and with PPIX + lipid Phospholipon 90. Continuous illumination of PPIX solutions were performed in a cylindrical photochemical reactor with “Pure White” LED lamps (14 W m-2). For changes detection and kinetic analysis, absorption UV-VIS spectroscopy has been used. Continually illuminated PPIX undergoes slow degradation in both methanol solutions (continuous absorbance decrease at 400 nm), obeying first-order kinetics with the rate constants values: 0,00164 min-1 and 0,00133 min-1 (PPIX and PPIX+lipid), showing no significant difference between two different samples. Illumination treatment of PPIX+lipid mixture induces a lipid peroxidation process showing continuous absorbance growth at 235 nm, characteristic for the lipid peroxidation products, with first-order kinetics (0,0012 min-1). The degradation and lipid peroxidation kinetics seem to be related (order and similar rate constants values) implicating photosensitization as a step in both detected processes.

Acnowledgements. This work was supported by the Ministry of education, science and technological development of the Republic of Serbia project 34012.

Chemical composition of headspace fractions from fruits and roots of selected *Heracleum* taxa collected in Southeastern Europe and its chemosystematic significance

Ušjak, Lj.[1], Drobac, M.[1], Niketić, M.[2], Petrović, S.[1]

1 Department of Pharmacognosy, University of Belgrade - Faculty of Pharmacy, Vojvode Stepe 450, 11221 Belgrade, Serbia

2 Natural History Museum, Njegoševa 51, 11000 Belgrade, Serbia

* *ljubos@pharmacy.bg.ac.rs*

Headspace fractions of fruits and/or roots of *Heracleum sphondylium*, *H. sibiricum*, *H. montanum*, *H. ternatum*, *H. pyrenaicum* subsp. *pollinianum*, *H. pyrenaicum* subsp. *orsinii* and *H. verticillatum*, belonging to group *H. sphondylium*, and *H. orphanidis*, all from sect. *Heracleum*, as well as *H. austriacum* subsp. *siifolium* from sect. *Wendia* (from Serbia, Montenegro, North Macedonia or Slovenia) were isolated using automatic headspace sampler and analyzed by GC-FID and GC-MS. Chemosystematic significance of identified constituents was evaluated using multivariate statistics: PCA, nMDS and UPGMA. GC analysis of headspace fractions from 17 fruit samples of all investigated taxa showed that octyl acetate or α-pinene (sect. *Heracleum*), or *n*-octanol (*H. austriacum*) were the most abundant. The analysis of the fractions from 13 root samples of investigated taxa belonging to sect. *Heracleum* revealed prevalence of β-pinene or (*Z*)-β-ocimene (group *H. sphondylium*), or *n*-nonane (*H. orphanidis*). Statistical analysis of fruit fractions revealed separation of *H. austriacum* and *H. orphanidis* from investigated members of group *H. sphondylium*. Morphologically related *H. sphondylium* and *H. montanum* were grouped together and *H. verticillatum* was well separated from other representatives of group *H. sphondylium*. Complete separation of *H. sibiricum*, *H. ternatum* and *H. pyrenaicum* samples was noticed in root fractions statistical analysis.

Acknowledgements. This work was supported by Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 173021).

Sideritis montana L.: Antioxidant properties of extracts of different polarity

Ilić, M.[1], Marković, M.[2], Mitić, V.[3], Dimitrijević, M.[3*], Stojanović, G.[3], Stankov Jovanović, S.[3]

[1]Laboratory Sector, Laboratory for Analytical Chemistry, Veterinary Specialized Institute 'Niš', Dimitrija Tucovića 175, Niš, Serbia

[2]Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

[3]Department of Chemistry, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

**marija.dimitrijevic@pmf.edu.rs*

Plants have specific chemical composition which depends on plant species, habitat and series of environmental factors. Several studies have confirmed link between pollution and plants metabolism, which means changes in productions of some compounds, caused by permanently exposure to pollutants. The aim of this research is examination of antioxidant activity, total phenol and total flavonoid content in *Sideritis montana* from 3 localities: Kravlje, Gornje Polje (mine depot) and Rogoška čuka, after wildfire site. *S. montana* is very rich in phenolic compounds with very strong biological activity, and is commonly used because of the antispasmodic, carminative and antimicrobial effects. For estimation of antioxidant activities- DPPH, ABTS, CUPRAC and total reducing power of ferrous assays were used (TRP). Determination of total phenols content was done by Folin-Ciocalteau assay, and determination of total flavonoids was performed using $AlCl_3$ test. Antioxidant activity of plant *S. montana* was examined for extracts of different polarity (methanol, acetone, hexane). Methanol extracts of plant from mine depot and after wildfire site (showed the best activity (DPPH, ABTS, CUPRAC and TRP) and the highest phenols and flavonoids content versus the one which grew in unpolluted area ..The same trend was followed by other examined extracts, while hexane extracts have the smallest antioxidant activity.

Acknowledgements: The research was supported by the Serbian Ministry of Education, Science and Technology Development (Grants No 172047 and 172051).

Chemical composition of *Chaerophyllum coloratum* L. headspace volatiles

Stamenković, J., Petrović, G., Stojanović, G.

Department of Chemistry, Faculty of Science and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

* *jelena.stamenkovic@pmf.edu.rs*

The present study was carried out in order to determine the chemical composition of the headspace (HS) volatiles of *Chaerophyllum coloratum* L. obtained from fresh root, stem and inflorescences which have not been previously reported. The plant material was collected at the location Bioče, Podgorica (Montenegro) in June 2017. Three hundred mg of milled fresh plant material was put into 20 mL HS vial than soaked with 2 mL of distilled water. The sample was heated at 80°C for 20 minutes and 500 µL of vapor generated from the samples was drawn out from the vial using a gas-tight syringe (90°C) and injected directly in the chromatographic column via a transfer line (75°C). The samples were analyzed by a 7890/7000B GC/MS/MS triple quadrupole system in MS1 scan mode (Agilent Technologies, USA) equipped with a Combi PAL sampler and Headspace for G6501B/G6509B. In all samples, the most dominant components were monoterpene hydrocarbons representing over 98% of the identified volatiles. (Z)-β-Ocimene was the most dominant component of volatiles obtained from the stem and inflorescences, representing 69.3% and 43.3% of total volatiles, respectively. β-Pinene (38.1%), accompanied by p-Cymene (18.8%), γ-Terpinene (14.2%) and α-Pinene (12.7%), make up over 83% of the root HS volatiles.

Acknowledgment. The authors are grateful to the Ministry of Education, Science and Technological Development for the financial support through the grant No 172047.

GC/MS profile of *Anthriscus cerefolium* L. hexane and dichloromethane extracts

Petrović, G., Stamenković, J., Jovanović, O., Stojanović, G.

Department of Chemistry, Faculty of Science and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

* *jelena.stamenkovic@pmf.edu.rs*

Above ground parts of *Anthriscus cerefolium* L. was collected at the location Gorica-Niš (April, 2016) in a full flowering phase. Hexane and dichloromethane extracts were prepared from the fresh aerial parts. The extracts were prepared by the mixing of the chopped and homogenized plant material with appropriate solvent (1:10 w/v). The extracts were separated by the filtration after 48h, the solvents were removed by vacuum evaporation, the samples were dissolved in hexane and immediately analyzed. Chemical compositions of the extracts were analyzed by GC and GC/MS. By the analysis of hexane and dichloromethane extracts, 18 and 30 components were identified what makes 99.5% and 95.0% (respectively) of present compounds. The most dominant class of compounds in both samples were phenylpropanoids but in slightly different proportions. The major components wereestragole (methyl chavicol), with the share of 79.2% and 65.1% and 1-allyl-2,4-dimethoxybenzene, with the share of 14.2% and 13.0%, in hexane and dichloromethane extracts, respectively. Some other phenylpropanoid compounds like chavicol and 1-allyl-2,5-dimethoxybenzene were also identified but in a much smaller amount. The structure of the new compound, 1-allyl-2,5-dimethoxybenzene, was tentatively determined by comparing of its MS spectra and retention indices with previously published references and literature data.

Acknowledgments. The authors are grateful to the Ministry of Education, Science and Technological Development for the financial support through the grant No 172047.

Cytotoxic and antimicrobial activity of selected *Hieracium* L. extracts and isolated sesquiterpene lactones

Milutinović, V.[1], Matić, I.[2], Grozdanić-Stanisavljević, N.[2*], Stanojković, T.[2], Soković, M.[3], Ćirić, A.[3], Niketić, N.[4], Petrović, S.[1]

[1] Department of Pharmacognosy, University of Belgrade - Faculty of Pharmacy, Vojvode Stepe 450, 11221 Belgrade, Serbia

[2] Institute of Oncology and Radiology of Serbia, Pasterova 14, 11000 Belgrade, Serbia

[3] University of Belgrade, Institute for Biological Research "Siniša Stanković", Bulevar Despota Stefana 142, 11000 Belgrade, Serbia

[4]Natural History Museum, Njegoševa 51, 11000 Belgrade, Serbia

* *nadjagrozdanic@gmail.com*

Cytotoxic and antimicrobial activities were investigated for MeOH extracts of flowering aerial parts of *Hieracium calophyllum* R. Uechtr. (CAL), *H. coloriscapum* Rohlena & Zahn (COL), *H. pseudoschenkii* (Rohlena & Zahn) Niketić (PSE), *H. valdepilosum* Vill. s.l. (VAL) and *H. glabratum* Willd. (GLA), their two isolated sesquiterpene lactones 8-epiixerisamine A and crepiside E, as well as for CH_2Cl_2 extract of flowering aerial parts of *H. scheppigianum* Freyn (SCH).

Crepiside E (IC_{50} = 46.00 µg/mL), COL (IC_{50} = 152.28 µg/mL) and SCH (IC_{50} = 148.12 µg/mL) showed the highest cytotoxic activity against HeLa cells in MTT test. The cytotoxic activity against LS174, A549, as well as against normal MRC-5 cells was significantly weaker. In microdilution test, crepiside E and 8-epiixerisamine A exhibited noteworthy antifungal effect against *Aspergillus ochraceus*, *Penicillium funiculosum*, *Candida albicans* and *C. krusei* (MIC = 0.15 - 0.4 mg/mL, MFC = 0.3 - 0.8 mg/mL). Among the extracts, the best antibacterial activity was shown by SCH and CAL against *Pseudomonas aeruginosa* (MIC = 1.68 and 2.52 mg/mL, MBC = 3.36 and 5.04 mg/mL), and the highest antifungal activity by SCH and VAL against *C. albicans* (MIC = 2.48 and 2.52 mg/mL, MFC = 4.96 and 5.04 mg/mL).

Acknowledgements. Ministry of Education, Science and Technological Development of the Republic of Serbia (Grants Nos. 173021, 175011, 173032).

Antimicrobial activity of eight *Geranium* L. species extracts

Ilić, M.[1], Drobac, M.[1], Marčetić, M.[1], Milenković, M.[2], Zlatković, B.[3], Kovačević, N.[1]

[1]Department of Pharmacognosy, Faculty of Pharmacy, University of Belgrade, Vojvode Stepe 450, Belgrade, Serbia

[2]Department of Microbiology, Faculty of Pharmacy, University of Belgrade, Vojvode Stepe 450, Belgrade, Serbia

[3]Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *ilicmilan88@yahoo.com*

The antimicrobial activity of methanol extracts of aerial parts of 8 *Geranium* L. species (*G. macrorrhizum* L., *G. phaeum* L., *G. sanguineum* L., *G. robertianum* L., *G. palustre* L., *G. pyrenaicum* Burm. f., *G. columbinum* L. and *G. lucidum* L.) was tested against 8 standard strains (*Staphylococcus aureus, Enterococcus faecalis, Bacillus subtilis, Escherichia coli, Klebsiella pneumaniae, Pseudomonas aeruginosa, Salmonella abony and Candida albicans*) as well as 10 clinical isolates of *E. coli*. Also, total phenolics and tannins were quantified using spectrophotometric *Folin-Ciocalteu*method. The extracts exhibited antibacterial and anticandidal activity with minimal inhibitory concentrations (MICs) between 12.5 and 200 µg/ml. *E. faecalis* was most sensitive strain (MIC 12.5-50 µg/ml), especially to *G. columbinum* and *G. phaeum* extracts (MICs 12.5 µg/ml). The determined amounts of total phenolics and tannins were in the range of 170-534 and 38-386 mg GAE/g of dry extract, respectively, with the highest content in *G. sanguineum* extract. However, the antimicrobial activity was not related to total polyphenolics or tannin content and further investigation in regard with phenolic profile is needed.

Hypoglycemic effect of traditionally used herbal mixture in normal and diabetic rats

Madić, V., Petrović, A., Jušković, M., Žabar Popović, A., Aleksić, M., Vasiljević, P.

Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *visnja.madic@pmf.edu.rs*

For centuries, many herbal mixtures have been used in the treatment of diabetes. One of the most commonly used in Europe is made *Rubus fruticosus* L. leaves, *Vaccinium myrtillus* L. leaves, *Potentilla erecta* (L.) Räuschel roots, *Geum urbanum* L. aerial parts and *Phaseolus vulgaris* L. pods. The aim of this study was to evaluate the hypoglycemic potential of this herbal mixture in normal and alloxan-induced diabetic female Wistar rats. Animals orally received herbal mixture extract (10, 20, 40 and 80 g/kg) for 14 consecutive days. Positive diabetic control received insulin glargine (13 IU/kg). Blood glucose was monitored on days 0, 7 and 14. With the exception of the highest tested concentration of the herbal mixture, which reduced blood sugar by 15% compared to the initial value, other tested concentration did not have effect on blood glucose of the healthy animals. In diabetic rats, chronic administration of herbal mixture significantly reduced blood glucose levels by 70, 75, 17 and 39% respectively at the dose of 10, 20, 40 and 80 g/kg, while insulin reduced blood glucose by 19%. It can be concluded that lower concentrations of this herbal mixture have significant anti-hyperglycemic activity in alloxan-induced diabetic rats.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, Grant No. 172047

Phytotherapy in patients with cardiovascular diseases - a descriptive survey in Vojvodina, Serbia

Hitl, M., Jeremić, K., Salaj, N., Kladar, N., Gavarić, N., Srđenović Čonić, B., Božin, B.

Department of Pharmacy, Faculty of Medicine, University of Novi Sad, Hajduk Veljkova 3, Novi Sad, Serbia

* *maja.bekut@mf.uns.ac.rs*

High morbidity and mortality associated with cardiovascular diseases (CVD) require lifestyle changes and preventive and therapeutic medications. Patients often opt for natural therapies, including phytotherapy. The aim of this study was to detect the use of herbs in CVD and to investigate safety of concomitant use of herbs with effect on CVD and conventional drugs. A prospective, repetitive cross-section survey was conducted in pharmacies in Vojvodina, during period of 2010-2015. The patients were enrolled in the specifically designed survey. All data were expressed as percentages (nearest whole number). Total of 749 patients were included in the study, out of which 168 (22%) of them were classified as patients with CVD. High usage of phytopreparations was detected; 39% of patients were using herbs with primary effects on CVD (ginkgo and garlic being most common), and 56% of them used herbs for other ailments. Approximately half of patients considered that it was not necessary to inform or consult doctor about herbal co-therapy. No adverse effects were recorded. Phytotherapy appears to be frequent in patients with CVD. Patients and doctors should improve communication concerning the use of herbal products in order to achieve effective and safe therapy of CVD.

Acknowledgements. This work was supported by The Ministry of Education, Science and Technological Development, Republic of Serbia (grant number OI 172058).

Essential oil quality of comercial available Ceylon and Indonesian cinnamon brark from Serbian markets

Jeremić, K.[1], Gavarić, N.[1], Kladar, N.[1], Vučinić, N.[1], Bekut, B.[1], Salaj, N.[1], Božin, B.[1]

[1] Department of Pharmacy, Faculty of Medicine, University of Novi Sad, Hajduk Veljkova 3, Novi Sad, Serbia

* *katarina.jeremic@mf.uns.ac.rs*

Cinnamon is considered one of the longest-existing spices in human history. According to researches, cinnamon is known to possess high medical potential mostly due to the pharmacologically active aromatic compounds found in essential oil. The aim of this study was to determine the composition of essential oil obtained from two types of cinnamon, Ceylon cinnamon (*Cinnamomum verum* J. Prese; Lauraceae) and Indonesian cinnamon (*Cinnamomum burmanii* Blume; Lauraceae) available in Serbia. The hydro-distilled volatile oil (according to Ph. Eur. IV) of the *C. verum* and *C. burmanii* powdered cinnamon bark was analyzed using GC-MS.The analysis showed that cinnamaldehyde was the major component in both samples. The higher value was recorded in Indonesian cinnamon oil (48, 11%) while in Ceylon cinnamon oil the content was 44, 21%. Both values are below the lower limit prescribed by the 6th Ph. Eur. (55% to 75%). Also, benzyl benzoate was found only in Ceylon cinnamon oil (2,5%) which is above the maximum prescribed by the pharmacopoeia (less than 1%). The study showed that essential oils obtained from Ceylon and Indonesian powdered cinnamon bark from markets in Serbia don't meet pharmacopoeial regulations criteria which may reflect on their quality, efficiency and safety.

Acknowledgements. The authors are grateful to The Ministry of Education, Science and Technological Development, Republic of Serbia (project OI 172058).

Cultivated plants from the *Lamiaceae* family as potential sources of pharmacologicaly active phenolic compounds

Jeremić, K.[1], Gavarić, G.[1], Kladar, N.[1], Aćimović, M.[2], Vučinić, N.[1], .Todorović, N.[1], Božin, B.[1]

[1]Department of Pharmacy, Faculty of Medicine, University of Novi Sad, Hajduk Veljkova 3, Novi Sad, Serbia

[2]Institute of Field and Vegetable Crops Novi Sad, Maksima Gorkog 30 21000 Novi Sad, Serbia

* *katarina.jeremic@mf.uns.ac.rs*

Family *Lamiaceae*, one of the largest and the most important plant families, is promising potencial sources of the medical active ingridients due to their high polyphenol content. The well-known and widely used members of this family are a variety of aromatic species such as thyme, mint, sage and winter savory. These plants are native to the Mediterranean region but also they are successfuly world widely cultivated. The aim of this study was to determine phenolic compounds in ethanol extracts of mint, sage, thyme and winter savory cultivated on The Alternative Crops Department trial fields.HPLC method was used to measure the amount of rutin, quercetin, quercitrin, gallic, chlorogenic, caffeic, rosmarinic, p-coumaric, trans cinnamic and ferulic acid in extracts. Rosmarinic acid was found to be the most represented compound in all four extracts. The highest amound was measured in mint extract (12863,6 mcg/ g). Sage extract showed the lowest amount of all measured phenolic compounds. The amount of caffeic acid was high in mint and thyme extract (979,77 mcg/g and 334,07mcg/g) while in savory and sage extracts was significatnly lower (31,17 mcg/g and 22,67 mcg/g). This study showed that cultivated plants are good sources of the pharmaceutical active ingredients.

Acknowledgements. The authors are grateful to The Ministry of Education, Science and Technological Development, Republic of Serbia (project OI 172058).

Total flavonoids, hydroxycinnamic acid derivatives, and antioxidative activity of *Stachys cretica*L. subsp. *cassia* (Boiss.) Rech. fil. extracts

Kostić, M.[1], Milutinović, M.[1], Zlatković, B.[2], Krstić, N.[3], Miladinović, B.[1], Branković, S.[4], Pavlović, D.[1], Kitić, D.[1]

[1] Department of Pharmacy, Faculty of Medicine, University of Niš, Blvd Zorana Đinđića 81, Niš, Serbia

[2] Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

[3] Faculty of Medicine, University of Niš, Blvd Zorana Đinđića 81, Niš, Serbia

[4] Department of Physiology, Faculty of Medicine, University of Niš, Blvd Zorana Đinđića 81, Niš, Serbia

* *milicakostic84@yahoo.com*

Stachys L. is a large genus of herbs and shrubs which plant species have been used and consumed as decoctions and infusions ("mountain tea") for the treatment of stomach, asthma, skin, rheumatic and ulcer disorders. The aim of this research is to determine the content of total flavonoids (TF) and hydroxycinnamic acid derivatives (THAD), as well as the estimation of the antioxidant activity of *Stachys cretica* L. subsp. *cassia* (Boiss.) Rech. fil. extracts. The plant material was extracted with absolute, 80% and 60% methanol, and concentrated (96%), 80% and 60% ethanol, by ultrasound technique. The aqueous extract was prepared by evaporation of the residue after isolation of the essential oil. TF were determined with $AlCl_3$ method. THAD were assessed according to Ph.Eur. 9.0 proscription. Antioxidant activity was estimated with DPPH (2,2-diphenyl-1-picrylhydrazyl) and BCL (β-carotene/linoleic acid) methods. Extract prepared with concentrated ethanol was the richest in TF and THAD were predominant in 60% methanol extract. The best antioxidant activity in the DPPH test was achieved with 60% ethanol extract, while the extract prepared with absolute methanol was the strongest antioxidant agent in the BCL test. The *S. cretica* subsp. *cassia* extracts could be the potential natural medicines in the reduction of oxidative stress.

Acknowledgements. The study was financially supported by the Ministry of Science and Technological Development of Republic of Serbia, Grants III 41018 and III 46013, and by the Internal Project of Faculty of Medicine, University of Nis, Serbia (No. 25).

Total phenols, tannins and antioxidant activity of *Satureja kitaibelii* Wierzb. ex Heuff. extracts

Milutinović, M.[1], Kostić, M.[1], Živanović, N.[2], Zlatković, B.[3], Miladinović, B.[1], Branković, S.[4], Kitić, D.[1]

[1]Department of Pharmacy, Faculty of Medicine, University of Niš, Blvd. Dr Zoran Djindjić 81, Niš, Serbia

[2]Faculty of Medicine, University of Niš, Blvd. Dr Zoran Djindjić 81, Niš, Serbia

[3]Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

[4]Department of Physiology, Faculty of Medicine, University of Niš, Blvd. Dr Zoran Djindjić 81, Niš, Serbia

* *milicam_86@hotmail.com*

Satureja kitaibelii Wierzb. ex Heuff. (Lamiaceae) is a Balkan Peninsula endemic species. Phenols, widespread in this species, are characterized with distinct biologically activities: antioxidant, antimicrobial, antiviral anti-inflammatory etc. The aim of the research was the determination of total phenols and tannins in *S. kitaibelii* extracts, as well as the testing of their antioxidant activity. The dried plant material was extracted using concentrated, 80% and 60% ethanol and absolute, 80% and 60% methanol, by ultrasonic method, while the water extract was obtained by evaporation of the residue after the isolation of essential oil. The total phenols and tannins contents were determined using Folin-Ciocalteu method. Antioxidant activity was assessed in DPPH (1.1-diphenyl-2-picrylhidrazyl) system and with BKL (β-carotene/linoleic acid) method. The highest amounts of total phenols and tannins were determined in extract prepared with 60% methanol (231.44±1.02 and 173.86±6.37 mg of gallic acid equivalents/g). The strongest antioxidant activity in DPPH system was determined in 80% methanol extract (IC_{50}= 1.57±0.04 μg/ml, while methanol extract was the most powerful in BKL system (IC_{50}=4.26±0.57 μg/ml). *S. kitaibelii* extracts could have a potential role in the prevention of diseases which are directly correlated with oxidative stress.

Acknowledgement. The research was supported by the Serbian Ministry of Education, Science and Technological Development (Grant no. III 46013 and III 41018) and by the Internal Project of Faculty of Medicine, University of Nis, Serbia (No. 25).

Chemical Composition of *Satureja kitaibelii* Wierzb. ex Heuff. Essential Oils from Serbia During Different Stages of Vegetative Development

Stepić, K.D.[1], Ickovski, J.D.[1], Palić, I.R.[1], Đorđević, A.S.[1], Ljupković, R.B.[1], Stojanović, G.S.[1]

[1] Department of Chemistry, Faculty of Science and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

* *ivanpalic@yahoo.com*

The volatile profile of fresh aerial parts of *Satureja kitaibelii* was determined by GC and GC/MS analysis during three different stages of vegetative development. The plant material was collected from three different locations: Devojački grob, Sićevačka klisura and Visočka Ržana. The research showed that the quantity of oil decreased (approximately Devojački grob 15; 3 Sićevačka klisura and 2.3 times Visočka Ržana, respectively) during different phases of vegetative development. In all samples were identified 181 components (79 in traces) accounting for 95.52 to 99.81% of total essential oil. The most common class of compounds were monoterpenoids (approximately 3/4 of total oil composition), while sesquiterpenoids were present to a significantly lesser extent (approximately 1/5 of total oil composition). The most abundant component was geraniol (from 17.58 to 51.10%), which represented about 1/3 of total essential oil. Limonene, caryophyllene oxide and linalool were present in significant quantities (up to 10.49% Devojački grob; 12.83% Visočka Ržana; 13.99% Sićevačka klisura, respectively). Geranyl acetate was present in relatively high quantity (up to 29.31%) in the *S. kitaibelii* essential oil from Visočka Ržana site.

Acknowledgments. Ministry of Education, Science and Technological Development of the Republic of Serbia [172047].

Assessment of polyphenol content and *in vitro* antioxidant potential of wild growing and cultured raspberry leaf

Pavlović, D.R.[1], Vukelić-Nikolić, V.[2], Marčetić, M.[3], Kitić, D.[1], Kostić, M.[1], Milutinović, M.[1], Miladinović, B.[1]

[1]IAS Pharmacy, Faculty of Medicine, University of Niš, Bul. Dr Zorana Đinđića 81, Serbia

[2]Faculty of Medicine, University of Niš, Bul. Dr Zorana Đinđića 81, Serbia

[3]Faculty of Pharmacy, University of Belgrade, Vojvode Stepe 450, Belgrade, Serbia

* *anagard@medfak.ni.ac.rs*

Rubus idaeus L., folium (raspberry leaf) is according to EMA/HMPC monograph indicated as traditional herbal medicinal product for: the symptomatic relief of minor spasm associated with menstrual periods, the symptomatic treatment of mild inflammation in the mouth or throat and the symptomatic treatment of mild diarrhea. The aim of this work was quantitative determination of phenolic compounds (namely: total polyphenols, tannins, flavonoids, arbutin and hydroquinone) and antioxidant capacity of the different leaves extracts of wild and cultivated *Rubus ideus*. Total polyphenols, tannins and flavonoids were determined spectrophotometrically, HPLC method was employed for quantification of arbutin and hydroquinone. DPPH test was used for fast antioxidant screening. Arbutin and hydroquinone were absent in all samples despite some literature date on arbutin presence in *Rubus idaeus*. Our phytochemical study showed that raspberry leaves extracts contain significant amounts of polyphenolic compounds, which could be useful in it's quality estimation. Cultured raspberry leaf extracts seem to be reacher source of this secondary metabolites while hydromethanolic extracts of wild growing plant material exhibited the strongest antioxidant activity. Polyphenolic content and demonstrated activity could, at least in part, explain pharmacological effects of raspberry leaves.

Acknowledgements. This work was supported by Ministry of Education and Science of the Republic of Serbia (project no. III 41018 and III 46013).

Bioactivity of crude extracts of *Laetiporus sulphureus* (Bull.: fr.) Murr collected from eastern Serbia

Novaković, A.[1], Karaman, M.[2], Radusin, T.[1], Jovanov, P.[1], Sakač, M.[1], Ilić, N.[1]

[1]Institute of Food Technology, University of Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia

[2]Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia

* *aleksandra.novakovic@fins.uns.ac.rs*

Mushrooms have become attractive for human's nutrition in the last decades as a source of physiologically beneficial bioactive compounds making them a functional food. The aim of this work was to study bioactivity of crude extracts prepared from wild-growing sporocarps of edible fungal species *Laetiporus sulphureus* (Bull.: Fr.) Murr, known as "chicken wood" collected from Eastern Serbia (Sikola). The bioactivity screen included antiradical (DPPH$^{\bullet}$ and OH$^{\bullet}$) andantiproliferative (human breast MCF-7 cancer cell-line; MTT assay) effects. Two kind polar extracts (aqueous - LsAq and ethanol – LsEtOH) including three different extract fractions among them (n-hexane: LsAqHex, LsEtHex; ethyl acetate: LsEtEt, LsAqEt; and water: LsEtAq, LsAqAq, respectively) were analyzed. In addition, LsAq and LsEtOH were primarily characterized by UV-VIS spectrophotometry, due to determination of chemical composition (total phenol and flavonoid contents). The highest anti-DPPH radical activity was observed for LsAq (IC_{50} = 73.53 µg/ml). In comparison with LsAq (IC_{50} = 12.94 µg/ml), less polar LsEtOH showed slightly better anti-OH radical activity (IC_{50} = 10.73 µg/ml). In addition, the obtained TP contents was shown to be the highest for the LsAq (111.17mg GAEq/g d.w.). The modest activities was found against MCF-7 cells LsAq after 72 h, IC_{50} = 235.6 µg/ml and extract fractions LsEtOH 197.61µg/ml. According to the obtained experimental data *L. sulphureus* can be considered as a good source of novel and potent natural antioxidants for the use in a regular human's diet.

Acknowledgement. This study was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Research Grant No. III 46001).

Acetylcholinesterase and butyrylcholinesterase inhibitory activity of methanol extracts of 28 *Hieracium* species and their selected metabolites

Milutinović, V.[1], Petrović, P.[2], Klaus, A.[3], Ušjak, Lj.[1], Niketić, M.[4], Petrović, S.[1]

[1]Department of Pharmacognosy, University of Belgrade - Faculty of Pharmacy, Vojvode Stepe 450, 11221 Belgrade, Serbia

[2]Innovation Center of the Faculty of Technology and Metallurgy, University of Belgrade, Karnegijeva 4, 11060 Belgrade, Serbia

[3]Institute for Food Technology and Biochemistry, University of Belgrade, Faculty of Agriculture, Nemanjina 6, 11080 Belgrade, Serbia

[4]Natural History Museum, Njegoševa 51, 11000 Belgrade, Serbia

* *vmilutinovic@pharmacy.bg.ac.rs*

The ability of the dried MeOH extracts of aerial flowering parts of 28 *Hieracium* s. str. species from Balkan Peninsula and their selected metabolites (seven flavonoids, three phenolic acids and two sesquiterpene lactones) to inhibit acetylcholinesterase (AChE) and butyrylcholinesterase (BuChE) was determined using colorimetric Ellman method. The study included: *H. gymnocephalum*, *H. orieni*, *H. blecicii*, *H. paratrichum*, *H. spirocaule*, *H. mokragorae*, *H. pannosum* s.l., *H. plumulosum*, *H. villosum*, *H. pilosum*, *H. pseudoschenkii*, *H. naegelianum*, *H. anastrum*, *H. calophyllum*, *H. scheppigianum*, *H. durmitoricum*, *H. guentheri-beckii*, *H. mirificissimum*, *H. coloriscapum*, *H. pyricephalum*, *H. albopellitum*, *H. glabratum*, *H. scorzonerifolium* s.l., *H. dentatum* s.l., *H. neilreichii*, *H. valdepilosum* s.l., *H. tommasinianum* and *H. macrodontoides*. The extracts were mainly more active towards AChE, i.e. all inhibited more than 50% AChE, with *H. pseudoschenkii* extract being the most potent (IC_{50}=0.64 mg/mL). Seven extracts reached 50% inhibition of BuChE, and *H. pilosum* extract was the most active (IC_{50}=0.56 mg/mL). The observed activity could be attributed to some tested constituents. Flavonoid aglycones apigenin, luteolin and diosmetin significantly inhibited both enzymes (IC_{50AChE}=47.12-89.89 µg/mL; $IC_{50BuChE}$=18.40-73.44 µg/mL). Sesquiterpene lactone 8-epiixerisamine A selectively inhibited AChE (IC_{50}=80.01 µg/mL). The other tested metabolites did not reach 50% inhibition of both enzymes.

Acknowledgements. This work was supported by Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 173021, III 46010).

Special differences in the adoption of copper in selected plant species of the Salicaceae family

Timotijević, S.[1], Novaković, M.[1], Stojadinov, M.[1], Simić, Z.[2], Đelić, G.[1]

[1]University of Kragujevac, Faculty of Science, Department of Biology and Ecology, Radoja Domanovića 12, Kragujevac, Serbia

[2]University of Kragujevac, Faculty of Science, Department of Chemistry, Radoja Domanovića 12, Kragujevac, Serbia

* *sinisa.timotijevic@pmf.kg.ac.rs*

Heavy metals pollution of surface soils is a major global issue. The aim of the research was to determine the differences between species *Salix caprea* L., *Salix purpurea* L., *Salix caprea* L., *Populus alba* L, *Populus nigra* L. and *Populus tremula* L. based on the content of copper in plant organs (twigs and leaves) and in the soil they grown. Research results showed that the tested species adopted a small amount of copper (the least copper was adopted by twig of *S. purpurea* 2.5 mg/kg, and the most was adopted by twig of *P. tremula* (12.5 mg/kg). Populus species adopted a higher amount of copper (6.2 mg/kg) than Salix species (4.6 mg/kg). It was found a higher concentration of copper in the twigs than in the leaves. A positive correlation was determined between copper amount in soil and copper amount in species *S. alba* and *P. alba*. The highest concentrations were obtained in *P. tremula* and the least in *S. purpurea.* The results show that there are statistically very significant differences in the amount of copper between selected species and soil they grown and in the amount of the copper between selected plant species.

Acknowledgements: This research was supported by the Ministry of Education of Science and Technological Development of the Republic of Serbia, the project Preclinical Testing of Bioactive Substances III 41010.

In vitro antioxidant activity of *Filipendula ulmaria* (L.) Maxim. and *Filipendula vulgaris* Moench

Samardžić, S.[1], Kotur-Stevuljević, J.[2], Maksimović, Z.[1]

[1]Department of Pharmacognosy, University of Belgrade – Faculty of Pharmacy, Vojvode Stepe 450, 11221 Belgrade, Serbia

[2]Department of Medical Biochemistry, University of Belgrade – Faculty of Pharmacy, Vojvode Stepe 450, 11221 Belgrade, Serbia

* *stevans@pharmacy.bg.ac.rs*

Filipendula ulmaria (L.) Maxim. and *F. vulgaris* Moench are traditionally employed in the treatment of peptic ulcer and pain. The aim of present study was to estimate their antioxidant properties in order to better understand reported ethnomedicinal use. Antioxidant activity of lyophilized flower infusions (LFIs), spiraeoside (quantitatively dominant flavonoid) and referent compound Trolox® was investigated in human serum *in vitro* by following their ability to decrease oxidative stress produced by the addition of *tert*-butyl hydroperoxide. Parameters indicating protective capacity (total antioxidative status, TAS; total oxidative status, TOS; and pro-oxidant–antioxidant balance, PAB) were determined spectrophotometrically and results were expressed as percentage of the value of the same parameter in control group. All tested samples (10–160 μg/mL) concentration-dependently and significantly increased TAS (for maximum concentration, values were 190-400%) and decreased PAB (for maximum concentration, values were 13-78%). LFIs in the applied concentration range did not significantly influence TOS, in contrast to spiraeoside which increased its values, and Trolox® which reduced TOS. Protective activity of Trolox® was more pronounced than the effect of herbal preparations and spiraeoside. The obtained results support folkloric use of *F. ulmaria* and *F. vulgaris* and indicate considerable antioxidant capacity which should be further investigated.

Acknowledgements. This research was supported by the Ministry of Education, Science and Technological Development of Republic of Serbia (Grant no. 173021).

Antioxidant phenolic compounds in *Hypericum perforatum* L. wild-growing plants collected in the Republic of Macedonia

Tusevski, O., Krstikj, M., Spasenoski, M., Gadzovska Simic, S.

Department of Plant Physiology, Institute of Biology, Faculty of Natural Sciences and Mathematics, University „Ss. Cyril and Methodius“, Archimedova str. 3, 1000 Skopje, Macedonia

* *oliver.tusevski@pmf.ukim.mk*

The aim of this study was to evaluate phenolic compounds composition and antioxidant activity in roots (RO), non-flowering shoots (NFS) and flowering shoots (FS) of *Hypericum perforatum* L. wild-growing plants collected in the Republic of Macedonia. The analyses of total phenolic compounds included quantification of phenolics, flavonoids, flavan-3-ols, condensed tannins and hypericins. Antioxidant activity in plant extracts was determined by the following assays cupric ions reducing antioxidant capacity, phosphomolybdenum test, reducing power and DPPH scavenging. The content of phenolics, flavonoids, flavan-3-ols and condensed tannins inFS and NFS were significantly higher than those found in RO extracts. Hypericin content in FS was about 2-fold increased compared to NFS, while RO showed low accumulation capability. Results for antioxidant activities showed that FS and NFS exhibited markedly higher values compared to RO. The highest value for phosphomolybdenum test was noticed in FS, followed by NFS, while the lowest activity was found in RO samples. In summary, aerial parts of *H. perforatum* accumulated significant amounts of antioxidant phenolic compounds compared to roots that are characterized with hydrogen atom donation, radical scavenging and participation in redox reactions.

Antioxidant and antimicrobial potential of *Gleditsia triacanthos* L. pods

Žabar Popović, A.[1], Aleksić, M.[1], Aleksić, A.[1], Madić, V.[1], Stojanović, J.[1], Stojanović-Radić, Z.[1], Vasiljević, P.[1]

[1]Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *andrea@pmf.ni.ac.rs*

Gleditsia triacanthos L. is a deciduous tree (fam. Fabaceac), originating form North America. The aim of this study was investigation of antimicrobial and antioxidant potential of *G. triacanthos* dry pod's extracts (methanolic and ethanolic). The following concentrations for DPPH test were used: 0.25 mg/ml, 0.5 mg/ml, 0.65 mg/ml, 0.75 mg/ml, 1 mg/ml. DPPH test showed that the methanolic extract had higher antioxidant properties than ethanolic extracts. The IC50 values were 1.91 mg/ml (methanol extract) and 2.4 mg/ml (ethanol extract). Total phenolic and flavonoid contents were calculated for methanolic extract: 30 mg of GAE/g of extract, 97 mg of QuE/g of extract, respectively, and for ethanolic extract: 19.5 of GAE/g of extract, 72 mg of QuE/g of extract. Antimicrobial activity (MIC, MBC/MFC) of *G. triacanthos* extracts was tested on three gram positive bacterial strains (*Enterococcus faecalis, Bacillus cereus* and *Staphylococcus aureus),* four gram negative bacterial strains *(Salmonella enteritidis, Pseudomonas aeruginosa, Enterobacter aerogenes* and *Escherichia coli)* and one fungal strain (*Candida albicans*). Ethanolic extracts had higher antimicrobial activity than methanolic extracts and had the highest inhibitory effect on *C. albicans*. MIC for ethanol and methanol extracts were 0.41-25 mg/ml and 12.5-25 mg/ml respectively. MBC for ethanol and methanol extracts were 6.25-50 mg/ml and 12.5-50 mg/ml respectively. All extracts had moderate antimicrobial activity.

Antiradical properties of homemade wines: white vs. red wine

Milena Aleksić[1], Andrea Žabar Popović[1], Jelena Stojanović [1], Višnja Madić[1], Perica Vasiljević[1]

[1]Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, Niš, Serbia

* *andrea@pmf.ni.ac.rs*

Grape wine is the most-produced fruit-fermented alcoholic products in the world. Polyphenolic compounds are determining several wine properties such as color, astringency and bitterness. The main objective of this work was to determinate the total content of polyphenols and antioxidant potential of some homemade wines. We tested two white wines (W1 and W2) and one red wine (R1). Total phenols were determined by Folin–Ciocalteu method (gallic acid was a standard) and total flavonoid content was determined by $AlCl_3$ method (quercetin hydrate was standard). Antioxidant activity of this wine was measured by DPPH scavenging radical assay. Total phenol content of white wines (W1 and W2) was 331mg/L GAE and 191mg/L GAE respectively, while in red wine was 2040 mg/L GAE. Content of flavonoids in W1 wine was 341.6 mg/L QuE, in W2 215 mg/L QuE and in R1 wine was 5464 mg/L QuE. White wines (W1 and W2) were able to neutralize DPPH free radical at significant level (83,46%, 77,85% respectively); while red wine (R1) completely neutralized DPPH free radical (100%). It could be concluded that homemade red wine was richer source of antioxidants when compared to the white wines. This is in correlation with the total content of polyphenols.

13th Symposium on the Flora of Southeastern Serbia and Neighboring Regions

Stara planina Mt. 20th-23th June, 2019

Agriculture, Forestry and Landscape Architecture

INTRODUCTORY LECTURE

Serbian spruce, endemicity and advantages

Mitrović, A.Lj., Bogdanović Pristov, J., Simonović Radosavljević, J., Radotić, K.

Institute for Multidisciplinary Research, University of Belgrade, Kneza Višeslava 1, 11000 Belgrade, Serbia

* *mita@imsi.rs*

Picea omorika (Pančić) Purkyně is Balkan endemic coniferous species and Tertiary relict of the European flora. Its natural habitat is fragmented and reduced to the middle and upper courses of the Drina River, in Western Serbia and Eastern Bosnia and Herzegovina. This region represents species long-term, cryptic and last refugium. The current limited natural range of Serbian spruce is mainly the result of the species poor competing ability. It retreats to areas less inhabitable by its competitors, predominantly *Picea abies* and *Fagus orientalis*. It inhabits open habitats, comprising cliffs and forest clearings, characterized by strong northerlywind, snow and rockfalls. Since the middle of the 19th century, its natural range declines continuously. Planting Serbian spruce outside its natural range has a long tradition, either as an ornamental tree species, or for afforestation, throughout Central and Northern Europe. Despite its endemism, *P. omorika* is considered as one of the most adaptable spruces.

Wood properties are determined by cell arrangement, size and shape, and cell wall structure and thickness. Conifers, as a response to mechanical stress, such as wind and stem lean, form reaction wood called compression wood (CW). Its formation occurs on the lower side of the leaning stem, resulting in eccentric growth. Wood opposite to the CW in the same growth ring is termed opposite wood (OW), while wood from growth rings that do not contain any CW is termed normal wood (NW). CW is characterized by reduced tracheid length, rounder cell cross-sectional profile, presence of intercellular spaces, absence of the S3 cell wall layer and presence of helical cavities in S2 layer. Higher lignification, as one of the main characteristics of CW, is associated with changed lignin composition, increased amounts of p-hydroxyphenyl monomers and increased condensation of monomer units in the polymer. Consequently, CW contains less cellulose, with greatly increased amounts of galactan, and slightly lower amounts of mannan and xylan, and with higher angle of cellulose microfibrils in the S2 layer of the cell wall, compared to NW.

CW occurs in a range of gradations from near NW to severe CW (SCW), mild CW (MCW) forming a continuum between NW and SCW. The degree of development of particular features of CW does not necessarily change in parallel to

each other, so the severity of a given tracheid is represented as a function of the degrees of development of individual features, mainly lignification, helical cavities and cell wall thickness. Visual detection of compression wood severity, more precisely the determination of MCW, is difficult. As the severity of CW affects mechanical and chemical properties of wood in forest products industry it is desirable to be able to measure CW severity.

We developed different morphometric and non-morphometric methods for distinguishing wood samples on a compression severity scale. They are based on tracheid double wall thickness, cellulose microfibrils order (distribution and alignment of cellulose microfibrils), or variation in lignin structure. We used confocal fluorescence microscopy and spectroscopy, and fluorescence-detected linear dichroism (FDLD) microscopy, combined with development of new algorithms and statistical analysis. We tested our methods on stem samples of *P. omorika* juvenile trees exposed to long term static bending. *P. omorika* belongs to slow-growing conifer species in which CW typically occurs in a severe form, while juvenile conifer wood is characterized by randomly distributed MCW, NW often being absent. These are the features that suggest *P. omorika* juvenile wood a good choice of samples for evaluation of the precision of methods suggested for estimation of compression wood severity.

Our methods for distinguishing wood samples on a compression severity scale provide a fine gradation of juvenile *P. omorika* wood samples from NW to the severest form of CW, compression severity scales being partially different. The presented results qualify our methods for use in estimation of compression wood severity in forest products industries, individually or in combination, and confirm juvenile *P. omorika* stem samples as a good choice of samples for evaluation of the precision of methods suggested for compression wood severity estimation.

Acknowledgements. This study was supported by Grant 173017 of the Ministry of Education, Science and Technological Development of the Republic of Serbia.

ORAL PRESENTATION

Growth characteristics of three-year-old Turkey oak (*Quercus cerris* L.) seedlings from natural regeneration under a dense canopy stand

Bobinac, B.[1], Andrašev, S.[2], Šušić, N.[3], Bauer-Živković, A.[1], Kabiljo, M.[4]

[1]University of Belgrade, Faculty of Forestry, Kneza Višeslava 1, Belgrade, Serbia

[2]University of Novi Sad, Institute of Lowland Forestry and Environment, Antona Čehova 13 D, Novi Sad, Serbia

[3]University of Belgrade, Institute for Multidisciplinary Research, Kneza Višeslava 1, Belgrade, Serbia

[4]Institute of Forestry, Kneza Višeslava 3, Belgrade, Serbia

* *martin.bobinac@sfb.bg.ac.rs*

A moprhometric analysis was conducted on three-year-old Turkey oak seedlings naturally regenerated from 2015 mast year in a degraded stand at Fruška gora on the site of pedunculate oak, European hornbeam and Turkey oak with limes (*Carpino betuli-Quercetum roboris*(Anić 59) Rauš 1971 var. geograf. *Tilia argentea* + *Tilia cordata* B. Jovanović & Tomić (1980) 1997). The tree layer in this 114-year-old stand consists of Turkey oak and silver lime. In the dense canopy conditions, the height growth of the seedlings during the first three years was characterized by monophase type growth. In the first year of growth, the height of the above-cotyledon-axis was between 8.6 and 44.1 cm, and the seedlings morphology was typical for shade conditions. The height growth increment in the second year of growth was 0.7–6.1 cm, and in the third year 0.5–5.4 cm. The total height of the seedlings in the third year was 13.0–47.0 cm, with 3–6 leaves and the root collar diameter between 2.0 and 3.9 mm. In the closed canopy conditions, the three-year-old seedlings are able to survive in large numbers while showing a specific norm of reaction in the first and the upcoming years. The monophase type of growth is the basic trait of the height growth. The results are pointing out to the Turkey oak ability of ontogenetic adaptation in the dense canopy conditions. This is an important trait in the process of natural regeneration of mixed-species stands.

Acknowledgements. This study was supported by the Ministry of Education, Science and Technological Development, Republic of Serbia [Project No. III43010; III31041].

Experimental Cropping of Nickel Hyperaccumulators in Northern Greece

Kyrkas, D.[1,2], Guillaume Echevarria, G.[3], Benizri, E.[3], Mantzos, N.[1], Patakioutas, G.[1], Susan Kidd, P.[4], Louis Morel, J.[3], Simonnot, M-O.[5], Tognacchini, A.[6], Puschenreiter, M.[6], Dimitrakopoulos, P.[2], Konstantinou, M.[7]

[1]Department of Agriculture, University of Ioannina, Kostakioi, Arta, Greece

[2]Department of Environment, University of the Aegean, Mytilini, Greece

[3]Université de Lorraine, INRA, Laboratoire Sols et Environnement, 54000 Nancy, France

[4]Instituto de Investigaciones Agrobiológicas de Galicia (IIAG), Consejo Superior de Investigaciones Científicas (CSIC), Santiago de Compostela, Spain

[5]Université de Lorraine, CNRS, Laboratoire Réactions et Génie des Procédés, 54000, Nancy, France

[6]University of Life Sciences (BOKU), Tulln, Austria

[7]Eastern Macedonia and Thrace Institute of Technology, Department of Landscape Architecture, Drama, Greece

* *mkonst@teiemt.gr*

The LIFE AGROMINE project (2016-2020) aims to establish a reference for demonstrating the feasibility of producing pure nickel (Ni) compounds on Ni-rich soils and wastes. The project has been established in four working field sites across western, central and southern Europe in order to cover ultramafic regions with different climatic and edaphic conditions. An abandoned farm, located in Koutsoufliani, in the mountain range of Northern Pindus, the heart of ultramafic areas in Greece, was selected for setting up the experimental plots. The native species *Odontarrhena muralis* (syn. *Alyssum murale*), *Bornmuellera emarginata* (syn. *Leptoplax emarginata*) and *B. tymphaea*, the latter being endemic to ultramafic areas of Northern Greece, were established in 50-m^2 plots (in triplicate) in May 2017 in order to evaluate their potential for use in Ni Agromining. The first harvest was carried out in June 2018. The biomass production reached 8.1 t ha^{-1} for *B. emarginata*, 6.1 t ha^{-1} for *B. tymphaea* and 13.5 t ha^{-1} for *A. murale* with Ni yields of 151 kg ha^{-1}, 88.3 kg ha^{-1}and 106.3 kg ha^{-1}, respectively. The Ni yield considered to be exceptionally high for *B. emarginata* and very promising for the other two species. The agronomic practices which have been applied so far will be discussed as well.

Acknowledgements. This work was supported by the LIFE Programme of the European Union (LIFE15 ENV/FR/000512).

Perspectives of plant secondary metabolites use in agriculture

Đorđević, T., Tanović, T.

Institute of Pesticides and Environmental Protection, Banatska 31b, 11080 Belgrade, Serbia

* *tijana.djordjevic@pesting.org.rs*

Due to increased demand for food production in the world with a continuously growing population, modern agriculture production relies on synthetic pesticides use. As a consequence, numerous problems arise, including residues in food products, health concerns, environmental pollution and resistance of pest species. In the search for effective and safer alternatives, the interest in the biocidal compounds naturally occurring in living organisms has increased. Plants are capable of synthesizing an enormous variety of secondary metabolites - low molecular weight compounds that are not essential for their growth and development, but rather are required for the interaction with the environment. Many of those bioactive compounds are showed to be a promising source of biorational pesticides. The potential of plants and their secondary metabolites as crop protectants could be utilized by employing living plants, crop debris or part of plants, but also by using crude or semirefined extracts that act directly on the target pests or induce plant resistance. A background and the newest researches regarding extracts of phenolic compounds, group of phytochemicals with considerable physiological importance in plants, our results regarding their biological activities, as well as their potential use in pest management will be discussed covering perspectives and challenges.

Acknowledgments. This study was carried out as a part of the projects No TR31043 and III46008, supported by the Ministry of Education and Science of the Republic of Serbia.

POSTER PRESENTATION

Changes in POD activity in soybean (*Glycine max* L.) seeds after the treatment with *Thymus serpyllum* L. aqueous extract

Šućur, J., Prvulović, D., Malenčić, Đ.

Department of Field and Vegetable Crops, Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, Novi Sad, Serbia

* *jovana.sucur@polj.edu.rs*

Abstract: Allelochemicals from one plant can cause oxidative stress in target plants and the response of target plants to damaging adverse circumstances is closely related to their enzyme activity. Therefore, the activity of antioxidant enzymes can be used as indicator of oxidative stress in plants. The aim of this study was to examine the impact of *Thymus serpyllum* L. aqueous extract on soybean seeds antioxidant properties. The effects of two concentrations, 0.2% and 0.4%, of *T. serpyllum* aqueous extract on the activity of the antioxidant enzymes in seeds of soybean (*Glycine max* L.) cv. Viktorija were examined. Peroxidase (POD) (EC 1.11.1.7) activity was measured using guaiacol and pyrogallol as substrates according to Morkunas and Gmerek (2007). The significant decrease in the activity ofpyrogallol peroxidase and guaiacol peroxidase was recorded in the soybean seeds treated with a higher concentration (0.4%) of the *T. serpyllum* aqueous extract. In the treatment with lower concentration (0.2%) there were no significant difference in the POD activity compared to the control group. Our results showed that *T. serpyllum* aqueous extract did not stimulate an increase in the POD activity in the soybean seeds which confirmed that the 0.2% and 0.4% concentrations of *T. serpyllum* aqueous extract did not induce oxidative stress in soybean seeds.

Acknowledgements. This study was carried out within a project of the Ministry of Education, Science and Technological Development, Republic of Serbia, Grant N° TR-31022.

Phenological phases of leaf unfolding and leaf fall of sessile oak (*Quercus petrea* Matt./Liebl.) on Fruška Gora

Pekeč, S., Orlović, S., Drekić, M., Katanić, M., Stojnić, S.

Institute of Lowland Forestry and Environment, University of Novi Sad, Antona Čehova 13, Novi Sad, Serbia

* *pekecs@uns.ac.rs*

Abstract: The paper presents the phenology of sessile oak (*Quercus Petrea* Matt./Liebl.) in a location for monitoring the impact of air pollution on forest ecosystems located on Fruška Gora. The monitoring of the phenology of leaf unfolding phase and leaf fall phase is presented in three years: 2014, 2016 and 2018. Between phenological phases of leaf unfolding phase and leaf fall phase in different years of monitoring there are differences in the beginning and end of these phases, as well as in the duration of the monitored phenological phases.

The effect of foliar application of nitrogen on the physical and chemical properties of apricot

Milović, M.[1], Magazin, N[1], Milić, B.[1], Mastilović, J.[2], Kevrešan, Ž.[2], Kalajdžić, J.[1], Popara, G.[1]

[1]Department of Fruit growing, Viticulture, Horticulture and Landscape architecture, Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, Novi Sad, Serbia

[2]Institute of Food Technology, University of Novi Sad, Bulevar Cara Lazara 1, Serbia

* *maja.miodragovic@polj.uns.ac.rs*

Nitrogen (N) deficiency has a negative impact on fruit size, the differentiation of flower buds and leads to the early onset of fruits maturation. Apricot trees provided with an optimum N supply have the higher yields and better storage potential. The objective of this research was to examine the effects of foliar N application on fruit physical and chemical properties of two apricot cultivars NS-6 and NS-4. The study was carried out in two experimental years, 2016 and 2017, in a high density plantation established in 2012, with planting distance 4 × 2 m with northeast-southwest row orientation. N was applied three times in a growing season with three different concentrations: 0.5, 1 and 1.5%, including the untreated control. Urea (46% N in amide form) mineral fertilizer was used for foliar treatments as a source of N. Fruits from untreated control had higher soluble solids content (SSC) and lower titratable acidity (TA) than N treated fruits in both cultivars tested in 2017. N application consistently increased fruit weight of cultivar NS-6. N application increased fruit firmness within the range from 25.6 to 33.6 % compared to the untreated controls depending on the cultivar and the year.

Acknowledgments. This work was funded by the Provincial Secretariat for Science and Technological Development of Autonomous Province of Vojvodina, within the long-term project “Improving quality and storage ability of fruits by using plant growth regulators and stimulators”.

Comparative analysis of peduncle secretory tissues of wild perennial sunflower species

Jocković J.[1], Terzić, S.[2], Zorić, L.[1], Radanović A.[2], Cvejić, S.[2], Miladinović, D.[2], Luković, J.[1]

[1]University of Novi Sad, Faculty of Sciences, Trg D. Obradovica 2, Novi Sad, Serbia

[2]Institute of Field and Vegetable Crops, Maksima Gorkog 30, Novi Sad, Serbia

* *jelena.lazarevic@dbe.uns.ac.rs*

The knowledge about characteristics of secretory tissues in the genus *Helianthus* L. is especially useful in breeding cultivated sunflower in order to increase resistance to biotic stress. Therefore, the aim of this research was to make detailed comparative analysis of secretory ducts and trichomes in peduncle of 19 perennial *Helianthus* species. For anatomical analyses cross-sections of peduncle were obtained using cryotechnic procedure. Observations were performed using light microscope. In all examined species secretory ducts were located in the cortical parenchyma, outside the peduncle vascular bundles. But some of the examined species (*H. glaucophylus*, *H. rigidus*, *H. nuttalli*, *H. maximiliani*, *H. giganteus*, *H. decapetalus*, *H. laevigatus*, *H. mollis*) had additional smaller ducts located close to xylem. Unlike other examined species, *H. mollis* was the only species with extra secretory channel positioned centrally in the peduncle parenchyma pith. Also, many of the examined species hadindumentum made of non-glandular (long, uniseriate, multicellular, comprising of 3-10 cells) and linear glandular trichomes (multicellular, uniseriate, comprising of 3-6 cells) with different density. However, two species *H. smithii* and *H. eggertii* were without any trichomes on peduncle surface. Comparative analysis of peduncle secretory tissues significantly contribute to understanding of resistance to insect pests in wild sunflower species and their potential use in breeding program of cultivated sunflower.

Acknowledgments. This study was supported by Provincial Secretariat for Higher Education and Science of Vojvodina, project 142-451-2422/2018-03.

Japanese garden in Balkan way

Anđelković, A.[1], Rančev B.[1], Zlatković, B.[2], Metalkova, M.[3]

[1]University of Niš, Faculty of Civil Engineering and Architecture, Aleksandra Medvedeva 14, Niš, Serbia

[2] University of Nis, Faculty of Science and Mathematics, Visegradska 33, Nis, Serbia

[3]University of Architecture, Civil Engineering and Geodesy, Bulevar Hristo Smirnevski 1, Sofia, Bulgaria

* *ana95a@gmail.com*

Japanese rock gardens have been a part of Japanese culture for many centuries and are well known for sophisticated, minimal design. Some of the basic elements of Japanese rock garden designing concept: the idea that garden should look as if it grew by itself, principle “less is more”, asymmetry, contrast, etc. can be successfully applied in non-Japan regions as well. Applying the Japanese concept into gardens of Balkan region can be efficiently achieved by appropriate choice of plant species native for Balkan Peninsula, like succulents are. Some of the representatives of Balkan flora suitable for this purpose belong to the plant family Crassulaceae which include species of the following genera: *Sempervivum*, *Sedum* and *Hylotelephium*. Numerous, original species of different life forms, leaf shapes and various flower colors, are available for ornamental purposes in the region. Special attention should be given to endemic and rare Balkan taxa that could be used in ex-situ conservation efforts adopted by the concept of Japanese garden. Making this joint of Balkan floristic richness and Japanese rock garden design concept, a unique mixture can arise providing specific multicultural esthetic and human values, establishing a connection between these two distinctive cultures.

Phenolic content and antioxidant activity of five sweet cherry cultivars

Milović, M., Ognjanov, V., Barać, G., Ljubojević, M., Dulić, J., Peić Tukuljac, M., Prvulović, D.

Department of Fruit growing, Viticulture, Horticulture and Landscape architecture, Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, Novi Sad, Serbia

e-mail: maja.miodragovic@polj.uns.ac.rs

Fruits of sweet cherry (*Prunus avium* L.) contain a large number of natural antioxidants. One of the most significant are different phenolic substances. For plants phenolic compounds are necessary for pigmentation, growth and development, reproduction, defense against pathogens and herbivores attacks, as well as due to many other functions. The aim of this work was to determine the content of different total phenolics and total flavonoids in fruits of 5 different sweet cherry cultivars: 'Carmen', 'Rita', 'New Star', '*Burlat' and* '*Peter'. Fruits samples of all cultivars were selected in a period of full maturity and* extracted with 70% ethanol and 70% acetone solutions and their antioxidant activity was estimated with 3 different assay: DPPH (2,2-diphenyl-1-picrylhydrazyl), ABTS (2,2'-azino-bis(3-ethylbenzothiazoline -6-sulphonic acid) and FRAP (ferric-reducing antioxidant power). The higher contents of total phenolics and antioxidant capacity were found in acetone extracts compared to ethanol extracts. Results showed that cultivar '*Peter' had* the highest amount of phenolic component and also highest antioxidant capacity of all investigated cultivars.

Acknowledgements. The research presented in this article is part of project No. TR-31038 financially supported by Ministry of Education, Science and Technological Development of the Republic of Serbia

Characteristic vegetation cover developing under different hydrological conditions in Ždralovac peatland in Livanjsko karst polje

Tvica, M.[1], Knežević, M.[2], Sarajlić, N.[3]

[1]Institute for Pedology, agrochemistry and melioration, Faculty of Agriculture and Food Sciences, University of Sarajevo, Zmaja od Bosne 8, 71000 Sarajevo, Bosnia and Herzegovina

[2]Dept. of Forestry, Faculty of Forestry, University of Belgrade, Kneza Višeslava 1, 11000 Belgrade, Serbia

[3]Dept. of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

* *mirzatvica@hotmail.com*

Ždralovac peatland was formed in two landscape depressions in Livanjsko polje, as a geogenous fen type peatland fed by groundwater that has been in contact with limestone. The traditional use of this area for livestock grazing and mowing is suppressed by the commercial extraction of peat. Extensive draining led to the decrease in water level (measured in a series of piezometers and comparing the duration of the flood with the situation prior to drainage) and mineralization of peat, as well as to frequent fires and changes in the vegetative cover. Depending on the hydrological conditions, four zones can be identified in the Ždralovac peatland. The northern "virgin" zone without drainage is dominated by Carex elata and dense Phragmites australis stands. The second zone is drained, bordered by dense reed, Salix and Populus trees. Zone three consists of the exploitation pools periodically filled with water, in which the process of natural revegetation is slow. In zone 4, at abandoned (20 years) meliorated peatland once used for agriculture, wetland vegetation is completely suppressed by grass, bushes and young forest. In the areas in which burning the top layer of peat has occurred, shrubs and trees have developed instead of reed and sedge.

Monitoring of soil on the presence of weed and alrgogenic plants in the urban and semiurban areas of the city of Novi Sad

Bojčić, S.[1], Samardžić, N.[2], Popov, M.[2], Konstantinović, B.[2], Igić, R.[1], Anačkov, G.[1]

[1]University of Novi Sad, Faculty of Sciences, Department of Biology and Ecology, Trg Dositeja Obradovića 3, Novi Sad, Serbia

[2]University of Novi Sad, Faculty of Agiculture, Department for Environmental and Plant Protection, Trg Dositeja Obradovića 8, Novi Sad, Serbia

* *slobodan.bojcic@dbe.uns.ac.rs*

Multi-year investigations of invasive, quarantine and allergenic plants have determined the mechanisms and ways of their spreading in urban and rural areas of Novi Sad. Weed species are characterized by a very high seed and fruit production, and their spreading in urban and semi-urban zones is done through human and animal activities. In recent years, often a large number of weed species, in the form of seeds and fruits that are present in the soil, reach into urban areas. During the soil monitoring for the presence of seeds and fruits of weed species, urban surfaces that have undergone changes through the arrangement and formation of grass surfaces with a humus layer which was added on the surface, were directly selected from the field areas around Novi Sad. In addition to these sites, part of this research was done on ruderal localities as well as agrobiocenosis. A sampling of soil was carried out by a probe, always of the same volume and at a depth of 0 to 15 cm, at 70 localities, by random sampling method. The number of fruits/seeds was determined by the method of physical extraction from the soil sample. Seeds and fruits are preserved in most cases, which indicates their ability to germinate in a favorable period. The total number of detected weed species in all samples was 41, among them 5 grass species that were used in the formation of lawns.

Monitoring of soil on the presence of weed and alergogenic plants in the urban and semiurban areas of the city of Novi Sad

Bojčić S.[1*], Samardžić, N.[2], Popov, M.[2], Konstantinović, B.[2], Igić, R.[1], Anačkov, G.[1]

[1] University of Novi Sad, Faculty of Sciences, Department of Biology and Ecology, Trg Dositeja Obradovića 3, Novi Sad, Serbia

[2] University of Novi Sad, Faculty of Agiculture, Department for Environmental and Plant Protection, Trg Dositeja Obradovića 8, Novi Sad, Serbia

* *slobodan.bojcic@dbe.uns.ac.rs*

Multi-year investigations of invasive, quarantine and allergenic plants have determined the mechanisms and ways of spreading these species in urban and rural areas of Novi Sad. The weedery species are distinguished by a very high production of seeds and fruits, and their spreading in sloping and semi-urban zones is done through man and animals. In recent years, often a large number of weed species, through seeds and fruits in the soil, reach into urban areas. Within the monitoring of this kind of soil for the presence of seeds and fruits of weed species, surfaces that have undergone change through the arranged and forming of grass surfaces with a humus layer, which is planed to the surface, are directly selected from the field areas around Novi Sad. In addition to these sites, part of the research is the ruderal locality and locality of agrobiocenosis. Sampling of soil was carried out by a probe of the same volume and at a depth of 0 to 15 cm, at 70 localities, by random sampling method. In determining the number of fruits / seeds, the method of physical extraction from the soil sample was applied. The seeds and fruits are preserved in the largest number of cases, which indicates the ability to precipitate in a favorable period. The total number of detected weed species in all samples is 41 species, with the presence of 5 grass species used in the formation of lawns.

The effect of age of cows on milk quality at first fertilization in standard lactations

Jevtić, A.

The College of Agriculture and Food Technology, Ćirila and Metodija Street No 1, Prokuplje 18400, Serbia

* *aleksandrajevtic76@gmail.com*

By studying the effect of age at the first fertilization and milk quality according to standard lactations, we have determined the following: Premature first mating slows down the development of a head of cattle which leads to a reduction in its production value. Early fertilized heifers give less vital and lighter calves and less milk in the first lactation. Therefore, special attention should be paid to the age during the first fertilization because it is reflected on the first lactation. Correlation coefficients in all cases indicate that the effect of age at the first fertilization and milk properties according to standard lactations of daughters of the selected bulls are not significantly correlated, since the coefficient of correlation ranges from -2.485 to 0.2516, i.e. r <0.50, and this is significant. The determination coefficient ranges from 0.0162 to 0.0633, indicating that in all cases of ¼ of the total deviation a typical systematic deviation occurs in the observed interrelations of the interdependence of the age at the first fertilization and the milk characteristics by standard lactations of the Major, OST and Osident daughters, that is maximum 1.6 % of cases, the age at first fertilization has an effect on milk properties by standard lactation. A strong correlation between milk properties in standard lactation of bull daughters was established.

Impact of simmental bulls in artificial insemination on some reproductive traits of cows

Jevtić, A.

The College of Agriculture and Food Technology, Ćirila and Metodija Street No 1, Prokuplje 18400, Serbia

* *aleksandrajevtic76@gmail.com*

The aim of our study was to determine the degree of influence of selected Simmental bulls on changing certain parameters of reproductive traits of cows in the Moravica, Raška and Rasina districts. The parameters that were monitored were: the number and percentage of inseminated cows, the number of pregnant cows after the first, second and third insemination, the insemination index, as well as the average number of spent semen doses per inseminated cow. What we also determined is the number of difficult calving, the percentage of stillborn calves, gestation length and body mass of newborn cows. Pregnancy rates per year was different and ranged from 50.8 – 88,6%. The insemination index ranged from 1.10 - 1.66%, and the number of spent semen doses per pregnant cow was 1.45 - 1.82%. The percentage of difficult calving ranged from 2-10%, and the percentage of stillborn calves was 5 - 6,2%. The length of gestation ranged from 283 - 288 days, and the body weight of calves was 38.3 - 44.8 kg.

Effects of salt stress factors on antimicrobial activity of two *Triticum aestivum* L. varieties

Hacioğlu Doğru, N., Acar, O.

Department of Biology, Faculty of Arts and Sciences, Çanakkale Onsekiz Mart University, Çanakkale, Turkey

* *nurcihan.n@gmail.com*

Salinity is one of the most common environmental stress factors that adversely affect plant growth and crop production in cultivated areas worldwide. Herbal or 'alternative' medicine is gaining popularity and scientific research about wheat grass as a "functional food" is becoming more available and popular. Wheat grass, *Triticum aestivum* L. has a long history and is widely used as a health food supplement. It is found to be used as a treatment for minor ailments and serious life threatening issues, and also as a preventative dietary supplement and therapeutic drugs. Current study was aimed at evaluation of antimicrobial properties of two varieties of *T. aestivum* L. [cv. Tosunbey (drought tolerant) and cv. Sultan 95 (drought sensitive)] which grown in three different condition [(1) control; not treatment with salt or acetyl salicylic acid; (2) treatment with sea water; (3) sea water and pre-treatment of seeds with acetyl salicylic acid]. The antimicrobial activity of the ethanol extracts of two varieties of *T. asetivum* were assayed against *Escherichia coli* NRRL B-3704, *Pseudomonas aeruginosa* ATCC 27853, *Proteus vulgaris* ATCC 13315, *Acinetobacter baumanii* ATCC 19606, *Bacillus subtilis* ATCC 6633, *Staphylococcus aureus* ATCC 25923, *S. haemolyticus* ATCC 43252 and Candida *albicans* ATCC 10231 test microorganisms by agar disc diffusion method and micro broth dilution methods**.** The results of showed that the ethanol extracts from the different treatments studied showed antimicrobial activities, with the diameters of the inhibition zone ranging from 8 to 13 mm and 2.5 to 20 µg/mL, respectively**.** But, the highest antimicrobial activity against *P. aeruginosa* ATCC 27853were demonstrated by the extract of *T. aestivum* cv. Sultan 95 which grown in sea water and pre-treatment of seeds with acetyl salicylic acid.

Effects of drought stress factors on antibacterial activity of two *Triticum aestivum* L. varieties

Acar, O., Hacioğlu Doğru, N.

Department of Biology, Faculty of Arts and Sciences, Çanakkale Onsekiz Mart University, Çanakkale, Turkey

* *nurcihan.n@gmail.com*

Triticum aestivum L. (Wheat grass), one of the members of Poaceae family, has been considered for very efficient therapeutic drugs. Current study was aimed at evaluation of antibacterial properties of two varieties of *T. aestivum* L. [cv. Tosunbey (drought tolerant) and cv. Sultan 95 (drought sensitive)] which grown in three different stress condition [(1) drought stress; (2) pre-treatment of seeds with acetyl salicylic acid; (3) drought stress and pre-treatment of seeds with acetyl salicylic acid].The antibacterial activity of the ethanol extracts were assayed against five pathogens (*Pseudomonas aeruginosa* ATCC 27853, *Proteus vulgaris* ATCC 13315,*Escherichia coli* NRRL B-3704, *Staphylococcus aureus* ATCC 25923 and *Bacillus subtilis* ATCC 6633) by agar disc diffusion method and micro broth dilution methods**.** The results of showed that the ethanol extracts from the different treatments studied showed antibacterial activities, with the diameters of the inhibition zone ranging from 8 to 15 mm and 2.5 to 20 µg/mL, respectively**.** But, the highest antibacterial activity against *B. subtilis* ATCC 6633 were demonstrated by the extract of *T. aestivum* cv. Sultan 95 which grown in drought stress and pre-treatment of seeds with acetyl salicylic acid.

13th Symposium on the Flora of Southeastern Serbia and Neighboring Regions

Stara planina Mt. 20th-23th June, 2019

Zoology (animal and plant interactions)

ORAL PRESENTATION

Invasive plant and fish species in the Međuvršje reservoir (Zapadna Morava River, Serbia)

Marković, G.[1], Tanasković, S.[1], Brković, D.[1], Vićentijević Marković, G.[2]

[1]Faculty of Agronomy, University of Kragujevac, Cara Dušana 34, 32000 Čačak, Serbia

[2]Grammar School "Takovski ustanak", Miloša Velikog 11, 32300 Gornj Milanovac, Serbiai

* *goranmsv@kg.ac.rs*

The Međuvršje reservoir is one of the oldest Serbian reservoirs, created in 1953. Its surface is 1.5km^2, length 9.32km, maximum width 272m and depth 12m. The original volume was 15.4 x 10^{6}m^3, but more than 70% is lost due to sediment deposition. This lake ecosystem is undergoing intense eutrophication. Favourable hydroecological conditions allow the development of plankton, bottom fauna, macrophyte and fish assemblies. Macrophytes (aquatic vegetation) include 18 species of 4 families. The dominance of *Potamogeton natans*, *Myriophyllum spicatum*, *Phragmites communis* and, especially, *Trapa natans* has been observed in recent years. Water chestnut (*T. natans*) is a highly invasive plant species, whose presence in the reservoir was first registered in 2011. It has acclimated very well to the new habitat, covering over 60% of the water surface in some reservoir sectors. Its further expansion would cause accelerated eutrophication of the ecosystem. The Međuvršje reservoir ichthyofauna includes 21 species of 6 families, with 6 allochthonous (non-native) species of 4 families. The increase in the number of allochthonous fish, especially Prussian carp (*Carassius gibelio*), threatens indigenous ichthyofauna and contributes to deteriorating water quality.

Acknowledgements. The research was part of Project TR31011 of the Ministry of Education, Science and Technological Development of Serbia

Results of monitoring of birds from the owls order Strigiformes Wagler, 1830 in the nature park "Stara planina"

Radaković, M., Medenica, I., Nedeljković, D., Jović, D.

Institute for Nature Conservation of Serbia, Street: Dr Ivana Ribara No 91, 11070 Belgrade, Serbia

* *milos.radakovic@zzps.rs*

Vegetation communities in the ecosystems also cause the presence of specific animal communities. Dependence of certain bird species on different types of forest communities is already known, and the quality of vegetation in ecological sense is one of the prerequisites of biodiversity. Establishment of monitoring system of nocturnal birds of pray in forest ecosystems was done in nature park „Stara planina" within the project„Monitoring of the birds of Stara planina" from 2015. Three areas (Arbinje, Široke luke, Babin zub – Aldinac) were determined as areas for conducting the research by placing artificial nest boxes for owls nesting. Three types of nest boxes for three owl species were placed – for Tawny Owl *Strix aluco* L. and Ural Owl *Strix uralensis* Pallas, 1771 and Boreal Owl *Aegolius funereus* (L.). Nesting of Tawny Owl in nest box was recorded on Babin zub. Presence of Eurasian Pygmy Owl *Glaucidium passerinum* (L.) was recorded for the first time in bird monitoring of Stara planina. It is confirmed that forestry practice has great impact on number and distribution of owls in NP „Stara planina".

Acknowledgement: The financing of the project "Bird Monitoring in NP „Stara Planina" was financed by PC „Srbijašume", FF "Pirot" by the funds of the Ministry of Agriculture and Environmental Protection.

Diversity assessment of epiphythic macroinvertebrate assemblages from DTD canals on the territory of Bački Petrovac municipality (Vojvodina, Serbia)

Jurca, T.[1], Miljanović, B.[1], Svirčev, Z.[1]

[1]Hydrobiology lab, University of Novi Sad, Faculty of Sciences, Depatment of Biology and ecology, Faculty of Sciences, Trg Dositeja Obradovića 2, Novi Sad, Serbia

* *tamara.jurca@dbe.uns.ac.rs*

Epiphytic fauna represents the animal organisms which can be found on and around the aquatic plants. Freshwater macroinvertebrates are free-living invertebrates visible to the human eye (with body dimensions more than 0.5 mm). Epiphytic macroinvertebrates can be perceived as bottom fauna, however because of their interactions with aquatic plants, such as feeding on biofilm or using them as refuge from predators, these epibionts form distinct communities in highly eutrophic, stagnant waters of DTD canals in Vojvodina. Four sampling sites on the territory of Backi Petrovac municipality in Vojvodina, were chosen for the exploration of the epibiotic macroinvertebrate communities associated with floatant and submerged macrophytes. The samples of littoral-dwelling invertebrates were taken using the standard FBA hand net from sites with dense macrophyte coverage, when present. The overall aim was to assess the changes in diversity between the assemblages recorded in spring and autumn seasons during 2017 and 2018. The results of two-year investigation have shown the high diversity including up to 38 different taxa (genera or species) belonging to up to 19 different families of freshwater macroinvertebrates from four sampling sites, recorded in single season. Among the groups with highest taxonomical richness, Gastropoda, Odonata and Oligochaeta could be distinguished.

Acknowledgements: We wish to thank the Municipality of Bački Petrovac for allowing us to use the results of study performed as part of the regular monitoring of the water quality. Tamara Jurca and Zorica Svirčev were co-funded by the Serbian Ministry of Education, Science, and Technological Development, through Grant No. III43002.

A contribution to the knowledge of ecology of the species *Serratella ignita* (Poda, 1761)

Savić, A.[1], Đorđević, M.[2], Milošević, Đ.[1], Jušković, M.[1], Đorđević, M.[3], Pešić, V.[4]

[1]Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Niš, Serbia

[2]Department of Mathematics, Faculty of Sciences and Mathematics, University of Niš, Niš, Serbia

[3]Department of Geography, Faculty of Sciences and Mathematics, University of Niš, Niš, Serbia

[4]Department of Biology, University of Montenegro, Podgorica, Montenegro

* *anka@pmf.ni.ac.rs*

This research focuses on life history parameters as life cycle and nymphal growth pattern of *Serratella ignita*, species widely distributed throughout the Palearctic region. This mayfly species is found in diverse permanent and temporary waters. The aims of this paper were: to determine the environmental factors most important for appearance and abundance of *Serratella ignita*; to determine the factors that control biomass of this species; to detect the differences in life cycle and behavior through comparison with data from the Mediterranean area (both from permanent and from temporary watercourses). Samples of *Serratella ignita* were taken on monthly basis at ten localities along the Nišava River during a one-year period. The significant factor that defined abundance of this species was percentage of stable substrates (p=0.042). Statistically significant correlation was determined between biomass of individuals and: water depth (p=0.000), conductivity (p=0.037), mass of periphyton (p=0.021), oxygen concentration (p=0.000), and concentration of chlorophyll a (p=0.034). Our study is similar to some in the Mediterranean area in recognizing the idea that this group of species may become dominant due to future global climate changes, by increasing the abundance of their populations on expense of other, more stenoecious species.

13th Symposium on the Flora of Southeastern Serbia and Neighboring Regions

Stara planina Mt. 20th-23th June, 2019

Index of author