



Department of Biology and Ecology,
Faculty of Sciences and Mathematics
University of Niš
Institute for Nature Conservation of Serbia

ABSTRACTS APSTRAKTI

**14th Symposium
on the Flora of Southeastern Serbia
and Neighboring Regions**

Kladovo 26 to 29 June 2022

**14. Simpozijum
o flori jugoistočne Srbije
i susednih regiona**

Kladovo 26. do 29. jun 2022.

Niš-Belgrade, 2022

Department of Biology and Ecology,
Faculty of Sciences and Mathematics, University of Niš
Institute for Nature Conservation of Serbia

**14th Symposium on the Flora of
Southeastern Serbia
and Neighboring Regions**

Kladovo, 26th to 29th June, 2022

Abstracts

14th Symposium on the Flora of Southeastern Serbia and Neighboring Regions,
Kladovo, 26th to 29th June 2022

Book of Abstracts

Publishers

Department of Biology and Ecology, Faculty of Sciences and Mathematics,
University of Niš
Institute for Nature Conservation of Serbia, Belgrade

Organizers

Department of Biology and Ecology, Faculty of Sciences and Mathematics,
University of Niš
Institute for Nature Conservation of Serbia, Belgrade

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Printed by

Grafik Centar Beograd

Number of copies

210

Niš-Belgrade, 2022

PROGRAMME

Sunday, June 26th, 2022

12.00-15.00 Registration

15.00-16.00 Opening Ceremony

16.00-16.30 Plenary Session

16.30-17.00 Coffee break

17.00-18.30 Session 1 and Session 2

Hall 1

Phytogeography, Floristics and Phytoecology

Hall 2

Taxonomy and Systematics

Monday, June 27th, 2022

9.00-10.30 Session 3 and Session 4

Hall 1

Phytogeography, Floristics and Phytoecology

Hall 2

Taxonomy and Systematics

10.30-11.00 Coffee break

11.00-13.00 Session 5 and Session 6

Hall 1

Ecology and Environmental Protection

Hall 2

Agriculture, Forestry and Landscape Architecture,
Genetics, Selection and Biotechnology, Zoology

Poster Session 1

15.00-16.30

Taxonomy and Systematics,
Phytogeography, Floristics and Phytoecology,
Nature Protection

Poster Session 2

17.00-18.30

Agriculture, Forestry and Landscape Architecture,
Genetics, Selection and Biotechnology, Zoology,
Ecology and Environmental Protection

Panel discussion

19.00-20.00

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9.00-11.00 Session 7 and Session 8

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Phytochemistry and Phytotherapy

Hall 2

Nature Protection

Poster Session 3a

11.30-13.00

Phytochemistry and Phytotherapy

13.00-13.30 Pause

Poster Session 3b

13.30-15.00

Phytochemistry and Phytotherapy

15.00-16.00 Lunch break
16.00 Excursion (Danube boat ride)
21.00 Conference dinner

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08.00-09.00 Breakfast
09.00-09.30 Closing ceremony
10.00 Check out

Detailed Programme

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Sunday, June 26th, 2022.

15.00-16.00

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Plenary Lectures

16.00-16.15

Ostojić, D., Department for Natural Resources, Landscape Values and Spatial Planning
Documentation, Institute for Nature Conservation of Serbia, Belgrade, Serbia
Natural and cultural values of NP Đerdap - concept and protection perspectives

16.15-16.30

Milanovici, S., Natural Science Department, National Museum of Banat, Huniade Square
no. 1, Timișoara City, Timiș County, Romania
Presence, distribution, and population status of several rare plant taxa in the Portile de Fier Nature Park (Romania)

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Phytogeography, Floristics and Phytoecology, Hall 1

Sunday, June 26th, 2022.

Chairs of the section: Purger, D., Trakić, S.

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Lakušić, D., Kuzmanović, N., Kovačević, J.
Kuzmanović, N., University of Belgrade, Faculty of Biology, Chair of Plant Ecology and
Phytogeography, Belgrade, Serbia
Generalized habitat map of Serbia

Oral Presentations

17.15-17.25

Čušterevska, R., Matevski, V., Kostadinovski, M., Mandžukovski, D.
Čušterevska, R., Institute of Biology, Faculty of Natural Sciences and Mathematics, Ss.
Cyril and Methodius University, Skopje, N. Macedonia
Priority habitats on the territory of the Republic of North Macedonia

17.25-17.35

Jogan, N., University of Ljubljana, Biotechnical Faculty, Dept. Of Biology, Ljubljana,
Slovenia
Ferns in the ex-Yu region: do we know them all?

17.35-17.45

Brujić, J., Koljanin, D., Milanović, Đ., Stupar, V.

Brujić, J., Department of Silviculture, Faculty of Forestry, University in Banja Luka, Banja Luka, Republic of Srpska, Bosnia and Herzegovina

Some wetland plants in Bosnia and Herzegovina - new records and conservation remarks

17.45-17.55

Novović, S., Menković, N., Stojanović, V.

Stojanović, V., Institute for nature Conservation of Serbia, Belgrade, Serbia

New data on the distribution of two protected and one invasive species in the flora of Serbia

17.55-18.05

Ranimirović, M., Đurović, S., Tomović, G., Niketić, M.

Ranimirović, M., Natural History Museum, Belgrade, Serbia

Distribution of Euphorbia sect. Helioscopia Dumort. (Euphorbiaceae) based on the data in Herbarium collections in Belgrade

18.05-18.15

Anastasiu, P., Sirbu, I.-M., Gavrilidis, A.A., Miu, V.I., Niculae, M.I.

Anastasiu, P., University of Bucharest, Bucharest, Romania

Alien plant species hot spots in Romania

18.15-18.25

Tabašević, M., Lakušić, D., Vukojičić, S., Kuzmanović, N.

Tabašević, M., Institute of Botany and Botanical Garden, Faculty of Biology, University of Belgrade, Belgrade, Serbia

Ruderal vegetation of the class Sisymbrietea in Serbia

Taxonomy and Systematics, Hall 2

Sunday, June 26th, 2022.

Chairs of the section: Rešetnik, I., Anačkov, G.

Introductory Lectures

17.00-17.15

Zorić, L., Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia

Trends in applied plant anatomy

Oral Presentations

17.15-17.25

Terlević, A., Temunović, M., Bogdanović, S., Grgurev, M., Ljubičić, I., Rešetnik, I.

Terlević, A., Department of Biology, Faculty of Science, University of Zagreb, Zagreb, Croatia

Morphological and ecological variability of the Dianthus sylvestris complex (Caryophyllaceae) on the Balkan Peninsula

17.25-17.35

Çiftçi, A., Botany Division, Department of Biology, Faculty of Science, Istanbul University, Vezneciler, Istanbul, Turkey

Testing techniques and usefulness of Elliptic Fourier Analysis on Anatomical Sections

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Niketić, M., Tomović, G., Buzurović, U., Vuksanović, S., Jakovljević, K., Lazarević, M., Dragičević, S.

Tomović, G., University of Belgrade, Faculty of Biology, Belgrade, Serbia

Centaurea ozrenii (Asteraceae) - a new and extremely rare species from Serbia

17.45-17.55

Erol, O., Abudurusuli, A., Çiftçi, A.

Erol, O., Botany Division, Biology Department, Faculty of Science, Istanbul University, Vezneciler, Istanbul, Turkey

Crocus pallasii Goldb. From North to South of Turkey: Just a Phenotypic Variation or Speciation?

Phytogeography, Floristics and Phytoecology, Hall 1

Monday, June 27th, 2022.

Chairs of the section: Nejc, J., Milanović, Đ.

Introductory Lectures

09.00-09.15

Papp, B., Lőkös, L.

Papp, B., Hungarian Natural History Museum, Botanical Department, Budapest, Hungary
Cryptogam flora (bryophytes and lichens) of Djerdap National Park

Oral Presentations

09.15-09.25

Marković, A., Schneider, S., Trajanovska, S., Biberdžić, V., Talevska, M., Imeri, A., Blaženčić, J.

Marković, A., Department of Chemistry, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade, Serbia

The Sava Lake – charophyte gem in the heart of Belgrade

09.25-09.35

Glišić, M., Jakovljević, K., Šinžar Sekulić, J., Lakušić, D., Vukojičić, S., Anačkov, G., Jovanović, S.†

Glišić, M., Unit for Agricultural and Business Studies and Tourism, Academy of Applied Studies Šabac, Šabac, Serbia

Alien flora of urban habitats in Serbia

09.35-09.45

Rat, M., Anačkov, G., Bogdanović, S.

Rat, M., University of Novi Sad, Faculty of Sciences, Department of Biology and Ecology, Novi Sad, Serbia

The Croatian flora plant material in the Herbarium BUNS

09.45-09.55

Tmušić, G., Bojčić, S., Anačkov, G.

Tmušić, G., Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia

Mapping urban invasions using Google street view – tree of heaven in Novi Sad

09.55-10.05

Vlku, A., Radak, B., Bokić, B., Peškanov, J., Anačkov, G.

Vlku, A., Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia

Contribution to the orchid flora of Northeast Serbia

10.05-10.15

Radak, B., Peškanov, J., Bokić, B., Tmušić, G., Obradov, D., Anačkov, G.

Peškanov, J., Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia

Vascular flora of the Special Nature Reserve "Wetlands of the lower Tisa" (Vojvodina, Serbia)

10.15-10.25

Radak, B., Peškanov, J., Bokić, B., Rat, M., Miljković, P., Beloica, J., Anačkov, G.

Radak, B., Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia

Novelties for the orchid flora of Montenegro

10.25-10.35

Milanović, Đ., Stupar, V.

Milanović, Đ., University of Banja Luka, Faculty of Forestry, Banja Luka, Bosnia and Herzegovina

Disentangling the syntaxonomy and nomenclature of Serbian spruce (*Picea omorika* (Pančić) Purk.) communities

Taxonomy and Systematics, Hall 2

Monday, June 27th, 2022.

Chairs of the section: Zorić, L., Tomović, G.

Oral Presentations

09.00-09.10

Harpke, D., Raca, I., Randelović, V.

Harpke, D., Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), Gatersleben, Germany

Series Verni Mathew (*Crocus L.*) in Southeastern Europe vol. 1 –resolving the polyploid mess

09.10-09.20

Raca, I., Harpke, D., Randelović, V.

Raca, I., Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Niš, Serbia

Series Verni Mathew (*Crocus L.*) in Southeastern Europe vol. 2 - matching the cytotypes and morpho-anatomical features with the traditional nomenclature

09.20-09.30

Bokić, B., Radak, B., Rat, M., Anačkov, G.

Bokić, B., Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia

Flower dimorphism and ginodioecy of *Mentha longifolia* (L.) L. and *M. spicata* L. from Balkan peninsula and Pannonian Plain – a pilot study

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Prijić, Ž., Peškanov, J., Marković, T., Xiuxin, Z., Jingqi, X., Rat, M., Zlatković, B., Panjković, B., Anačkov, G.

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

Variation in seed morphology of Paeonia L. taxa from Serbia

09.40-09.50

Gavrilović, M., Oskolski, A., Rančić, D., Trajković, M., Janačković, P.

Gavrilović, M., University of Belgrade, Faculty of Biology, Department of Morphology and Systematics of Plants, Belgrade, Serbia

Anatomy of Leontopodium nivale subsp. alpinum (Cass.) Greuter (Gnaphalieae, Asteraceae) from Serbia

Ecology and Environmental Protection, Hall 1

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Chairs of the section: Stamenković, S., Nikolić, D.

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Jakovljević, K., Mišljenović, T., Tomović, G., Baker, A., van der Ent, A., Echevarria, G.

Jakovljević, K., Institute of Botany and Botanical Garden, Faculty of Biology, University of Belgrade, Belgrade, Serbia

Metal hyperaccumulation in plants: State of knowledge and potential for future research

Oral Presentations

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Milovanović, V., Jakovljević, O., Subakov Simić, G., Trbojević, I.

Milovanović, V., University of Belgrade, Faculty of Biology, Institute of Botany and Botanical Garden "Jevremovac", Belgrade, Serbia

Not so big, yet so important: First insight into the phytobenthic algal diversity of a small pond

11.25-11.35

Vidović, M., Tosti, T., Nikolić, N., Pantelić, A., Veljović Jovanović, S.

Vidović, M., Institute of Molecular Genetics and Genetic Engineering, Laboratory for Plant Molecular Biology, University of Belgrade, Belgrade, Serbia

The role of polyphenols, sugars, and cell-wall associated polymers in desiccation tolerance of Ramonda serbica

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Ristić, S., Stamenković, S.

Stamenković, S., Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš, Niš, Serbia

Monitoring of air quality 1997-2020 in the urban area of Prokuplje (southeastern Serbia) using corticolous lichens

11.45-11.55

Stanković, V., Stanković, M., Perić, R.

Stanković, V., Institute of Criminological and Sociological Research, Belgrade, Republic of Serbia

Monitoring of Invasive Plant Species in SRP Zasavica

11.55-12.05

Temunović, M., Ljubičić, I., Bogdanović, S., Rešetnik, I.
Ljubičić, I., Department of Agricultural Botany, Faculty of Agriculture, University of Zagreb,
Zagreb, Croatia

**Maxent modelling for predicting the potential distribution of an amphi-
Adriatic plant *Festuca bosniaca* Kumm. et Sendtn. (Poaceae)**

Agriculture, Forestry and Landscape Architecture, Hall 2

Monday, June 27th, 2022.

Chairs of the section: Stanković, N., Petrov, Đ.

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Petrov, Dj., Ocokoljić, M.
Petrov, Dj., Department of Landscape Architecture and Horticulture, Faculty of Forestry,
University of Belgrade, Belgrade, Serbia

***Picea abies* (L.) H. Karst. morphological characteristics variability in the
climate change conditions on Čemernik mountain**

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Bobinac, M., Andrašev, S., Šušić, N., Kabiljo, M.
Bobinac, M., University of Belgrade, Faculty of Forestry, Belgrade, Serbia
***Growth characteristics of sessile oak (*Quercus petraeae* (Matt.) Liebl.,
Fagaceae) young crop in conditions of small size regeneration areas***

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Bobinac, M., Andrašev, S., Šušić, N., Radaković, N., Maksimović, M.
Bobinac, M., University of Belgrade, Faculty of Forestry, Belgrade, Serbia
***The distribution of Tree-of-Heaven (*Ailanthus altissima* (Mill.) Swingle,
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Yurdugül, S., Bolu Abant İzzet Baysal University, Department of Biology, 14030, Bolu,
Turkey
***Determination of various enzymatic activities of *Saccharomyces cerevisiae*
grown in Yeast-Potato Dextrose medium supplemented with Oak (*Quercus
robur*) leave debris***

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Marković, G., Brković, D., Đelić, G.

Marković, G., Faculty of Agronomy, University of Kragujevac, Čačak, Serbia
Plant material in chub (*Squalius cephalus* L., Cyprinidae) diet

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Ćirković, G., Ajtić, R.

Ćirković, G., Department of Biology and Ecology, Faculty of Science, University of Kragujevac, Kragujevac, Serbia

Preliminary investigation of tadpoles diet of species *Rana temporaria*, *Rana dalmatina*, *Bufo bufo* and *Bufo viridis* from different localities in Serbia and determination of presence of microplastics

Poster Session 1:

Taxonomy and Systematics

Phytogeography, Floristics and Phytoecology

Nature Protection

15.00-16.30

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Šovran, S., Mašić, E.

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First records of freshwater epizoic cyanobacteria and algae on two turtles *Trachemis scripta* Thunberg and Schoepff, 1792 (Reptilia, Emydidae) and *Emys orbicularis* Linnaeus, 1758 (Reptilia, Emydidae) identified in selected artificial ponds from Bosnia and Herzegovina

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Genetics, Selection and Biotechnology

Zoology

Ecology and Environmental Protection

17.00-18.30

Monday, June 27th, 2022.

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Zorić, L., Živanov, D., Karagić, Đ., Milić, D., Katanski, S., Karanović, D., Luković, J.

Stem anatomy related to lodging resistance of Vicia species

2

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

Seed priming mediated germination improvement physiological performance of radish (Raphanus sativus L.) seedlings

3

Janošević, D., Vojisavljević, K., Pećinar, I., Mitrović, A.

***Populus x euramericana* tension wood as a model for selection of microscopic methods for rapid screening of cell wall structure in the analysis of plant stem properties**

4

Bartolić, D., Prokopijević, M., Stanković, M., Radotić, K.

Characterization of Mung bean (Vigna radiata L.) seeds: antioxidant activity, chlorophyll and carotenoid content

5

Bojčić, S., Tmušić, G., Samardžić, N., Popov, M., Konstantinović, B., Anačkov, G.

Novel approach to control and suppress invasive weeds in the urban area of Novi Sad

6

Nagl, N., Kuzmanović, B., Zanetti, F., Vollmann, J., Marjanović Jeromela, A.

Genetic variation and relationship of spring Camelina accessions of different origin

7

Žugić Petrović, T., Mladenović, K., Grujović, M., Kolašinac, S., Orović, D.

Organic sunflower honey from the area of Banat (northeastern Serbia) - physicochemical and microbiological characterizations

8

Čuković, K., Bogdanović, M., Simonović, A., Todorović, S.

An efficient Agrobacterium tumefaciens - mediated genetic transformation method for Centaureum erythraea via secondary somatic embryogenesis

9

Stojičić, D., Tošić, S., Zlatković, B., Blagojević, S., Manić, B., Budimir, S., Uzelac, B.

Micropropagation of Clinopodium thymifolium (Scop.) Kuntze (Lamiaceae)

10

Krstić, T., Lozo, J., Stanković, S., Berić, T., Joković, N.

Rhizosphere of sugar beet as a source of bacteria with plant growth-promoting and biocontrol properties

11

Krstić, T., Novaković, M., Pešić, S., Žabar Popović, A., Joković, N., Vitorović, J.

In-vitro antioxidant and anti-inflammatory activities of CBD hemp seed oil

12

Pavlović, M., Joković, N., Nešić, M., Tošić, S.

Phytotoxic effect of aluminium on the early vegetation period of Cucumis melo L.

13

Ćirić, E., Stojanović, D., Pavlović, M.

Effect of potassium on salinity tolerance in Solanum lycopersicum L. seedlings

14

Savić, A., Dmitrović, D., Đorđević, M., Pešić, V.

The use of macroinvertebrate to characterize some ecosystem attributes in springs of southeastern Serbia

15

Miličević, A., Jakovljević, O., Popović, S., Krizmanić, J.

Influence of small hydro power plant on diatom community and water quality of the Ljuboviđa River (Serbia)

- 16 Andrejić, G., Kovačević, M., Aleksić, U., Dželetović, Ž., Rakić, T.
Effects of NPK fertilization on absorption of Pb in Miscanthus × giganteus grown on flotation tailings
- 17 Dorđević, B., Troter, D., Todorović, Z., Veljković, V.
Lecithine-based deep eutectic solvent in CaO-catalyzed ethanolysis of black mustard (Brassica nigra L.) seed oil
- 18 Jovanović, Ž., Marin, M., Radović, S.
Nickel (Ni) accumulation in the cells of Alyssum markgrafii - ultrastructural changes
- 19 Aleksić, U., Lazarević, M., Jakovljević, K., Andrejić, G., Lazarević, P., Tomović, G.
Metal accumulation in selected Scleranthus species (Caryophyllaceae) from different types of geological substrates in Serbia
- 20 Petronijević, T., Stanković, N., Milovanović, A., Milošević, Dj., Mihajilov-Krstev, T.
Influence of Microcystin-LR on two phytoplankton species (Nostoc sp. and Coelastrum sp.)
- 21 Mandić Bulić, T., Landeka, N., Sladonja, B., Poljuha, D., Cvek, M., Uzelac, M., Sudarić Bogojević, M., Grgat, T.
Early detection and eradication of Takahashia japonica Cockerell in the city of Pula
- 22 Bakić, V., Trakić, S., Muratović, E., Đug, S.
Pollen of allergenic plants in honey samples from Bosnia and Herzegovina
- 23 Todorović, M., Stanković, M., Kanjevac, M., Bojović, B., Zlatić, N.
Effect of different salts on the germination dynamics of Salvia officinalis L. seeds
- 24 Novaković, J., Jovanović, B., Jovičić, I., Janačković, P.
Detection of flowering plants in winter as a biological indicator of climate change
- 25 Ćirić, M., Gavrilović, B., Krizmanić, J., Dojčinović, B., Vidaković, D.
Diatom community on natural and artificial substrates in soda pans in early spring
- 26 Stamenković, O., Buzhdygan, O., Milošević, Dj., Čerba, D., Cvijanović, D., Stojković Piperac, M.
Drivers of epiphytic macroinvertebrate diversity along human pressure gradient in ponds
- 27 Tričković, D., Mitić, T., Savić, A.
Composition and structure of macroinvertebrate communities in two spring ecosystems in Southeastern Serbia

28

Nikolić, D., Jušković, M., Savić, A., Jenačković Gocić, D., Raca, I., Randelović, V.
The impact of invasive species *Elodea nuttallii* (Planch.) H. St. John on morphological characteristics of *Potamogeton gramineus* L.

29

Cvijanović, D., Novković, M., Milošević, Dj., Stojković Piperac, M., Čerba, D., Stamenković, O., Damjanović, B., Đurić, B., Popović, D., Anđelković, A., Minucsér, M., Pavić, D., Cyffka, B., Drešković, N., Radulović, S.
Assessment of wetlands trophic state using UAV photogrammetry (The Middle Danube, Serbia)

Phytochemistry and Phytotherapy, Hall 1

Tuesday, June 28th, 2022.

Chairs of the section: Radulović, N., Malenčić, Đ.

Introductory Lectures

09.00-09.15

Radulović, N., Živković Stošić, M.

Radulović, N., Department of Chemistry, Faculty of Sciences and Mathematics, University of Niš, Niš, Serbia

Primula L. epicuticular waxes - an underexplored source of chemically diverse metabolites

09.15-09.30

Uzelac, B., Budimir, S., Stojičić, D.

Uzelac, B., Department of Plant Physiology, Institute for Biological Research "Siniša Stanković" - National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia

Insight into the structure and chemistry of glandular trichomes of selected *Micromeria* and closely related *Clinopodium* species (Lamiaceae): the in vitro culture approach

Oral Presentations

09.30-09.40

Sirignano, C., Rigano, D., Formisano, C., Bancheva, S., Bruno, M.

Sirignano, C., Department of Pharmacy, University of Naples "Federico II", Naples, Italy
Phytochemical study on *Centaurea* species collected in Balkan peninsula

09.40-09.50

Badalamenti, N., Bruno, M.

Badalamenti, N., Department of Biological, Chemical and Pharmaceutical Sciences and Technologies (STEBICEF), University of Palermo, Palermo (PA), Italy

Essential oils as green pesticides

09.50-10.00

Akhlaghi, H., Department of Chemistry, Azad University, Sabzevar Branch, Sabzevar, Iran
Green synthesis of iron nanoparticles using *Mentha piperita* L. extract and investigating its antioxidant properties

10.00-10.10

Yildiz, S., Yurdugül, S.

Yurdugül, S., Department of Biology, Bolu Abant İzzet BAYSAL University, Bolu, Türkiye
Production of a skin cream combined with *Pinus sylvestris*, olive oil, coenzyme Q and milled rice and its characterization

10.10-10.20

Zlatković, D., Đorđević Zlatković, M., Radulović, N.

Zlatković, D., Department of Chemistry, Faculty of Sciences and Mathematics, University of Niš, Niš, Serbia
On the configuration and occurrence of cyclocuparanols: resolving a lasting discrepancy

10.20-10.30

Živković Stošić, M., Stojković, M., Radulović, N.

Živković Stošić, M., Department of Chemistry, Faculty of Sciences and Mathematics, University of Niš, Niš, Serbia
Chemical composition of epicuticular waxes of *Liriodendron tulipifera* L. flowers and leaves

Nature Protection, Hall 2

Tuesday, June 28th, 2022.

Chairs of the section: Stojanović, V., Nedeljković, D., Škondrić, S.

Introductory Lectures

09.00-09.15

Stojanović, V., Bjedov, I., Jovanović, I., Jelić, I., Obratov-Petković, D., Nešić, M., Nedeljković, D.

Stojanović, V., Institute for Nature Conservation of Serbia, Novi Beograd
Invasive alien species in Serbia

Oral Presentations

09.15-09.25

Stanković, M., Nature Conservation Movement of Sremska Mitrovica - SNR Zasavica, Sremska Mitrovica

Findings of alochtone aquatic species *Cabomba caroliniana* A. Gray 1837 in Vojvodina and Mačva

09.25-09.35

Stanković, M., Nature Conservation Movement of Sremska Mitrovica - SNR Zasavica, Sremska Mitrovica

New species in Zasavica flora in the period 2013-2021

09.35-09.45

Petković, A., Jović, D., Nešić, D., Stojiljković, B., Stojković, Z., Ostojić, D., Branković, S., Medenica, I.

Petković, A., Institute for Nature Conservation of Serbia, Belgrade
Special natural values and the concept of the outstanding natural landscape "Vardenik" protection

09.45-09.55

Durović, S., Dorđević, V., Vukojičić, S.

Durović, S., University of Niš, Faculty of Agriculture, Kruševac, Serbia

Herbarium as a source of information on protected plant species: specimens of plant taxa included in CITES distributed in Serbia deposited in BEOU

09.55-10.05

Durović, S., Buzurović, U., Veljić, M., Vukojičić, S., Kabaš, E., Lazarević, P.

Durović, S., University of Niš, Faculty of Agriculture, Kruševac, Serbia

Contribution to the inventory of protected plant species in Nature Park Radan

Poster Session 3a:

Phytochemistry and Phytotherapy

11.30-13.00

Tuesday, June 28th, 2022.

1

Kiprovski, B., Malenčić, Đ., Ognjanov, V., Veberič, R., Hudina, M., Mikulič-Petkovšek, M.

Sugars and organic acids content in unripe and ripe fruits of Sambucus nigra

2

Kiprovski, B., Malenčić, Đ., Ljubojević, M., Ognjanov, V., Veberič, R., Mikulič-Petkovšek, M.

Total and individual phenolics in wild and cultivated elderberry during development

3

Dorđević, N., Mančić, S., Karabegović, I., Stanojević, J., Cvetković, D., Danilović, B., Savić, D.

Effect of the extraction method on chemical composition and biological activity of basil essential oils (Ocimum basilicum L.)

4

Boskov, I., Savić Gajić, I., Savić, I.

Mineral composition of aqueous extract of black locust (Robinia pseudoacacia L.) flowers obtained using microwave-assisted extraction

5

Srećković, N., Katanić Stanković, J., Mihailović, V., Matić, S.

Do Lysimachia vulgaris methanol extracts have a DNA protective potential against oxidative damage?

6

Srećković, N., Katanić Stanković, J., Mihailović, V., Matić, S.

In vitro protective potential of the Lunaria annua L. aerial part and root extracts against DNA oxidative damage

7

Bogdanović, S., Zlatković, I., Randjelović, D.

Antimicrobial activity of oak moss resinoids (Evernia prunastri) on certain clinical isolates

8

Badalamenti, N., Bruno, M.

Chemical compositions and antioxidant activities of essential oils, and their combinations, obtained from flavedo by-product of seven cultivars of Sicilian Citrus aurantium L.

9

Simonović, N., Milenković, A., Stanojević, Lj., Zvezdanović, J., Cvetković, D., Stanojević, J.

Chemical composition of commercial and isolated essential oils from Tagetes spp. (marigold) flowers

10

Milenković, A., Simonović, N., Zvezdanović, J., Stanojević, J., Cvetković, D., Stanojević, Lj.

The influence of the operation conditions on the yield, composition and antioxidant activity of ethanol extracts from cubeb pepper (Piper cubeba L.) fructus

11

Kitić, D., Randelović, M., Živanović, S., Miladinović, B., Milutinović, M., Branković, S., Kitić, N., Jovanović, M., Zlatković, B.

Flavones content in Salvia aethiopis L. ethanolic extracts

12

Dončić, S., Zvezdanović, J., Troter, D., Konstantinović, S.

UHPLC-DAD-ESI-MS analysis of the Malus sylvestris (wild apple) leaf infusion

13

Nikolić, V., Zvezdanović, J., Petrović, S., Savić, S., Konstantinović, S.

Chemical and mineral composition of Centaurium erythraea infusion

14

Mitić, Z., Cvetković, V., Nikolić, J., Jovanović, S., Stojanović-Radić, Z., Ickovski, J., Nikolić, B., Zlatković, B., Stojanović, G.

Chemical profile, antimicrobial properties and toxicological evaluation of the essential oil of Abies cephalonica from Peloponnesus

15

Mladenović Drinić, S., Dragičević, V., Srdić, J., Anđelković, V., Vukadinović, J.

Variability of phytochemicals in sweet corn (Zea mays L. saccharata) from Serbia

16

Radović, J., Kundaković-Vasović, T.

Lipids in tinder fungus, Fomes fometarius (L.) Fr., Polyporaceae

17

Lazarević, J., Ilić, K., Zlatković, B., Zvezdanović, J.

Lipid peroxidation study of simple coumarins isolated from Daphne mezereum (Oleaceae)

18

Lazarević, J., Gocić, V., Đorđević, A., Stojanović, G.

Antimicrobial effects of naturally derived hydroxychalcones

19

Ušjak, Lj., Drobac, M., Niketić, M., Petrović, S.

Heracleum ternatum from Mt. Durmitor: furanocoumarins, polyphenols and antioxidant activity of leaf and flower extracts

20

Pavlović, D., Grigorov, M., Stanojević, Lj., Stanojević, J., Cvetković, D., Milutinović, J.

Composition comparison of thyme and lemon balm hydrolates and essential oils

21

Pavlović, M., Branković, S., Đelić, G.

Content of metals, total phenols, flavonoids and antioxidant potential of plant organs of the species *Sanguisorba minor*

22

Zlatanović, I., Dimitrijević, I., Jovanović, S., Ickovski, J., Stojanović, G.

GC-MS profile of herbal mixture used in Balkan peninsula to eliminate the kidney stones

23

Radović, J., Kundaković-Vasović, T.

Anti-alpha amylase activity of *Macrolepiota procera* (Scop.: Fr.) Sing.

24

Stojković, J., Mitić, Z., Stojanović, G., Zlatković, B., Jovanović, S.

Distribution of inflorescence headspace volatiles in fifteen *Achillea taxa* from Serbia

25

Lazarević, J., Brizzolari, A., Zlatković, B.

Phytochemical screening and evaluation of DPPH antioxidant potential of selected *Daphne* (Oleaceae) species from Serbia

26

Grigorov, M., Pavlović, D., Kocić, B., Mladenović-Antić, S., Tasić-Kostov, M., Ilić, D., Milutinović, J.

Antimicrobial activity of different hydrolates against selected bacterial strains

27

Ickovski, J., Jovanović, O., Zlatković, B., Đorđević, M., Stepić, K., Ljupković, R., Stojanović, G.

Correlation between the essential oils' composition and the geographical distances of selected *Artemisia* species growth sites' - Mantel test

28

Matejić, J., Pavlović, D., Jovanović, M., Žarković, L., Džamić, A.

Herbal products used in the Sokobanja municipality

29

Žarković, L., Mileski, K., Matejić, J., Rajčević, N., Džamić, A.

Total phenolic and ellagic acid content in *Rosa arvensis* leaves and hips extracts

30

Oalđe Pavlović, M., Lunić, T., Mandić, M., Alimpić Aradski, A., Marin, P., Duletić-Laušević, S.†, Božić Nedeljковиć, B.

Antineuroinflammatory and neuroprotective activities of ethanolic extracts of commercial *Lamiaceae* medicinal plants from Serbia

32

Džamić, A., Matejić, J., Marković, M., Žarković, L., Mileski, K., Marin, P.

Radical scavenging capacity and total phenolic content of *Ajuga laxmannii* (Murray) Benth.

33

Milutinović, M., Kostić, M., Miladinović, B., Krstić, V., Kitić, D.

Herbal medicinal products in hypertension and dyslipidemia therapy: a cross-sectional study among the adults from the Niš region

34

Stojković, J., Stojanović, G., Stojanović-Radić, Z., Zlatković, B., Ickovski, J., Zlatanović, I., Jovanović, S., Mitić, Z.

Achillea pseudopectinata essential oil: chemical composition, antimicrobial activity and toxicity toward crustaceans

35

Mladenović, M., Radulović, N., Stojanović, N.

The essential oil of Melissa officinalis L. (Lamiaceae): structural elucidation and acute toxicity of new acetals

36

Mladenović, M., Ristić, M., Radulović, N., Ristić, N., Dekić, V., Dekić, B., Randelović, V.

Diethyl-ether flower washings of four Dianthus taxa (Caryophyllaceae): Identification of new natural products

Poster Session 3b:

Phytochemistry and Phytotherapy

13.30-15.00

Tuesday, June 28th, 2022.

1

Stojanović-Radić, Z., Dimitrijević, M., Aleksić, A., Stanković, N.

Antistaphylococcal activity of Thymus vulgaris and Origanum vulgare essential oils: time-lapse kinetics, antibiofilm activity and synergistic potential

2

Zlatković, D., Đorđević Zlatković, M., Radulović, N.

Chemical investigation of Microbiota decussata diethyl-ether extract

3

Đorđević Zlatković, M., Zlatković, D., Radulović, N.

A comparative study on marjoram essential oils from southeastern Serbia and Egypt

4

Đorđević Zlatković, M., Zlatković, D., Radulović, N.

Scilla bifolia L. wax is a source of rare alkane-1,3-diols

5

Stojković, O., Živković Stošić, M., Radulović, N., Dimitrijević, M., Otašević, S., Stojanović-Radić, Z.

Antifungal and anti-biofilm activity of Thymus serpyllum essential oil against Aspergillus otomycosis

6

Stojković, O., Vasić, T., Dimitrijević, M., Stojanović-Radić, Z.

Antimicrobial, anti-virulence and synergistic potential of Citrus aurantifolia essential oil against Klebsiella spp. and Escherichia coli clinical isolates

- 7
Randelović, M., Zlatković, B., Miladinović, B., Milutinović, M., Živanović, S., Branković, S., Kitić, N., Kitić, D.
Contents of phenolic acids and flavonoids in *Satureja kitaibelii* Wierzb. Ex Heuff. extracts
- 8
Živković Stošić, M., Krstić, M., Radulović, N.
Chemical composition of essential oil of *Malabaila aurea* (Sm.) Boiss fruits
- 9
Nešić, M., Nešić, M., Radulović, N., Randelović, V.
Structure elucidation of new tiglic acid esters from *Bupleurum falcatum* L.
- 10
Nešić, M., Nešić, M., Radulović, N.
Isolation and identification of secondary metabolites from *Bupleurum affine* Sadler
- 11
Marčetić, M., Vidović, B., Samardžić, S., Ilić, T., Božić, D.
Chemical composition and prebiotic effect of the fruit of *Prunus spinosa* L., Rosaceae
- 12
Jovanović, D., Nešić, M., Radulović, N.
Isolation and identification of secondary metabolites from *Acorus calamus* L.
- 13
Dimitrijević, M., Nešić, M., Radulović, N.
Study of the reaction of *p*-cymene with hydrogen peroxide in trifluoroacetic acid and its usage for the identification of *Doronicum columnae* Ten. secondary metabolites
- 14
Radulović, M., Gavrilović, M., Rajčević, N., Janakiev, T., Dimkić, I., Janačković, P.
Essential oil composition of different parts of *Artemisia absinthium* and its antibacterial activity against phytopathogenic bacteria
- 15
Ivanović, S., Gođevac, D., Simić, K., Anđelković, B., Jovanović, Ž., Rakić, T.
NMR metabolomics study of the desiccation and recovery process in the resurrection plants *Ramonda serbica* and *Ramonda nathaliae*
- 16
Stamenković, J., Đorđević, A., Petrović, G.
Chemical profile of *Chaerophyllum temulum* L. headspace volatiles obtained from different plant organs
- 17
Petrović, G., Đorđević, A., Stamenković, J.
Phytochemical analysis of the *Elaeagnus angustifolia* L. flower hexane extract
- 18
Arsenijević, J., Slavkowska, V., Drobac, M., Stojanović, D., Zbiljić, M., Kovačević, N.
Comparison of phenolic profiles of *Satureja kitaibelii* Wierzb. ex Heuff. and *Satureja montana* L. (Lamiaceae)

- 19 Miletić, M., Ivanov, M., Novaković, J., Glamočlija, J., Janačković, P.
Anticandidal activity of Centaurea glaberrima
- 20 Aksić, J., Nikolić, D., Genčić, M., Radulović, N.
Two new abietane diterpenes from Lycopus euroapeus L. fruits
- 21 Aksić, J., Nikolić, D., Genčić, M., Radulović, N., Baldovini, N.
NO-scavenging capacity of Helichrysum italicum essential oils and two italdiones
- 22 Miladinović, B., Kostić, M., Milutinović, M., Živanović, S., Branković, S., Kitić, D.
Antioxidant activity and vitamin C content of different red currant (Ribes rubrum L.) juices
- 23 Novaković, A., Karaman, M., Tomić, J., Krsmanović, N., Peulić, T., Ikonić, P., Stupar, A.
Nutritional and phenolic profile of edible mushroom Armillaria mellea (Vahl) P. Kumm. (1871)
- 24 Milutinović, V., Ušjak, Lj., Niketić, M., Petrović, S.
Chemical composition and antioxidant potential of Teucrium scorodonia L. (Lamiaceae) from Serbia
- 25 Milutinović, V., Ušjak, Lj., Niketić, M., Petrović, S.
Chemosystematic significance of triterpenes from dichloromethane extracts of 28 Hieracium L. species from the Balkan Peninsula
- 26 Zbiljić, M., Stojanović, D., Marčetić, M.
The new data on the variability of essential oil of Teucrium montanum L. from Balkan Peninsula
- 27 Dimitrijević, M., Stojanović-Radić, Z., Stevanović, M., Nešić, M., Radulović, N.
Antimicrobial activity and chemical composition of Helichrysum italicum essential oil on isolates of the Staphylococcus aureus and isolates of the genus Candida: time-lapse kinetics and antibiofilm activity
- 28 Dimitrijević, M., Stojanović-Radić, Z., Pejčić, M., Nešić, M., Radulović, N.
Antimicrobial and synergistic effects and chemical composition of the selected essential oils on clinical isolates of the genus Candida
- 29 Pejčić, M., Stojanović-Radić, Z., Dimitrijević, M.
Time lapse kinetics of sage and winter savory essential oils and combined oils effects against Pseudomonas aeruginosa clinical isolates
- 30 Gulin, S., Vujčić Bok, V., Rusak, G., Šola, I.
Intestinal bioavailability of total glucosinolates and phenolics from broccoli sprouts: Impact of high growing temperature
- 31 Veličković, I., Simin, N., Bekvalac, K., Marin, P., Lakićević, S., Grujić, S.

Chemical composition and antidiabetic properties of Rubus serpens extracts

32 Grujić, S., Veličković, I., Lakićević, S.

Rubus praecox - Antioxidant activity of ethanol extracts

33 Branković, S., Glišić, R., Đelić, G., Grbović, F., Rajičić, V., Marin, M., Vasić, M., Bogosavljević, J.

Metal bioaccumulation and translocation potential of species Phragmites australis (Cav.) Trin. ex Steud on mine tailings rudnik DOO "Rudnik" (Republic of Serbia)

34 Madić, V., Petrović, A., Žabar Popović, A., Maksimović, B., Jušković, M., Vasiljević, P.

Biological activity of 'anti-diabetic' herbal mixture and five medicinal plants methanolic and ethanolic extracts

35 Maksimović, B., Petrović, A., Madić, V., Mladenović, N., Zlatković, B., Vasiljević, P., Đorđević, Lj.

Traditionally used polyherbal mixture ameliorates diabetes-related spleen damage in a rat model of type 2 diabetes

36 Petrović, A., Madić, V., Mladenović, N., Stojković, K., Zlatković, B., Vasiljević, P., Đorđević, Lj.

Antioxidative, antidiabetic and cytoprotective activity of two polyherbal mixtures and five medical plants traditionally used in type 2 diabetes therapy

IN MEMORIAM

Professor Dr. Slobodan Jovanović, inspiring ecology professor and esteemed director of the Botanical Garden “Jevremovac” – *IN MEMORIAM*

Lakušić, D., Mišljenović, T.

University of Belgrade, Faculty of Biology, Chair of Plant Ecology and Phytogeography, Takovska 43, 11000 Belgrade, Serbia

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Prof. Dr. Slobodan Jovanović, renowned professor of the Faculty of Biology University of Belgrade passed away on February 1, 2021 at the age of 65. Until his recent retirement, Prof. Jovanović taught with great enthusiasm and high pedagogical professionalism at all levels of study at the Faculty of Biology, especially in the fields of environmental protection, urban ecology as well as invasive ecology. With his ten-year commitment as Deputy Director and later as Director of the Institute of Botany and “Jevremovac” Botanical Garden, Professor Jovanović made an immeasurable contribution to the affirmation and development of “Jevremovac” Botanical Garden, which today is recognized as one of the historical and pedagogical-scientific foundations of our society. The scientific work of Professor Jovanović includes 240 bibliographic units. Of particular importance are the results in the field of urban flora and vegetation research and in the field of invasive species ecology, which highlight Professor Jovanović as our leading expert in this field. Colleagues and students will forever remember the talent and ease with which he delivered inspiring lectures, the energy and enthusiasm he invested in the revitalization of the Botanical Garden, and the love he had for the vocation of a teacher.

IN MEMORIAM

Prof. dr. Sonja Duletić-Laušević (1962-2021)

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Professor Sonja Duletić-Laušević suddenly passed away on December 18, 2021, leaving a large void behind. As a full professor at the University of Belgrade-Faculty of Biology, she made great contributions both as a teacher and scientist. She was interested in various fields of botany, including micromorphology, anatomy, phytochemistry, biological activity research as well as fungi. During her career, she was included in several scientific projects, collaborating with many colleagues. She was author of several textbooks and supervisor of many doctoral and master theses. Scientific opus of Professor Sonja includes more than 230 bibliographic units. She was a member of Serbian Biological Society, Serbian Society for Microscopy and many others. She worked on the popularization of botany, both as co-author of books for kids that are translated in several languages and editor of Creative Center textbook editions. She used to suggest to younger generations that “the challenge is to be a botanist and know that you belong to the few who feel at home among plants”.

**14th Symposium on the Flora of
Southeastern Serbia
and Neighboring Regions
Kladovo 26th-29th June, 2022**

Plenary Presentation

Presence, distribution, and population status of several rare plant taxa in the Portile de Fier Nature Park (Romania)

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The Portile de Fier Nature Park, also known as the Danube Gorge, covers an area in the southwestern part of Romania, along the Danube. It is one of the largest protected nature areas in Romania. Because of its geographical position, heterogeneous geological substrate, and specific microclimatic conditions, it represents one of the richest and most important floristic areas of Romania, in which numerous rare and endemic plant species have found suitable habitat. For the last ten years, this area has been under great anthropogenic pressure mainly because of tourism. Construction of tourism infrastructure puts a large part of the natural habitats that stretch along the Danube bank under a great threat of extinction. Field research in this area confirmed the presence of several rare plant taxa (*Crocus banaticus*, *Pulsatilla vulgaris* subsp. *grandis*, *Linum uninerve*, *Spiranthes spiralis*) and discovered some unreported localities for them. In addition, the presence of a new species for this area (*Pontechium maculatum*) was recorded. Along with the research of the rare plant taxa presence, the number of individuals within the identified populations was noted, as well as endangering factors that negatively affect their survival with the proposal of appropriate prevention and protection measures.

**14th Symposium on the Flora of
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Taxonomy and Systematics

INTRODUCTORY LECTURE

Trends in Applied Plant Anatomy

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Plant anatomy is one of the fundamental and oldest disciplines of botany, oriented towards an examination of the structure of plant cells and tissues, as well as the structure of plant organs as a whole. It has advanced significantly from its primary descriptive purpose. Applied plant anatomy integrates the knowledge of plant structure with its function and application for many purposes in different scientific disciplines. It is fundamental in the understanding of plants' function, growth patterns, evolution and ecology. Applied plant anatomy gives essential data sets and increases the number of characters useful in taxonomic research and evaluation of systematic position of specific taxa. Anatomical data are useful in agronomy, especially in development of selection and breeding strategies of cultivated plant species, but also in forestry and growing of cultivated tree species. It helps in understanding the main principles of adaptation and reaction to changing environment, plants' water status regulation and resistance to biotic and abiotic stresses. Applied plant anatomy also intersects with other disciplines, such as pharmacology, physiology, engineering, biochemistry, and more. Many of the applied anatomical data may have economic value. Development of instruments for structural analyzes and improvement of their technical performances, as well as development of software and artificial intelligence systems, allows more precise analyzes, measurements and application of anatomical data. An overview of the anatomical research performed at the University of Novi Sad, Faculty of Sciences, Department of Biology and Ecology, will be presented in a way that emphasizes its application in different fields, mainly agronomy.

ORAL PRESENTATIONS

Morphological and ecological variability of the *Dianthus sylvestris* complex (Caryophyllaceae) on the Balkan Peninsula

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Wide-range species often exhibit morphological variability that is mostly shaped by ecological and evolutionary processes, and the resulting diversity is frequently reflected in infraspecific taxonomy. The *Dianthus sylvestris* complex on the Balkan Peninsula encompasses six subspecies: *Dianthus sylvestris* subsp. *alboroseus*, subsp. *bertisceus*, subsp. *kozjakensis*, subsp. *nodosus*, subsp. *sylvestris* and subsp. *tergestinus*. Their identification is challenging due to great morphological variability between subspecies and complex patterns of variation with respect to ecological preferences. Here, 97 populations of *D. sylvestris* were evaluated regarding the variability of 27 morphological characters, and 20 environmental variables were used to identify patterns of morphological variability along environmental gradients. Number and shape of epicalyx scales, calyx length and petal denticulation turned out to capture the greatest extent of morphological variability between populations. *Dianthus sylvestris* subsp. *nodosus*, subsp. *sylvestris* and subsp. *tergestinus* have similar morphologies and share parts of their geographic distributions and cannot be clearly differentiated using morphological characters. However, a different flowering period differentiates subsp. *tergestinus*. By quantitatively assessing niche overlap, equivalency and similarity of the subspecies, our results indicate that niche similarity is more common than divergence. Environment, rather than geography, plays a potentially more important role in shaping the morphological variability of this complex.

Acknowledgments. The work of Ana Terlević and Ivana Rešetnik has been supported by Croatian Science Foundation under the project UIP-2017-05-2882 (AmphiAdriPlant), as well as by the “Young researchers' career development project – training of doctoral students” of the Croatian Science Foundation funded from the European Social Fund.

Testing techniques and usefulness of Elliptic Fourier analysis on anatomical sections

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Geometric morphometric studies have become well established in systematics in recent years due to their holistic and numerical nature, which makes them less prone to errors than manual techniques and are fast and efficient when dealing with large numbers of specimens. In systematic botany, leaf morphology studies have so far benefitted from these methods the most. The aim of this work is to determine the usability and usefulness of shape analysis in leaf cross sections of crocuses. The leaves of *Crocus* L. are known to have a unique shape in cross-section and their morpho-anatomical features, including keel shape, arm length and arm curvature, are used in systematic studies. In line with this purpose we sampled and analyzed all known populations of *Crocus mathewii* Kerndorff & Pasche, a rare and endemic taxon from the Western Taurus region (Turkey). Morphometric studies were conducted using MASS and PAST computer programs. Classical anatomical characters and measurements were also used with PCA in order to compare the two methods. Elliptic Fourier analysis was found to be useful in *Crocus* leaf sections when dealing with great number of specimens.

Acknowledgements. This work is supported by the Istanbul University Scientific Research Unit through grant number FBA-2020-36860. I would like to thank Dr. Osman Erol and Dr. Levent Şık for their invaluable help in field work.

Centaurea ozrenii (Asteraceae) – a new and extremely rare species from Serbia

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A new species of *Centaurea* sect. *Acrocentron* (Cass.) DC. (Asteraceae) was found on the Ozren mountain in southwestern Serbia near Sjenica and named as *Centaurea ozrenii* Niketić, Tomović & Buzurović, sp. nov. It inhabits xerophilous and steppe-like habitats, on ultramafic geological substrate. *Centaurea ozrenii* is morphologically close to *C. calocephala* Willd., *C. murbeckii* Hayek, *C. kotschyana* Heuff. ex Koch and recently described *C. zlatiborensis* Zlatković, Novaković & Janačković. The most unique morphological features of the new species are undivided to simply pinnatisect (non lyrate) subglabrous leaves, with linear segments, upper leaves with an aristate apex and cream coloured to pale yellow florets of which the outer ones are much longer than the inner ones. Phyllaries are intermediate in relation to *C. calocephala* and *C. kotschyana*. The chromosome number of the new species is $2n = 22$. After thorough field investigations, it is established that *C. ozrenii* grows in a single micro locality. The only confirmed population covers an area of ca 100 m² and consist of 12–24 flowering individuals (depending on the year of observation). Therefore, by applying IUCN red list categories and criteria, *C. ozrenii* should be considered as Critically Endangered (CR).

Acknowledgements. This research was supported by The Ministry of Education, Science and Technological Development of the Republic of Serbia and Ministry of Science of the Republic of Montenegro - Bilateral Project “Flora and vegetation on ultramafics (serpentinites) as a basis for expanding the national lists of plants and habitats in Montenegro and Serbia, with special reference to the bioaccumulation potential of individual plants for phytoremediation”.

***Crocus pallasii* Goldb. from north to south of Turkey: Just a phenotypic variation or speciation?**

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The *Crocus pallasii* Goldb. species complex in Turkey is a very diverse group with different chromosome numbers and karyology, as well as morphology. This variation, in addition to ecological and geographical isolation among populations, suggests a need for deeper investigation into this species (and its close relatives). The morphological variation of *C. pallasii* populations in Turkey has never been investigated and evaluated using statistical methods. The aim of this study is to determine the morphologically distinct populations before diving into molecular work. We collected and examined the morphology of plants from 32 populations in Turkey. Qualitative and quantitative data were obtained from the samples collected for the project and also from herbarium material in ISTF. One-way Analysis of Variance (ANOVA) and Principal Coordinate Analysis (PCoA) were conducted using Graphpad Prism and PAST. The results showed a significant difference between geographically distant populations.

Acknowledgements. This study is supported by Istanbul University Research Projects Unit through project number FBA-2021-38022.

Series *Verni* Mathew (*Crocus* L.) in Southeastern Europe vol. 1 – resolving the polyploid mess

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The complexity of series *Verni* results from questionable taxonomy of some representatives, the high variability of chromosome numbers and the probable presence of allopolyploids. Therefore, we attempted to define the evolutionary units, their taxonomical status and identify ploidy levels of the cytotypes of the Southeastern European series *Verni* representatives (*C. kosaninii*, *C. tommasinianus*, *C. vernus*, *C. cf. heuffelianus*). The inference of ploidy levels was based on chromosome numbers ($2n = 8$ to $2n = 22$) and genome sizes ($2C = 5.5$ pg to 12 pg). Our data showed that ploidy levels in crocuses cannot be inferred from chromosome numbers alone. The chromosome number of *C. tommasinianus* ($2n = 16$) is twice as high as that of *C. vernus* ($2n = 8$), but both have similar genome sizes ($2C = 5.5$ pg) and therefore, the same ploidy level. However, the $2n = 18, 20, 22$ cytotypes of *C. heuffelianus sensu lato* could be clearly identified as recently originated polyploids. Chloroplast sequences (*matK-trnQ*, *trnL-F*, *ycf1*) and genome wide SNP data derived from genotyping-by-sequencing were used to further disentangle phylogenetic relationships and to infer the parental origin of the polyploids. Phylogenetic analysis revealed the existence of three groups in $2n = 18$ cytotypes: Pannonian-Illyric, Western Carpathian, and Southern Carpathian probably going back to three different hybridization events involving *C. vernus* from the Alps and Dinaric Alps, respectively, and *C. heuffelianus sensu stricto* ($2n = 10$ cytotype) as the other parent. The $2n = 20, 22$ cytotypes originated from the same polyploidization event with *Crocus heuffelianus s. s.* as paternal and *C. vernus* from the Dinaric Alps as a maternal parent. The allopolyploidization was followed by the fission of chromosomes resulting in today's two different cytotypes ($2n = 20, 22$). We could demonstrate that it is possible to disentangle such complex groups like the Southeastern European series *Verni* species by combing genome sizes and chromosome numbers with a comprehensive molecular data set.

Acknowledgements. This study was funded through the project of The Ministry of Education, Science and Technological Development of the Republic of Serbia (contract no. 451-03-68/2022-14/200124) and through the research grants of: the Deutscher Akademischer Austauschdienst (DAAD; grant to I.R.), International Association for Plant Taxonomy (IAPT; grant to I.R.) and the Deutsche Forschungsgemeinschaft (grant HA7550/2 to D.H.).

Series Verni Mathew (*Crocus* L.) in Southeastern Europe vol. 2 - matching the cytotypes and morpho-anatomical features with the traditional nomenclature

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The complexity of the series *Verni* is also a result of the confusing nomenclature and numerous synonyms, followed by the high morpho-anatomical variability. In this part, we infer if the morpho-anatomical differentiation reflects molecular differentiation of the cytotypes from Southeastern Europe (*C. kosaninii*, *C. tommasinianus*, *C. vernus*, *C. cf. heuffelianus*) using traditional methodology. Previously defined diagnostic characters were confirmed for *C. kosaninii*, *C. tommasinianus*, and *C. vernus*. For *C. heuffelianus sensu stricto* ($2n = 10$ cytotype) we could show that its most distinguishable characters are the mostly glabrous throats and intensive perigone color. The former *C. cf. heuffelianus* $2n = 12$ cytotype, described as *C. bertiscensis* by us, is characterized by flatter and paler perigone segments, hairy throats, extremely short perigone tubes, and a white stripe/leaf diameter ratio of 1/7. The Pannonian-Illyric group of $2n = 18$ *C. cf. heuffelianus* cytotype is sometimes referred to *C. vittatus* in the literature, Western Carpathian to *C. scepusiensis*, while the Southern Carpathian group of this cytotype is referred to *C. exiguus*. From the aspect of morpho-anatomy, the investigated polyploid cytotypes $2n = 18, 20, 22$ are representing intermediate forms between parental species reflecting their hybrid origin.

Acknowledgements. This study was funded through the project of The Ministry of Education, Science and Technological Development of the Republic of Serbia (contract no. 451-03-68/2022-14/200124) and through the research grants of: the Deutscher Akademischer Austauschdienst (DAAD; grant to I. R.), International Association for Plant Taxonomy (IAPT; grant to I. R.) and the Deutsche Forschungsgemeinschaft (grant HA7550/2 to D. H.).

Flower dimorphism and gynodioecy of *Mentha longifolia* (L.) L. and *M. spicata* L. from Balkan peninsula and Pannonian Plain – a pilot study

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Gynodioecy is a dimorphic breeding system in which male-sterile individuals (i.e., females) coexist with hermaphrodites in populations, thus is an important, intermediate step in the evolution of separate sexes in flowering plants. The genus *Mentha* L. (Lamiaceae) is known to be a gynodioecious and morphologically extremely variable, but its sexual system and morphological differences between different flower morphs from the populations on Balkan peninsula and Pannonian Plain has never been investigated in depth before. The present study is focusing on the careful investigation of nearly 1.000 flowers of *M. longifolia* and *M. spicata* collected from a natural populations in Serbia, Montenegro, Bosnia and Herzegovina, North Macedonia, Bulgaria and Greece. We examined 1) if and how often females coexist with hermafrodites in populations, and 2) are there morphological differences between perfect and pistilate flowers of *M. longifolia* and *M. spicata*. The results confirm that both species are gynodioecious, with different population structure – ratio of females and hermafrodites. Almost all investigated floral characters of both species (e.g., corolla, calyx, filament and anther) are significantly different between two morphs – perfect and pistilate flowers. These findings are the first step in the investigation on reproductive system of genus *Mentha* in the study area.

Acknowledgements. The authors acknowledge financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2022-14/200125).

Variation in seed morphology of *Paeonia* L. taxa from Serbia

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Seed traits have proven to be a useful taxonomic tool in a variety of plant groups and at various systematic levels. The goal of this study was to compare and describe the morphological seed features of following four *Paeonia* taxa. Light and scanning electron microscopy were used to examine samples gathered from 15 populations across the Republic of Serbia's territory. In total, 17 seed characters were determined, with 14 of them being qualitative. The obtained data were processed by the methods of basic and multivariate statistics, on quantitative and qualitative characteristics. The results provide clear species discrimination and highlight the characters that can be used in the determination. Sets of selected characters and interrelationships can be used to distinguish herbaceous Peony seeds or as an addition to morphological character assessment in *Paeonia* species.

Acknowledgements. This work was supported by joint funding from the Ministry of Science and Technology of the Republic of Serbia (451-03-1202/2021-09) and the National Key R&D Program of China (2021YFE0110700).

Anatomy of *Leontopodium nivale* subsp. *alpinum* (Cass.) Greuter (Gnaphalieae, Asteraceae) from Serbia

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Vegetative anatomy of *Leontopodium nivale* subsp. *alpinum*, an alpine perennial plant from Europe and Central Asia, was examined. The wood has fascicular and interfascicular sections which is common in most Gnaphalieae. The interfascicular sections, consist of parenchyma, continue the medullary rays. The fascicular sections, consist of libriform fibres, axial parenchyma and vessel elements, are rayless. The lack of large clusters of thick-walled fibres both in primary and in secondary phloem might represent an important distinctive feature of *Leontopodium* comparing to most Gnaphalieae. Imbricate arrangement of petiole epidermal cells is a prominent trait that has not been reported in other Asteraceae. Palisade mesophyll in leaf lamina is not clearly distinguished from the spongy mesophyll; it has a large intercellular spaces in regular arrangement. This regularity suggest that this palisade mesophyll is in fact a spongy mesophyll with honeycomb 3D pattern. Spongy mesophyll on the abaxial side also has a honeycomb pattern, but with different topological and geometrical properties than the adaxial mesophyll. Similar structure of the mesophyll has also been reported in some species of *Raoulia*, a genus of Gnaphalieae from New Zealand, also distributed in alpine habitats.

Acknowledgments. Financial support was provided by the Ministry of Education, Science and Technological Development of the Republic of Serbia (451-03-68/2022-14/200178).

POSTER PRESENTATIONS

Various records of lichens from southeastern Albania

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This study aims to enrich the list of lichen species found in Albania, thus expanding the map of their distribution. A list of 117 taxa of lichens was compiled from the species found and collected at various localities in the district of Pogradec and Korça. More than half of them (62 species) are new to the study area and 27 species are new to the country. Of the latter can be mentioned: *Arthonia apatetica*, *Athallia cerinella*, *Athallia pyracea*, *Bagliettoa parmigerella*, *Circinaria hoffmanniana*, *Enchylium polycarpon*, *Gyalolechia flavorubescens*, *Micarea globulosella*, *Placidium lachneum*, *Placocarpus schaereri*, *Placolecis opaca*, *Polycauliona polycarpa*, *Protoparmeliopsis graeca*, *Pyrenodesmia chalybaea*, *Rinodina anomala*, *Scytinium fragile*, *Syalissa ramulosa*, *Thalloidima diffractum*, *Variospora dalmatica*, *Verrucaria caerulea*, *Xanthomendoza fallax*, *Xanthoparmelia glabrans* etc. It should be noted that in Korça town itself only three species were found, and were poorly developed (*Physcia biziana*, *Physciella chloantha* and *Phaeophyscia orbicularis*). Compared to the coastal towns visited so far this is poor, presumably because of the dry climate far from the coast. Calcareous rocks on *Carpinus* scrub south of Pogradec belong to an area characterized by drought but influenced by human activity. The following species were noticed on *Carpinus*: *Anaptychia ciliaris*, *Gyalolechia flavorubescens*, *Physcia leptalea*, *Rinodina pyrina*, while *Placocarpus schaereri*, *Placolecis opaca*, *Scytinium fragile*, *Syalissa ramulosa*, *Thalloidima diffractum* were found on limestone.

Diversity of freshwater red algae (Rhodophyta) in Bosnia and Herzegovina

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This study presents a review of all freshwater red algae (Rhodophyta) recorded on the territory of Bosnia and Herzegovina from 1901 till today. The authors used all the available literature regarding the distribution, ecology and diversity of the freshwater red algae in B&H. The analysis of literature data on the territory of B&H revealed 10 taxa of freshwater red algae: *Audoinella* (2), *Bangia* (1), *Batrachospermum* (2), *Hildenbrandia* (1), *Lemanea* (2) and *Paralemanea* (2). In addition, data from field work during the summer seasons 2021 are included. Phytobenthos samples were collected in period May-August from 12 localities. Water temperature, pH, conductivity, oxygen concentration and saturation were measured *in situ* using Multi 3420 portable device. Collected macroalgae were examined under Stemi DV4 stereomicroscope and using a Carl Zeiss AxioImager MRc5 with AxioVision 4.9 software. On the basis of relevant literature 8 freshwater red algal taxa were identified. New taxa of red algae for B&H are: *Lemanea rigida* (Sirodot) De Toni, *Lemanea fucina* Bory de Saint Vincent and *Paralemanea catenata* (Kütz) Vis & Sheath. It is very important to continue further research of this group of algae, which are an excellent indicator for assessing the state and stability of aquatic ecosystems.

Acknowledgment. This work was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2020-14/200178) and Rufford Foundation 2021-06 to 2022-06 | GrantRufford Foundation (London, Great Britain, GB) GRANT_NUMBER: 34941-2.

First records of freshwater epizoic cyanobacteria and algae on two turtles *Trachemis scripta* Thunberg and Schoepff, 1792 (Reptilia, Emydidae) and *Emys orbicularis* Linnaeus, 1758 (Reptilia, Emydidae) identified in selected artificial ponds from Bosnia and Herzegovina

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Cyanobacteria and algae occur in nearly all surface water bodies in every biome across the globe. This group of organisms can also inhabit different substrata, both macroalgae and aquatic macrophytes (epiphytic) and animals (epizoic). To assess the diversity of epizoic cyanobacteria and algae two turtles *Trachemis scripta* Thunberg and Schoepff, 1792 (Reptilia, Emydidae) and *Emys orbicularis* Linnaeus, 1758 (Reptilia, Emydidae) found in artificial ponds in the Botanic garden in the National Museum in Sarajevo (Bosnia and Herzegovina) were studied. Taking into account all groups of cyanobacteria and algae, a total of 17 taxa were recorded. The highest number of taxa was identified within class *Bacillariophyceae*, while taxa of *Cyanophyceae*, *Chlorophyceae* and *Trebouxiophyceae* occurred with a smaller numerical value. High diversity of cyanobacteria and algae were identified in *T. scripta* (15 taxa), while on the *E. orbicularis* only five taxa were identified. Dominant taxa identified on *T. scripta* belong to the class *Bacillariophyceae* (*Achnanthydium* sp., *Denticula kützingii*, *Epithemia turgida*, *Eunotia arcus*, *Fragilaria capucina*, *F. pinnata*, *Gomphonema truncatum* and *Navicula* sp.), while on the *E. orbicularis* dominant taxa belong to the classes *Chlorophyceae* (*Chlorella vulgaris* and *Pediastrum boryanum*) and *Bacillariophyceae* (*Eunotia* sp. and *Gomphonema truncatum*). Based on the conducted research it can be concluded that the surface of turtles can serve as a good substrate for a different group of algae and in the future survey it is necessary to continue with this research.

Acknowledgements. This work was supported by the Rufford Foundation (London, Great Britain, GB) GRANT_NUMBER: 34941-2.

Diversity and ecological properties of epiphytic algae identified from selected macroalgae and aquatic macrophytes in Bosnia and Herzegovina

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The term “epiphyte” has several definitions and has been the subject of disagreements amongst researchers exploring the role of these organisms. The main characteristic of epiphytes is that they are attached algae or microorganisms on the surface of plants that are submerged in water or are present on the surface of the water habitat. In aquatic ecosystems, it has been shown that these forms of cohabitation have a great influence on the surrounding environment since epiphytic algae systems increase the complexity of the habitat and provide larger surface areas for colonization of invertebrates and other smaller organisms. To assess the diversity of epiphytic cyanobacteria and algae, macroalgae (*Chara virgata*), moss (*Fontinalis antipyretica*) and several aquatic macrophytes (*Calitriche palustris*, *Ceratophyllum demersum*, *Nuphar lutea*, *Nymphaea alba*, *Potamogeton natans* and *Ranunculus aquatilis*) were studied. In the qualitative and quantitative composition of epiphytic cyanobacteria of algae identified from different macroalgae and aquatic macrophytes sampled at selected localities in Bosnia and Herzegovina, a total of 46 taxa were found. Identified taxa belong to the following classes: *Bacillariophyceae* (32 taxa or 69.57%), *Zygnematophyceae* (5 taxa or 10.87%), *Chlorophyceae* (2 taxa or 4.35%), *Cyanophyceae* (2 taxa or 4.35%), *Trebouxiophyceae* (2 taxa or 4.35%), *Xanthophyceae* (1 taxa or 2.17%), *Dinophyceae* (1 taxa or 2.17%) and *Euglenophyceae* (1 taxa or 2.17%). Based on the conducted research it can be concluded that the macroalgae and aquatic macrophyte can serve as a good substrate for colonization with different groups of algae, especially diatoms. In the future, it is necessary to continue this type of research and establish a database of epiphytic algae and use it as a good bioindicator in the monitoring of freshwater ecosystems.

Acknowledgements. This work was supported by the Rufford Foundation (London, Great Britain, GB) GRANT_NUMBER: 34941-2.

A study on the chorology of the genus *Iris* L. (Iridaceae Juss.) from Bulgaria

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Genus *Iris* L. consists of 10 naturally distributed species in Bulgaria. It is divided into two separate genera – *Limniris* (4 species) and *Iris* (6 species). Based on the critical processing of the collections in the national herbariums (SOM, SOA and SO), the literature sources, and our field observations, we prepared distribution maps. The samples stored in SOA are 504 samples, of which 476 are from Bulgaria. 374 specimens are stored in SOM, 315 of them are from Bulgarian localities. The material in SO possess 182 specimens, and 178 of them have Bulgarian origin. The results of the study display a more limited distribution of *I. graminea* L. in Bulgaria, in comparison to the records in the floristic publications. New chorological data are reported for *I. reichenbachii* Heuff., *I. suaveolens* Boiss. & Reut., and *I. × germanica*. *Iris mellita* Janka, whose taxonomical status is under investigation, was reviewed as a synonym of *I. suaveolens*. The distribution of *I. aphylla* L. in Bulgaria was not confirmed until now, with the current collection for the Bulgarian flora.

Acknowledgments. This work was financially supported by the National Science Fund, Ministry of Education and Science, Bulgaria (Project “Biodiversity and taxonomic structure of Iridaceae Juss. in Bulgarian flora” № KP-06-N31/5).

Micromorphological traits of four *Clinopodium* taxa from Zlotska gorge, Serbia

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Clinopodium L. (Lamiaceae) is a taxonomically complex genus, comprising about 180 taxa. The traditional concept of the genus, based on morphological characteristics, has been completely transformed in recent years, primarily supported by molecular evidence. The leaf indumentum, especially trichome types present on the leaf, is a very important taxonomic character in the Lamiaceae family. To provide a more clear insight into infrageneric differentiation, this study was focused

on the leaf trichome characterization of four *Clinopodium* taxa collected from the same locality. The leaves of *Clinopodium acinos* (L.) Kuntze, *C. alpinum* (L.) Kuntze subsp. *hungaricus* (Simonk.) Govaerts, *C. vulgare* L. and *C. menthifolium* (Host) Stace were collected in Zlotska Gorge (Serbia), air-dried and subsequently examined by scanning electron microscope. In the leaf indumentum of the investigated samples, both non-glandular and glandular trichomes (peltate and capitate) were observed, showing a clear difference in trichome traits between all examined taxa. All trichome types were notably more abundant on the abaxial leaf surface, with the greatest variability of capitate trichomes, especially in the *C. alpinum* subsp. *hungaricus*. Based on the present results, capitate trichomes show the most potential to be informative for taxa delimitation within the genus *Clinopodium*.

Acknowledgments. This work was funded by the Ministry of education, science and technological development of the Republic of Serbia (451-03-68/2022-14/200178).

Structural changes of needle epicuticular waxes of *Abies cephalonica* in relation to natural weathering

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This is the first report on the structural changes of needle epicuticular waxes of *A. cephalonica* Loudon (Pinaceae) in relation to natural weathering. On the adaxial needle surface where stomata were absent, irregular, often rounded wax structures in form of granules were observed. The amount of granules increased with needle aging, so they were the most present on the oldest (three-year-old) needles. On the abaxial needle surface, where stomata were arranged in longitudinal rows forming two parallel bands, the main wax crystalloids were tubules with a tendency to concentrate within stomatal complexes and between them in the stomatal rows. Namely, tubules were quite dense with reticular aspect inside the stomatal pores, but sparsely present on the epistomatal rims and non-stomatal surfaces of the stomatal bands. In the course of time the tubules reached more advanced stages of

agglomeration, thickening and fusion forming amorphous wax crusts. Therefore, both the tendency of amount of granules to increase and the degree of degradation of tubules into amorphous crusts as the result of natural ageing process were well-documented.

Acknowledgements. This research was supported by Grant No 451-03-68/2022-14/200124 by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

Cytotype diversity and genome size variation in *Festuca varia* complex (Poaceae) in south-eastern Europe

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Festuca L. is a highly diverse genus of grasses and its perennial species constitute important grassland vegetation worldwide. Recent phylogenetic studies revealed two main evolutionary lineages corresponding to broad-leaved and fine-leaved species. Within fine-leaved fescues, the earliest diverging group is *F.* sect. *Eskia*, known also as *F. varia* complex, which includes approximately 20 species. The taxonomic complexity of the group is especially evident in the Balkan Peninsula, from where several narrowly endemic taxa and a number of lower taxonomic entities have been described. The aim of the present study is to explore genome size variation and the incidence of polyploidy within the representatives of *F. varia* complex on the Balkan and Apennine Peninsulas based on comprehensive

geographic sampling. Our relative genome size measurements conducted with flow cytometry revealed that the majority of populations are diploid ($2n=14$) and they are distributed across most of the distribution area. Tetraploids are more restricted and were found in southern Dinaric Mountains, whereas hexaploids were found only on Mt. Pirin (Bulgaria). Our detailed screening of cytotype diversity and genome size variation in *F. varia* complex will contribute to the integrative approach combining phylogenomic and morphological analyses in order to resolve relationships within this intricate group.

Acknowledgments. The research was funded by the Croatian Science Foundation project “Phylogeography and evolution of three ecologically divergent groups of amphi-Adriatic plants” (project No. UIP-2017-05-2882) to I.R., and by the Austrian Agency for International Cooperation and the Croatian Ministry of Science and Education – Austria-Croatia bilateral project “Diversification of the *Festuca varia* group (Poaceae)” to B.F. and I.R.

Citizen participation in the enrichment and maintenance of the collections of the Botanical Garden of BAS

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The Botanical Garden of the Bulgarian Academy of Sciences is a specialized unit that preserves and maintains the richest in Bulgaria scientifically organized and documented collections of living plants, which serve to spread knowledge about the world's plant diversity. Currently, the number of species in the Garden exceeds 4,700. The most remarkable is the collection of tropical and subtropical plants, which with its over 3,700 species is at a very good world average in terms of wealth. The park part of the Garden covers an area of about 300 decares and includes mainly species that grow naturally in the temperate zone of the Northern Hemisphere. There are over 1,000 species. The rich collections kept in the Botanical Garden and the magical place where it is located attract many citizens who are happy to donate plants or help with their volunteer work to maintain the Garden. In the last 2 decades, more than 200 citizens, companies, nurseries and other botanical gardens have donated plants to our collections. There is a great interest in conducting volunteer actions for the maintenance of the greenhouses and the park. This is a

positive trend, which is extremely useful for the Botanical Garden, but also for the education of citizens in the love of beauty and plant biodiversity.

A comparative assessment of ISSR markers for molecular diversity of subgenus *Limniris* (Tausch) Spach (Iridaceae Juss.) in Bulgaria

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Understanding the genetic variation in genus *Iris* L. within and between populations is essential in modern plant taxonomy, especially when taxonomy features based on floral morphology are unclear and misleading. This study investigated the genetic diversity of four Bulgarian *Iris* species from subgenus *Limniris* using seven ISSR markers. A barcode (pattern) consisting of one hundred twenty-three bands, including 84 polymorphic ISSR products, was generated and used for further clustered analysis. Dendrograms derived from individual ISSR markers were consolidated in a single consensus tree using CONSENSE software (PHYLIP). Two of the primers (L3 and L5) were proven as ISSR markers providing the most biologically relevant data and, respectively, most statistically significant species clustering. Interestingly a close genetic relationship between *Iris pseudacorus* and *Iris graminea*, species with mesophilic and hydrophilic habitats, respectively, were found.

Acknowledgments. This work was financially supported by the National Science Fund, Ministry of Education and Science, Bulgaria (Project “Biodiversity and taxonomic structure of *Iridaceae* Juss. in Bulgarian flora” № KP-06-N31/5).

Contribution to the knowledge of serpentine flora of Northern Pindus in Greece

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Mediterranean Europe and especially the Balkans have been recognized as centre of serpentine floristic diversity. Pindus mountain range is the heart of serpentine areas in Greece presenting high floristic diversity. However, limited research has been done so far in this field in Greece. A new project started in order to study the floristic composition and ecology of the plant communities on serpentine in the mountain range of Northern Pindus. The total study area covers more than 850 km². The in-the-field research started during the vegetative period of 2021 among the limitations due to the covid-19 pandemic. Till now, 81 relevés were sampled according to the Braun-Blanquet method. All vascular plant taxa were recorded. Furthermore, soil samples have been collected in order to determine the soil environment of the plant communities, in particular the phytoavailability of nickel and other metals. According to the first floristic results of the research, 277 plant taxa have been identified, representing 51 families. Asteraceae and Fabaceae are the most abundant families with 43 and 27 taxa, respectively. Almost 60% of the taxa are hemicryptophyte. 14 taxa are Greek endemics, while 55 taxa distributed to Balkan Peninsula and 95 taxa in the Mediterranean region.

Herbarium Moesiacum Niš (HMN) – State of the Art

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The Herbarium Moesiacum Niš (HMN) consists of approximately 2,500 species collected mostly throughout Serbia and other parts of the Balkan Peninsula in the last 60 years. It contains approximately 33,000 exemplars, collected by professors, researchers, and students, with Vladimir and Novica Randelović, Vidak Jovanović, Bojan Zlatković, Marina Jušković, Marija Marković, and Olivera Papović contributing over the 3/4 of the collected specimens. The taxonomical analysis of the general collection highlighted the most abundant plant families: Asteraceae (338 collected species), Poaceae (186), Fabaceae (160), Rosaceae (136), Caryophyllaceae (122), Lamiaceae (119), Apiaceae (110), Brassicaceae (107), Ranunculaceae (78), and Cyperaceae (61); and genera: *Trifolium* (55), *Centaurea* (38), *Carex* (37), *Crocus* (36), *Ranunculus* (36), *Achillea* (30), *Veronica* (28), *Potentilla* (28), *Sedum* (27), and *Hieracium* (26). The collection also consists of a large number of fungi and lichen specimens. The space dedicated for the HMN collection storing is currently being expanded and renovated. Further efforts will be directed toward the registration, digitization, and establishment of the functional seed bank.

Acknowledgments. This study was funded by The Ministry of Education, Science and Technological Development of the Republic of Serbia (contract no. 451-03-68/2022-14/200124).

Morphological study of the rosette leaves of *Sempervivum ciliosum* and *S. ruthenicum* complexes from the Balkan Peninsula

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Complexes *Sempervivum ciliosum* (comprises *S. ciliosum* s.s., *S. klepa*, *S. galicicum*, *S. octopodes*, *S. jakucsii*) and *S. ruthenicum* (*S. ruthenicum* s.s., *S. zeleborii*, *S. leucanthum*, *S. kindingeri*) represent taxonomically intriguing groups of yellow-flowered *Sempervivum* taxa from the Balkan Peninsula. Although characteristics of the rosette leaves are often applied for identification purposes, due to their prominent morphological variability, it is challenging to assert if those characteristics are employable as relevant traits for differentiation and taxonomic characterization of the mentioned taxa. Hence, the scope of this study was to determine the differences in rosette leaf characteristics between analyzed taxa and, consequently, clarify the taxonomic relationships among these complexes and taxa within. We analyzed four quantitative traits, length of the lower and upper part, width and thickness of the rosette leaf, at the level of 130 specimens (9 populations). Results illustrate that all traits are highly statistically significant for the differentiation of analyzed taxa. Multivariate analysis, CDA and AHC, divided taxa similarly, showing pronounced delamination at the level of complexes (as *a priori* groups) with somewhat lesser appointed separation of taxa within complexes. The exception is *S. leucanthum* which more closely resembles taxa within *S. ciliosum* complex rather than taxa within *S. ruthenicum* complex.

Acknowledgments. This study was funded by The Ministry of Education, Science and Technological Development of the Republic of Serbia, Grant No. 451-03-68/2022-14/200124.

Floral morphometry and microcharacters in *Inula*, *Dittrichia*, *Limbarda* and *Pulicaria* (Inuleae, Compositae) and their taxonomic implications

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Morphometric and micromorphological floral characters of 17 species of the tribe Inuleae (*Inula* L., *Dittrichia* Greuter, *Limbarda* Adans. and *Pulicaria* Gaertn.) were analyzed to evaluate their reliability as taxonomic markers. Plant material was collected from native populations and each of the species was collected from the three localities, minimum fifteen samples from fifteen different individuals belonging to each population were analysed. Comparative analyses of ray and disk florets features have been carried out using stereoscopic and scanning electron microscopy. The corolla pubescence was studied in detail and obtained results indicated the presence of non-glandular and glandular trichomes. Distribution and density of trichomes were variable among species and their types did not reflect the differentiation among them. Discriminant analysis findings of quantitative characters indicated that those related to the lobes of the ray and disk florets as well as length of disk florets contributed the most to the discrimination of the studied taxa. However, the findings showed that certain characters are important for separating individual taxa, but their grouping did not follow the current classification.

Acknowledgments. The authors acknowledge financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2022-14/200125).

**14th Symposium on the Flora of
Southeastern Serbia
and Neighboring Regions
Kladovo 26th-29th June, 2022**

**Phytogeography, Floristics and
Phytoecology**

INTRODUCTORY LECTURES

Generalized habitat map of Serbia

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The generalized habitat map of Serbia is one of the products of the project carried out for the needs of the Institute for Nature Protection of Serbia by the Faculty of Biology University of Belgrade in cooperation with the geomatics company MapSoft d.o.o. The map was created using an adapted methodology for extracting different habitat types from remote sensing data. To interpret the basic habitat types, the following input datasets were used: Sentinel-2 satellite data, EU-DEM terrain elevation data, Basic land cover map, Copernicus pan-European high resolution layers, Open Street Map data, pedological and geological map of Serbia, and numerous training data. The map was created by integrating the rasters of each habitat type into a single raster, separating additional habitat subtypes by crossing them with additional sources (geologic and pedological map, basic land cover map, etc.). The final results are presented in the form of a spatial raster, with 32 cartographic classes defined based on the typology of habitats according to the Rulebook on Habitats of Serbia. In addition, manual vectorization of several other habitat types (springs - 37,284 objects, caves - 499 objects, waterfalls - 109 objects) was performed, and these results are provided in the form of vector point entities.

Cryptogam flora (bryophytes and lichens) of Djerdap National Park

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Research of the cryptogam flora of Serbia has been a neglected discipline for a long period of time. However, in last decades advances in the field have been remarkable marked by successful field studies and many new data. In our presentation we give an overview on the bryophyte and lichen flora of Djerdap National Park mainly based on a collecting trip carried out in 2004. During bryological survey altogether 192 bryophyte taxa (25 liverworts and 167 mosses) were recorded. Among them five were reported for the first time from Serbia (*Encalypta spathulata*, *Grimmia decipiens*, *Grimmia elatior*, *Imbricium microerythrocarpum*, *Taxiphyllum densifolium*). Four species of European conservation interest were recorded: *Claopodium rostratum* and *Encalypta spathulata* are placed in vulnerable category in the European IUCN Red List of Bryophytes, *Taxiphyllum densifolium* is evaluated as endangered, and *Porella arboris-vitae* is near-threatened. The lichenological survey revealed the occurrence of more than 190 lichen species. The high contribution of caloplacoid, lecanoroid and verrucarioid species (ca 25%) is remarkable. Three species found (*Gyalecta leucaspis*, *Sarcopyrenia gibba*, *Scytinium callopismum*) can be reported here to be new for the lichen flora of Serbia. In addition, several bryophyte and lichen species were found that are of national conservation interest.

ORAL PRESENTATIONS

Priority habitats on the territory of the Republic of North Macedonia

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The Republic of North Macedonia is characterized by major diversity of wild plant and animal species in diverse ecosystems. This is a result of the geographic position at the transition from Mediterranean to temperate-continental climate, and of a considerable diversity of habitats, resulting in a wide spectrum of diverse ecological conditions. Vegetation research on the territory of North Macedonia is not yet completely finalized, so there are many gaps in the knowledge of several vegetation types and habitat types. On the territory of North Macedonia, 15 priority habitats of the following groups according to the Habitat Directive have so far been registered: two from Coastal and halophytic habitats, one from Temperate heath and scrub, four from Natural and semi-natural grassland formations, two from Raised bogs and mires and fens and five of Forests. For each of these habitats, a relationship with another type of classification is indicated, such as codes and names from the Palearctic Classification of the habitats (abbreviated PAL. CLASS.), and habitat type according to the EUNIS classification (abbreviated EUNIS). A brief description of the habitat is given, with registered plant communities found in this type of habitat. Ecological characteristics of the habitat, characteristic plant species, and distribution on the territory of the Republic of North Macedonia will be presented. Defining all these features will enable monitoring of the state of the habitats, defining the threats and taking conservation measures for their preservation and restoration.

Ferns in the ex-Yu region: do we know them all?

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Ferns are among the few groups of vascular plants dealt with in never finished monumental monograph “Analitička flora Jugoslavije” (Horvatić & al. 1967-1986), and as such expected to be well studied. But on one hand Mayer and Horvatić could only have produced a compilation of data available in 1967, when Yugoslavian territory had a very uneven floristic coverage, on the other hand ferns with several interesting and critical taxonomic groups especially due to polyploidy and/or hybridization had been studied more thoroughly only in the following decades. And there is also a third important factor: due to superficial similarity and phenotypic plasticity ferns are quite often somehow neglected during floristic field work and as result of that under-represented in herbaria. In the study an overall situation of knowledge of fern taxa in the discussed territory will be presented with the emphasis on gaps in our knowledge and/or geographical coverage. Based on analysis the most “promising” groups of ferns are recognized and reasons for their complexity briefly presented as e.g. *Asplenium trichomanes* (s. l.), *A. ceterach* (s. l.), *A. adiantum-nigrum* agg., *Dryopteris affinis* (s. l.), *D. carthusiana* agg., *Polypodium vulgare* (s. l.), *Polystichum*.

Some wetland plants in Bosnia and Herzegovina - new records and conservation remarks

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The distribution pattern of six species that are mostly common in Central European countries but mostly rare and endangered in Southern Europe is the focus of this article: *Achillea ptarmica*, *Carex elongata*, *Carex strigosa*, *Comarum palustre*, *Drosera rotundifolia* and *Prunus padus*. These taxa are conditioned by high level of surface/underground water, being restricted to wet habitats. The marsh habitat species can be considered among the most threatened ones in Bosnia and Herzegovina. In the Dinaric mountains the wetland flora is typically reduced to the

karst fields, peatlands, mountain plateaus, spring areas and banks of glacial lakes, scattered in suitable conditions throughout the mountain range occupying small areas and have a typical disjunct distribution. Some of them are more typical to the lowland part on the north of the country, occupying the remnants of riparian forests. For each studied species, previous chorological data in Bosnia and Herzegovina, general distribution and ecology, recently confirmed and new records, description of habitat, threats on habitats and species, and estimation of threatened status based on IUCN criteria are provided.

New data on the distribution of two protected and one invasive species in the flora of Serbia

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Following the trace of the photograph published in 2004 in the book “Divčibare” (author Bogoljub Loma), new locality of the relict, protected species *Hypericum androsaemum* L. (Hypericaceae) in Serbia was confirmed. According to the data from the literature, the species is present at four localities: Boranja, Gučevo, Cer and Krupanj. The “new” site on Maljen, near Gornji Lajkovac, has been known since about twenty years ago, when Dr. Nebojša Menković and Miroslav Jeremić, the photographer from Valjevo found this plant. This data on the findings was not published, but the photograph was sufficient for the finding to be re-checked (November 3, 2021 and April 20, 2022). During the latest investigation (May 11, 2022) of the nature of Jelica mountain, a protected fern species *Thelypteris palustris* Schott (Thelypteridaceae) was found at wet habitat within beech forest. In November, 2021 the associates of PE “Srbijašume”, forest unit “Gornji Milanovac”, informed the Institute for Nature Conservation of Serbia about new finding of an invasive species *Opuntia humifusa* (Raf.) Raf. (Cactaceae) on Mount Vujan. This finding was confirmed during fieldwork (May 03, 2022). Until now, it was recorded near Korbovo, in Deliblatska peščara and in Pčinja.

Distribution of *Euphorbia* sect. *Helioscopia* Dumort. (Euphorbiaceae) based on the data in Herbarium collections in Belgrade

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Specimens of *Euphorbia* sect. *Helioscopia* Dumort. deposited in the Herbarium of the University of Belgrade (BEOU) and General herbarium of the Balkan Peninsula in the Natural History Museum in Belgrade (BEO) were studied. A total of 723 herbarium sheets were analysed: 303 deposited in BEO and 420 deposited in BEOU. Data on distribution and habitat preferences were collected. Twelve out of 15 species reported for Serbia were confirmed: *E. angulata* Jacq., *E. carniolica* Jacq., *E. epithymoides* L., *E. glabriflora* Vis., *E. helioscopia* L., *E. illirica* Lam., *E. montenegrina* (Bald.) K. Malý., *E. nuda* Velen., *E. palustris* L., *E. platyphyllos* L., *E. serpentinei* Novák, and *E. stricta* L., whereas specimens of *E. fragifera* Jan., *E. lingulata* Heuff. and *E. verrucosa* L. were not found. Distribution of each species was shown on the UTM grid 10×10 km² based on Military Grid Reference System and the Universal Transverse Mercator (UTM) projection.

Acknowledgements. Grants funded by Ministry of Education, Science and Technological Development No 451-03-68/2022-14/ 200178 and No 451-03-1/2022-14/4.

Alien plant species hot spots in Romania

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To fulfill the obligations incumbent on Romania, a Member State of the European Union, derived from Regulation (EU) 1143/2014, an important aspect is represented by the intensive inventory and mapping in the hot spots and priority points of introduction of alien plant species. This activity has been running since 2019 within the project “Adequate management of invasive species in Romania, in accordance with EU Regulation 1143/2014”, SMIS code 2014+ 120008 and mainly targets 130 plant species considered invasive and potentially invasive for Romania. The data collection was performed according to a methodology established within the project, which aimed to obtain information on the location of the species, the size of the populations, the abundance, the phenology, the type of invaded habitat, and the accompanying species. The data collected in 2019 were the basis for the adjustment of the working protocol, and those from 2020 and 2021 were organized in a database that serves to analyses and interpret the information. In 2020 there were 7,822 field records performed, and in 2021 there were 7,970 records. Among the species with the most collected points there are: *Ambrosia artemisiifolia* (1,028), *Robinia pseudoacacia* (1,017), *Erigeron canadensis* (960), *Xanthium orientale* subsp. *italicum* (881), *Amaranthus retroflexus* (816). High concentrations of invasive alien species are confirmed along roads and railways, in harbours, in border areas or along the Danube. In the Danube's entrance area in the country (Iron Gates Natural Park) and in the Danube Delta (Danube Delta Biosphere Reserve) the most invasive and potentially invasive alien species are present. The species of EU concern inventoried in hot spots are *Ailanthus altissima*, *Asclepias syriaca*, *Elodea nuttallii*, *Impatiens glandulifera* and *Ludwigia peploides*. The data obtained by us on the presence of invasive and potentially invasive alien plant species will serve to implement the National Action and Control Plan.

Ruderal vegetation of the class *Sisymbrietea* in Serbia

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The class *Sisymbrietea* Gutte et Hilbig 1975 includes zoo-anthropogenic and modern anthropogenic vegetation of animal shelters and disturbed ruderal sites. In this study, the class is presented using a comprehensive database of relevés compiled from various literature sources from Serbia, as well as original relevés collected during a 5-year survey of ruderal vegetation in 20 Serbian cities. The final database included 327 relevés, in which 381 taxa were recorded. Plant communities were distinguished by cluster analysis and identified diagnostic species. The syntaxonomical diversity of the class *Sisymbrietea* in Serbia is represented by the order *Sisymbrietalia sophiae*, 3 floristically differentiated vegetation alliances (*Atriplicion*, *Sisymbriion officinalis*, *Malvion neglectae*) and 14 communities (*Hordeetum murini*, *Plantago lanceolata* comm., *Malva sylvestris* comm., *Polygono arenastris*–*Chenopodietum muralis*, *Ivaetum xanthiifoliae*, *Kochietum densiflorae*, *Ambrosietum artemisiifoliae*, *Chenopodietum stricti*, *Atriplicetum nitentis*, *Cynodonto dactyli*–*Atriplicetum tataricae*, *Matricario*–*Helianthetum annuuae*, *Euclidietum syriaci*, *Malvetum pusillae*, *Urtica urens* comm.). *Atriplicion* is represented by 184 relevés, *Sisymbriion officinalis* by 125, and the least represented are the communities of the *Malvion neglectae* alliance (18 relevés), which were recorded only in the earlier period. As confirmed by the cluster and ordination analysis, the syntaxa are floristically well separated, although the syntaxonomical position of some communities remains unclear due to their transitional character.

Acknowledgements. This research was funded by Ministry of Education, Science and Technological Development of the Republic of Serbia, grant number 451-03-68/2022-14/200178.

The Sava Lake – charophyte gem in the heart of Belgrade

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The Sava Lake, originating from a branch of the Sava river, is situated next to the island Ada Ciganlija on the right bank of the Sava river in Belgrade (Serbia). It is an urban recreational lake under strong anthropogenic influence, especially during the summer days. Investigations of aquatic vegetation were conducted several times during the last decades and the latest systematic survey was conducted in summer 2017 as a part of STARWALK project. Since then, sampling was continued sporadically, revealing a great diversity of charophyte algae. Overall, we discovered eight charophyte species in the lake, which is a remarkable number even for unimpacted natural lakes. The species found belong to four out of six genera of living charophytes. The genus *Chara* is represented with three species, *C. globularis*, *C. contraria* and *C. virgata*, the genus *Nitella* also with three, *Nitella mucronata*, *N. gracilis*, *N. flexilis*, and genera *Tolypella* and *Nitellopsis* with one species, respectively, *T. intricata* and *N. obtusa*. Moreover, almost all discovered species are red listed in Serbia and the Balkans, according to IUCN criteria. Six of them are strictly protected according to national legislation. The finding of *Nitella flexilis* was the first finding of this species for Serbia.

Acknowledgements. The project was funded by the Norwegian Ministry of Foreign Affairs (STARWALK project) and supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2022-14/200026). The authors gratefully acknowledge the diving club “Amfora” for the help provided during the field work.

Alien flora of urban habitats in Serbia

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Urban habitats are usually characterized by the strong presence of alien species. The survey of seven habitat types in 24 cities of Serbia revealed the presence of 172 alien plant species (25.79% of the total). The percentage of alien species in the urban flora of Serbia is significantly lower than the percentage of alien species in the urban flora of Central Europe. Of the alien plants recorded, 60.47% are neophytes and 39.53% are archaeophytes. The presence of all alien species, archaeophytes and neophytes varies according to the type of urban habitat. The highest percentage of alien plants was found in residential areas with open building patterns, while the lowest percentage was in habitats with mid-succession vegetation stages. Archaeophytes are represented mainly by species of the Rosaceae, Poaceae and Asteraceae families, while among neophytes, Asteraceae and Amaranthaceae are the most numerous. In contrast to native plants in urban habitats, which are dominated by hemicriptophytes, therophytes are most abundant in alien flora, both among archeophytes and neophytes. In addition, archeophytes and neophytes differ in their indicator values, both among themselves and in relation to the native flora.

The Croatian flora plant material in the Herbarium BUNS

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Herbarium BUNS is the botanical collection, with nearly 150,000 specimens. Most of the material was collected in Vojvodina (Serbia), but also in the neighbouring countries: Croatia, Montenegro, Bosnia and Herzegovina, and North Macedonia. The indeterminate material is organized according to the country of origin, and the collection of Croatian flora is arranged in 29 boxes. Sandro Bogdanović (ZAGR) completed a revision of full herbarium of the Croatian material, during 2021. Preliminary results showed that material was collected in the second half of the 20th century, mainly during the 1960s and 1970s. The location sites are in Dalmatia, Lika and Slavonia. The most important collector of materials is Melanija Obradović. In total 1,483 specimens are databased. Of these, 1,274 are determined to species level. The collection includes 691 species, from 405 genera, and 108 families. Among them 35 are endemics, 23 species are rare, and only 26 are cultivars. The important data for the following species in Croatia has risen: *Astrantia carniolica*, *Euphorbia barrelieri* subsp. *hercegovina*, *Kitaibela vitifolia*, *Stachys mentifolia* and *Viola ambigua*. Although the data are not part of a systematic survey of the territory of Croatia, they represent a contribution to the knowledge of rare, endemic and common flora.

Acknowledgements. The authors acknowledge financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2022-14/200125).

Mapping urban invasions using Google street view – tree of heaven in Novi Sad

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The urban environment is prone to plant invasions, especially when ornamental woody and shrubby species are in the way. Mapping and monitoring such plants is essential in their successful management and control. Google Street View (GSV) has proven to provide accurate distribution data along roads. However, it has not been used in the urban landscape yet. Using this method, we mapped the tree of heaven on the territory of Novi Sad, organizing our findings (a total of 887) into four groups depending on a plant phenophase and abundance. We managed to distinguish the presence of the tree of heaven between the private (146) and public (741) areas and estimate potential damage to the city's infrastructure (202) and its greenery (562). There is a distinct parallel between the degree of urbanization and planted (105) trees, as most are near the city center. Despite some minor difficulties (i.e., similar species, the uncertainty of cultivation status and property), we find GSV service a powerful tool in mapping the invasive trees, shrubs, and perennial plant species in the urban environment.

Contribution to the orchid flora of Northeast Serbia

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Northeast Serbia stretches from the Danube River on the north and east, to the Mt. Rtanj on the south and Mt. Homolje and Resava gorge on the west. The geography and ecology of this area are complex, composed of a series of mountain folds and river gorges with mixed deciduous forest vegetation. This study aimed to compare literature to field data and potentially present new chorological data for orchid taxa in NE Serbia. Based on the reviewed literature data, 28 orchid taxa are present in NE Serbia. During the field research in the spring and summer of 2021/2022, 11 orchid taxa were recorded. Based on data published so far, there are two new orchid taxa in NE Serbia – *Neotinea ustulata* registered on slopes of Mt.

Mali Krš and Mt. Stol, and *Cephalanthera damasonium* found in the forests around Majdanpek. Furthermore, new chorological data in NE Serbia were identified for *Anacamptis morio*, *A. papilionacea*, *Himantoglossum calcaratum* subsp. *rumelicum* and *Orchis purpurea*. Considering the old and insufficient number of literature records for orchid flora of NE Serbia and the floristic potential of the region, it is necessary to continue and expand the research area to get further knowledge about the distribution of orchid taxa in this region of Serbia.

Acknowledgments. The authors acknowledge the financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2022-14/200125).

Vascular flora of the Special Nature Reserve “Wetlands of the lower Tisa” (Vojvodina, Serbia)

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SNR “Wetlands of the lower Tisa” is a protected area, which includes a mosaic of wetlands, water, and forest habitats, around eight old meanders of the river Tisa. Older literature sources provide data for the region of Potisje, but systematic floristic research in sites that are today in boundaries of this SNR has not been conducted so far. In the study of protection of this area (2012), only 294 taxa of vascular plants were recorded. As it has been ten years since this area was formally protected, the need for extensive and systematic floristic research has arisen. Floristic field research was carried out from 2019 to 2022 in the Reserve. As a result, 50 new taxa of vascular flora, or 15% of the total registered flora of the Reserve were found. Most of these species inhabit ruderal and riparian habitats and belong to therophytes and areal types of wide geographical distribution (Cosmopolitan, Eurasian, etc.). Based on these results, it can be said that SNR “Wetlands of the lower Tisa” is an important place for the survival of many indigenous plant species that inhabit wetlands and floodplain forests in a predominantly agricultural region and an important component of the Tisa River ecological corridor.

Acknowledgements. The authors acknowledge the financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2022-14/200125) and owe special gratitude to the management and staff of SNR “Wetlands of the lower Tisa”.

Novelties for the orchid flora of Montenegro

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In the vascular flora of Montenegro there are about 3,600 plant species and subspecies, of which 70 to 80 are orchids. Research on diversity of the Orchidaceae family in Montenegro has not been systematic, and most of the published data come from floristic studies. During the last decade, within the research of orchid diversity of the Balkan Peninsula, great attention of the Laboratory for Plant Systematics and Phytogeography, Faculty of Sciences in Novi Sad, has been dedicated to Montenegro. As a part of the research, in the last two years five new taxa were registered – *Ophrys rhodostephane* Devillers & Devillers-Tersch (Dalmatian endemic), two natural intrageneric hybrids of the genus *Anacamptis* Rich. – *A. × gennarii* (Rchb.) H. Kretzschmar, Eccarius & H. Dietr. and *A. × olida* (Bréb.) H. Kretzschmar, Eccarius & H. Dietr., as well as one intergeneric hybrid – *× Serapicamptis rousii* (Duphy) H. Kretzschmar, Eccarius & H. Dietr. All taxa were recorded on the northern or southern slopes of the Rumija mountain, except *A. × olida*, which was recorded on the mountain Prekornica. In addition to these results, during the same research, new localities for *Ophrys × flavicans* Vis. and *O. sphenodes* Mill. subsp. *araneola* (Rchb.) M. Láinz were found.

Acknowledgements. The authors acknowledge the financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2022-14/200125) and Ministry of Agriculture and Rural Development of the Republic of Montenegro (Grant No. MNE-MIDAS2-8820-ME-CQ-CS-20-1.2.3.17).

Disentangling the syntaxonomy and nomenclature of Serbian spruce (*Picea omorika* (Pančić) Purk.) communities

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By studying the numerous references dedicated to Serbian spruce, about 20 forest communities with this endemic-relict species have been described so far at the association or subassociation level. Most of the names used by many authors should be considered invalid and/or illegitimate, as they do not comply with the International Code of Phytosociological Nomenclature. Consequently, the rejection of these names is considered necessary. On the other hand, the syntaxonomy of forests with Serbian spruce is far from being settled, which was the reason that the sampling of vegetation in all known natural populations has been carried out in last 15 years (ca 60 relevés were taken in the field). The hierarchical cluster analysis of these relevés supplemented by those taken from literature has shown that there are only seven ecologically and floristically well-separated groups of these forests which could be considered as associations or subassociations. Hence, along with the rejection of the old invalid and/or illegitimate names, the new and correct names must be introduced for these communities.

POSTER PRESENTATIONS

Orchids of Mt. Zlatibor (western Serbia): distribution and ecological preferences

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Zlatibor Mountain (western Serbia) is known as a large serpentine massif and one of the most important tourist centres in Serbia. Data on the distribution and ecological preferences of orchids from Mt. Zlatibor were collected during field research, obtained from material of herbarium collections, and extracted from relevant published sources. The field research was conducted from 2013 to 2021. The occurrence of 36 orchid species and subspecies, classified into 16 genera, was established on Mt. Zlatibor. The most species-rich genera are *Dactylorhiza* (five taxa), *Epipactis* (five), and *Anacamptis* (four). The greatest numbers of orchids were recorded on limestone (24 species and subspecies), followed by serpentine (17), ophiolitic mélanges (15), and schists-gneiss-phyllites (seven). Orchids were recorded in plant communities from nine classes, 14 orders, and 19 alliances. Most orchid species were found to grow in communities of the classes *Festuco-Brometea*, *Molinio-Arrhenatheretea*, and *Carpino-Fagetea sylvaticae*; the orders *Brachypodietalia pinnate* and *Fagetalia sylvaticae*; and the alliances *Fagion sylvaticae*, *Nardo-Agrostion tenuis*, and *Piceion excelsae*. The study provides a good basis for a better understanding of the potential impact of habitat changes and climate changes on orchid diversity and for more effective planning of their conservation inside and outside the Zlatibor Nature Park.

Acknowledgements. This work was supported by the Ministry of Education, Science, and Technological Development of the Republic of Serbia (grant No. 451-03-68/2022-14/200178) and by the Užice Forest Estate of the “Srbijašuma” State Enterprise, Užice.

Monitoring of allochthonous and invasive plant species in the Zlatibor Nature Park (western Serbia)

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Allochthonous species are known to occur in areas of high anthropogenic influence, such as urban areas, but little is known about their occurrence in protected mountain areas. Monitoring of allochthonous and invasive plant species in the Zlatibor Nature Park was carried out in 2020 and 2021. During the field research, data were collected on the distribution, abundance and ecological preferences of the species. A total of 18 allochthonous and invasive taxa from 14 genera were recorded. The sporadic occurrence of the following species was noted: *Ailanthus altissima*, *Solidago gigantea*, *Helianthus tuberosus* and *Vitis vulpina*, while *Robinia pseudoacacia* was more widespread in villages and along roads, mainly as a planted species. *Erigeron canadensis*, *Erigeron annuus* and *Ambrosia artemisiifolia* occurred mainly in degraded habitats, while *Amaranthus retroflexus*, *Galinsoga parviflora*, *Galinsoga quadriradiata*, *Oenothera biennis* and *Oenothera × glazioviana* occurred in ruderal and segetal habitats. In general, the main hotspots for allochthonous species are the construction sites of tourist facilities and the surroundings of the busy Zlatibor - Nova Varoš highway. Active measures to control and manage the abundance of these species and determine the degree of invasiveness are recommended to maintain the natural characteristics of the Zlatibor Nature Park.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (number 451-03-68/2022-14/200178) and by the Užice Forest Estate of the Srbijašume State Enterprise, Užice.

Incidence of phytopathogenic fungi on endemic plants in Croatia – general overview

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The flora of Croatia has about 5,000 plant species and subspecies, of which 384 are endemic taxa. Occurrence and incidence of phytopathogenic fungi on endemic plant species in Croatia is very poorly investigated. Phytopathogenic fungi can cause various diseases or mycoses, whose development can have very negative impact for endemic plants. In order to determine incidence of phytopathogenic fungi on endemic plants in Croatia, appearance of fungal disease symptoms has been monitored on 35 endemic plant taxa from 24 genera: *Aguilegia*, *Arenaria*, *Berberis*, *Campanula*, *Centaurea*, *Cerastium*, *Cerinth*, *Corydalis*, *Degenia*, *Dianthus*, *Edraianthus*, *Fibigia*, *Helleborus*, *Iris*, *Lilium*, *Moltkia*, *Onosma*, *Petteria*, *Portenschlagiella*, *Polygala*, *Primula*, *Seseli*, *Sibiraea* and *Viola*. Samples of these infected endemic plant taxa were collected at various locations in Croatia (national parks, botanical gardens ec.). Determination of species of phytopathogenic fungi was performed on the basis of their main morphological characteristics (spores and spore-bearing structure). Sixteen phytopathogenic fungal species were determined on twenty endemic plant taxa. Most of determined phytopathogenic fungal species are the first time determined in Croatia and all mentioned endemic plant taxa are therefore new host plants for these phytopathogenic fungi.

Monitoring of the *Trifolio-Brachipodietum rupestris* Hodak 1975 association in South Croatia

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The association *Trofolio-Brachipodietum rupestris* Hodak 1975 was described in eu-mediterranean belt of the the *Quercetea ilicis* vegetation zone of South Croatia. So far, this association has not been researched in detail or found in other regions in Croatia. This paper describes phytosociology and ecology of these

stands and monitors the floristic composition of the association over three years (2020-2022).

On the occurrence of *Anogramma leptophylla* in Bulgaria

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The aim of the current presentation is to report *Anogramma leptophylla* (Pteridaceae) as a spontaneous element in Bulgarian flora for the first time. The species was observed and collected in the Valley of River Struma (Southern) floristic subregion, SW Bulgaria in February 2022. The range of its populations and their state were studied in the period March-May 2022. At the established localities *A. leptophylla* exhibit diffuse distribution pattern. It is presented within about 20 microsites, each composed of tens to few hundreds of individuals. A brief morphological description of the species, including photographs and SEM morphographs of spores and sporangia are presented. The floristic and ecological features of its sites are also discussed, supplemented by distribution map and geographic coordinates. The species was evaluated under IUCN criteria, so provisional threatened status, and some initial conservations measures are proposed.

Comparative study of the anthropogenic impact on the spread of non-native invasive species *Impatiens balsamina* L. and *Reynoutria japonica* Houtt. in the upper basin of the Bistrita and Bistricioara rivers, in the Eastern Carpathians, Romania

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In this paper, we want to make a comparison between two areas, medium-sized river basins in the Eastern Carpathians. It is about the hydrographic basin of the Bistricioara river, a tributary of the Bistrita river as well as the upper basin of the Bistrita river. Starting from the climatic similarities, altitude difference and floristic composition, we evaluated the spread of the species invasive *Impatiens balsamina* L. and *Reynoutria japonica* Houtt. as well as the anthropogenic impact on the natural and semi-natural habitats in the investigated areas. The populations of these species were evaluated as well as the conditions that favor the spread of these invasive non-native species. Habitat analysis was performed using the Corine Land Cover (CLC) tool as well as visual assessment and mapping. Risk maps have also been developed with the help of indices regarding the possibilities of spreading these two species inside the assessed river basins.

A noxious weed vs. useful honey plant: nectar production of common milkweed (*Asclepias syriaca* L.) depending on environmental conditions

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Common milkweed (*Asclepias syriaca* L.) is a plant native to North America, which was introduced to Europe in the 17th century. Since that time it has been spreading rapidly due to its ability to reproduce by seeds and also vegetatively by underground rhizomes, forming large clones. Thus, common milkweed became an invasive, harmful weed occupying natural habitats. At the same time, it is widely used as a honey plant. The environmental factors affecting the nectar production in different habitats of the non-native distribution range are less known. Our study was performed in 2020-2021 on two sites in Hungary and one site in Serbia. We

measured nectar volume and sugar content in 15 inflorescences, air temperature and humidity, soil moisture, collected soil samples and recorded 5 coenological relevés (2×2 m) per site. The amount and sugar content of nectar was significantly different in each study site and correlated with the cover of milkweed. *Asclepias* plants were taller and covered larger parts of sample plots on abandoned vineyards than on dry sandy grasslands. Nectar production was positively affected by humidity and soil moisture, while no correlation was found between other soil characteristics and nectar traits.

Acknowledgements. This work was supported by a grant from the National Research, Development and Innovation Office; NKFIH, K 132044.

Morphological variability of *Armeria* species from Serbia and Bulgaria

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The genus *Armeria* Willd. (Plumbaginaceae) includes about 120 species distributed from Madeira and Portugal in the west to Anatolia and Lebanon in the east. The western Mediterranean region is the centre of distribution of this genus. Three species of the genus *Armeria* have been recorded in Serbia: *A. alpina* (DC.) Willd., *A. canescens* (Host.) Boiss. and *A. rumelica* Boiss., whereas two species: *A. alpina* and *A. rumelica* are present in Bulgaria. *Armeria canescens* grows on ultramafic geological substrate in Serbia, while *A. alpina* and *A. rumelica* occur on siliceous geological substrate in Serbia and Bulgaria. Only one population of *A. rumelica* in Serbia is present on ultramafic geological substrate. We analysed the variability of 19 quantitative morphological traits in the samples from 12 populations (two of *A. alpina*, four of *A. canescens* and six of *A. rumelica*). The scapes and spatha of *A. canescens* and *A. rumelica* are longer than the scapes and spatha of *A. alpina* and *A. rumelica* has the longest scapes and spatha compared to

other two species. The spikelets of *A. canescens* and *A. alpina* are sessile or subsessile, while the spikelets of *A. rumelica* are stipitate.

Acknowledgements. Research was financed by the Ministry of Education, Science and Technological Development, Republic of Serbia (Contract reg. no. 451-03-68/2022-14/200383 and 451-03-68/2022-14/200178).

***Polygonum graminifolium* in Serbian flora – distribution and new data**

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Polygonum graminifolium Wierzb. ex Heuffel 1858 is an annual species morphologically very similar to the *P. aviculare* group. As a characteristic member of Nanocyperon vegetation its typical habitats are pebble alluvial shores in the lower and middle Danube valley (from Slovakia across Hungary and Serbia to Romania). This paper presents all known data on the distribution of *P. graminifolium* in Serbia based on the survey of literature sources, relevant national and international botanical collections, and our field observations. Since its discovery in the vicinity of Stara Palanka by Wierzbicki (1839), this species had been recorded on a few occasions along the river Danube in the wider Belgrade area. Its last confirmed record originates from 1936. In the course of field investigations of its historical and potential habitats conducted along the Danube the new and hitherto unknown population of *P. graminifolium* was discovered in Prahovo (NE Serbia) which represents the first record of this species after almost 85 years. Considering this and the fact that recent field research has not confirmed the presence of this species in any of its previously known localities, we believe that an assessment of the conservation status of *P. graminifolium* would be necessary.

Acknowledgements. This research was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2022-14/200125).

***Himantoglossum robertianum* (Orchidaceae), a confirmed species in the flora of Bosnia and Herzegovina**

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The genus *Himantoglossum* comprises 12 species and two subspecies distributed in Europe, North Africa, Asia Minor, the Caucasus, Israel and southwestern Iran. According to the 'Checklist of the Orchidaceae of Bosnia and Herzegovina', the status of *Himantoglossum robertianum* was unconfirmed, i.e., there are published data but no herbarium or photographic material confirming the only known record from the Čitluk locality. During the botanical survey conducted in March 2022 near the church of St. Anthony in Stari Neum, *H. robertianum* was found, which is the first confirmed record of this species on the territory of Bosnia and Herzegovina. Furthermore, this is the first record of this species in MGRS 33T YH15 10×10 km² UTM grid cell. Eight individuals of *H. robertianum* were found in a place where the forest of *Quercus ilex* is in the process of degradation, on limestone at an altitude of approximately 133 m. On the basis of the IUCN Red List Categories and Criteria, *H. robertianum* is estimated as Critically Endangered in Bosnia and Herzegovina. Given the presence of suitable habitats, the species is considered to be more widespread and have a larger population size in the southern part of the country.

Acknowledgements. Vladimir Randelović, PhD, was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (grant No. 451-03-68/2022-14/200124); Vladan Djordjević, PhD was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (grant No. 451-03-

68/2022-14/200178). We are grateful to the Environmental Fund of the Federation of Bosnia and Herzegovina (www.fzofbih.org.ba) for supporting this research.

Phytosociological analysis of stands dominated by *Carpinus orientalis* in gorges and canyons of Eastern Serbia

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Carpinus orientalis Mill. is a xero-thermophilous tree species that grows mainly on slopes in shallow, humus-poor or even rocky soils, preferring calcareous substrates. In southeastern Europe, *C. orientalis* is a typical element of sub-Mediterranean vegetation, but it can also be found in warmer sites in the continental regions of its range. Using the Braun-Blanquet sampling methodology, we collected 102 relevés of stands dominated by *C. orientalis* in five gorges and canyons in eastern Serbia. Hierarchical cluster analysis of the dataset was performed using Flexible beta and Sorensen (Bray-Curtis) distance measure. Diagnostic, dominant and constant species for the identified clusters were determined using the measure of species fidelity. The results of the numerical analyses showed that the examined stands can be divided into four groups characterized by a distinct floristic composition with clearly defined diagnostic species. The most distinctive group includes stands on screes and stony habitats on steep slopes. Others include stands on both deep and skeletal soils, with different tree species as diagnostic, such as *Quercus petraea*, *Quercus pubescens*, *Carpinus betulus*, etc. All the studied groups are characterized by a high floristic richness, which make stands dominated by *C. orientalis* in ravine habitats a valuable natural resource worth protecting.

Acknowledgments. This research was funded by the Ministry of Education, Science and Technology Development of the Republic of Serbia (Contract No. 451-03-9/2021-14/200007 and 451-03-68/2022-14/200178).

Flora and vegetation on dolomite island of special conservation interest for Bosnia and Herzegovina

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The locality Bor is a small branch of Bjelašnica Mt. (2,067 m) which is wide mountain massif situated NW from Sarajevo. The bedrock at the very peak of Bor (1,100 m) and on its Western slopes is made of bare dolomite rocks. Here black pine woods occur, which were probably distributed over larger area in the past and are responsible for the name of the locality. Due to its specificity, the locality was investigated in terms of its floristic composition by several authors in the past. In period 2020-2022 we have conducted phytocoenological research according to Braun-Blanquet. In total, 26 relevés were done comprising 171 plant species. Here we present inventory of vascular plants, emphasizing their conservation status, and syntaxonomical scheme for the locality. Based on our findings and the fact that it corresponds with *9530 code of Natura 2000, it should be designated as a new Natura 2000 site in Bosnia and Herzegovina.

Flora of Petrovaradin fortress

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Petrovaradin Fortress is the oldest inhabited part of the City of Novi Sad. The fortification, built on the slopes of Mt. Fruška gora, has occupied the area on the right bank of the Danube river for more than 300 years. The fortress is a spatial cultural and historical asset. The natural values of this area are also important, considering conservation of autochthonous flora and introduction of cultivars and neophytes. Spatially, the fortress was divided into: outer walls, inner walls, and the upper fortress. To assess diversity of plants, field research was organized in 2020

and 2021. A total of 225 species were recorded during field research. Complementing the floristic list with previously published data, plant diversity includes nearly 350 species. Outer walls, oriented towards the Danube, are important for conservation in the current state due to the presence of numerous native species, while on inner walls numerous autochthonous and cultivars are widespread. A critical analysis of the list of recorded species, in comparison with their spatial distribution and number of individuals, pointed to certain patterns that are important not only for the conservation of the fortress itself, but also its natural flora.

Acknowledgments. The authors acknowledge financial support of City of Novi Sad, City Administration for Environmental Protection (Grant No. 501-2/202-11d-II) and the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2022-14/200125).

Bryophyte flora of cemeteries in Novi Sad (Serbia)

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The survey of bryophyte flora of six old cemeteries in Novi Sad was performed during spring 2021. Studied cemeteries were: Rusinsko, Nazarensko, Jevrejsko, Uspensko, Almaško and Complex of Catholic cemeteries. Plant material was collected from concrete and marble monuments, tree barks, rocks, walls, and bricks. As a result of field research, 51 bryophyte taxa were recorded (50 mosses and 1 liverwort). Mosses belong to 33 genera and 14 families. The most common species (recorded at every studied site) were *Grimmia pulvinata* and *Tortula muralis*. There was only one species listed on Bryophyte Red List of Serbia and Montenegro with the status least concern. The cemetery with the highest number of species was a Complex of Catholic cemeteries, while the smallest number of species was recorded at Nazarensko cemetery. A comparison of all studied sites showed that the highest similarity was between Uspensko and Complex of Catholic cemeteries, while the lowest was between Rusinsko and Jevrejsko cemeteries. This research represents the first data of bryophyte flora of cemeteries in Novi Sad.

Acknowledgements: The authors acknowledge financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2022-14/200125).

***Brometum comutati* – a new halophytic plant association in South Serbia**

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In the saline habitats of Southern Serbia, a new plant community named *Brometum comutati* ass. new was recorded and phytocenologically described. This association is present at saline habitats of Oblačina and Bresničić salt areas within the altitudinal range of 289-308 m above sea level. The total plant cover of vegetation plots at these localities is 100%. After the continuous monitoring of floristic composition during one vegetation season, it was determined that association included 58 species. In addition to the dominant species *Bromus commutatus*, the most abundant species with highest cover values include *Hordeum geniculatum*, *Puccinellia distans*, *Cerastium dubium* and *Trifolium lappaceum*. Due to grazing activities and proximity of arable land, a large number of ruderal plants are also represented in the association. At Oblačina salt area this plant community covers larger areas. Although this plant association was recorded on lower-salinity soils, in the syntaxonomic sense it still belongs to the alliance *Puccinellion limosae* Soó 1933 with which it is floristically similar.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Contract Number 451-03-68/2022-14/200124).

Vegetation of the seasonally flooded habitats near the village of Levosoje (South Serbia)

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Phytocoenological research of habitats which are seasonally flooded by the Moravica river was performed in order to collect data about diversity of emergent macrophytic plant communities and their floristical composition as well. By applying Braun-Blanquet methodological approach, 73 relevés were recorded during the summer of 2017 year. UPGMA classification method was carried out on Bray-Curtis resemblance matrice in order to establish degree of differentiation among the plant communities in terms of species composition. Based on the results of classification analysis and composition of diagnostic species within cluster groups, it has been established that 15 plant communities – *Typhetum latifoliae*, *Phragmitetum australis*, *Glycerietum notatae*, *Sparganietum erecti*, *Phalaridetum arundinaceae*, *Eleocharietum palustris*, *Butometum umbellati*, *Bolboschoenetum glauci*, *Phalarido arundinaceae-Bolboschoenetum laticarpi*, *Caricetum ripariae*, *Caricetum vulpinae*, *Cyperetum longi*, *Bolboschoenetum maritimi continentale*, *Schoenoplectetum tabernaemontani* and *Oenantho fistulosae-Beckmannietum eruciformis*, take part in composing plant cover on the territory investigated. Unlike *Typhetum latifoliae*, *Oenantho fistulosae-Beckmannietum eruciformis*, *Eleocharietum palustris*, *Glycerietum notatae* and *Butometum umbellati* have been separated at the lowest level of classification. All plant communities are composed of native plants which is becoming rare for this kind of habitats in the last decades. Uniqueness of this area in terms of species and communities richness, and naturality as well, are the main reasons for conducting more intensive research in the future.

Acknowledgements. This study was funded by The Ministry of Education, Science and Technological Development of the Republic of Serbia (contract no. 451-03-68/2022-14/200124).

Preliminary taxonomic study of vascular flora of Natural Monument “Lisine”

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The morpho-hydrological complex “Lisine”, located on the slopes of the mountain Beljanica in eastern Serbia, includes spring Veliko vrelo and waterfall Veliki buk. Declared as a Natural Monument in 1995, this area represents a distinctive landmark of the geo heritage fund of Serbia. The diversity of vascular plants is one of the many criteria when evaluating, declaring and implementing conservation measures in protected areas. Since data on vascular plants diversity on the territory of NM “Lisine” weren't previously known, the scope of this study was to compile a preliminary inventory of vascular plant taxa followed by taxonomic analysis. A field survey was conducted in 2021. We identified a total of 160 taxa pertaining to 128 genera and 50 families. Families with the highest number of taxa are Lamiaceae (22 species), Rosaceae (14), Fabaceae (11), Asteraceae (9), Poaceae (8). The species-richest genera are *Lamium* (4 species), *Geranium* (4), *Euphorbia* (4), *Stachys* (3), *Veronica* (3). Among the recorded, several protected species are detected, such as *Cornus mas*, *Vinca herbacea*, *Hypericum perforatum* and invasive species *Reynoutria japonica*. Continuing investigations of the flora of this area are necessary for the future in order to complete this list and prevent endangerment of diversity.

Acknowledgements. We are truly grateful to public company “Resavska pećina” (Despotovac, Serbia) for their financial support. Furthermore, we are indebted to our hardworking volunteers - members of the Biological Society “Dr. Sava Petrović” for participation in field activities: Danica Popović, Marko Zdravković, Ana Samardžić and Aleksandra Janković.

The first report of orchids in North Banat (Vojvodina, Serbia)

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North Banat is one of the regions of Serbia with the least preserved areas under natural vegetation. There are different types of saline habitats, fragments of steppe vegetation, as well as extremely reduced belts of forest, and shrubby vegetation around watercourses. The most dominant habitat types with the best preserved natural vegetation in this area are salines. In all previous floristic studies, representatives of Orchidaceae family had not been registered in North Banat. Taking into account the lack of information, floristic research was conducted from 2020 to 2022, to determine the actual state of the diversity of the Orchidaceae family in this area. Four orchid taxa have been registered – *Anacamptis palustris* (Jacq.) R. M. Bateman, Pridgeon & M. W. Chase subsp. *palustris* (Kikinda), *Dactylorhiza incarnata* (L.) Soó subsp. *incarnata* (Kikinda), *Epipactis palustris* (L.) Crantz (Kikinda), while *A. morio* (L.) R. M. Bateman, Pridgeon & M. W. Chase subsp. *morio* was found exclusively on salines at six localities – Iđoš-Padej, Siget, Crna Bara, Crna Bara-Banatsko Aranđelovo, and Čoka. Taking into consideration the obtained results, it is necessary to continue research on the diversity of the Orchidaceae family in the area of the North Banat.

Acknowledgements. The authors acknowledge the financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2022-14/200125).

Contribution to the vascular flora of Ljubić Mt. (Republic of Srpska, B&H)

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Mountain Ljubić is situated in the northern part of Republic of Srpska (B&H), south of Prnjavor. It represents one of ultramafic sites in Bosnia and Herzegovina. Flora of Ljubić was part of the study of the ultramafic complexes of Bosnia and Herzegovina, which was conducted by the acclaimed botanist Hilda Ritter-Studnička in the middle of the last century. Our floristic field researches of Mt Ljubić were carried out during the vegetation season of 2020. A total number of 135 taxa of vascular plants have been identified, i.e. 127 species and 8 subspecies. We concluded that six of the identified taxa were listed on the Rulebook of strictly protected and protected wild species in the Republic of Srpska. Strictly protected taxa are *Cephalanthera longifolia*, *Cerastium malyi* subsp. *serpentini*, *Halacsya sendtneri* and *Platanthera bifolia*, while *Dianthus giganteus* subsp. *croaticus* and *Noccaea kovatsii* are protected species. The results of our study may contribute to a better knowledge of the flora on ultramafics in the Republic of Srpska.

Comparative anatomical study of stems and leaves of endemic *Euphorbia* L. species from Serbia

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The genus *Euphorbia* L. is one of the most species-rich genera among vascular plants and, at the same time, the largest genera of the Euphorbiaceae family. Although anatomical studies were proven to be important for taxonomic analysis within this genus, many *Euphorbia* species are not yet investigated from this aspect, especially those with restricted distribution. Therefore, the objective of this study was to determine the differences, or similarities, of aerial organs (stem,

leaves) of three endemic species from the territory of Serbia: *Euphorbia serpentini* Novák (Sect. *Chamebuxus* Lázaro), *E. subhastata* Vis. & Pančić (Sect. *Esula* Pers.) and *E. glabriflora* Vis. (Sect. *Helioscopia* Dumort.). Additional goal was to determine anatomic parameters that may be used in taxonomy of studied species. Cross-sections of stem and leaves of a total of 90 individuals were analyzed. In a quantitative sense, analyzed species are best differentiated based on stem diameter, palisade tissue thickness on the abaxial side of the leaf, leaf blade, sclerenchyma and cylinder parenchyma thickness. Also, significant differences were observed in trichome presence, the number of cell layers in collenchyma, position and number of cell layers of palisade tissue, the shape of anticlinal walls of epidermal cells, etc. Principal Component Analysis (PCA) and Discriminant Analysis (CDA) showed a clear separation of analyzed species.

Acknowledgements. This study was funded by The Ministry of Education, Science and Technological Development of the Republic of Serbia, Grant No. 451-03-68/2022-14/200124.

Macrophytic vegetation of the Pusta river

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At the end of the summer 2021, phytocenological research was conducted on aquatic and wetland vegetation of the Pusta river - left tributary of the South Morava river, along the river course from the village of Bojnik to the municipality of Doljevac. Using UPGMA classification method and Bray-Curtis distance, degree of floristic differentiation between studied vegetation plots was quantified. Analysis was conducted on a set of 96 relevés and 44 species. Based on the results of classification, it was established that 7 plant communities take part in composing vegetation of the Pusta river – *Potametum nodosi*, *Myriophyllo-Potametum*, *Typhetum latifoliae*, *Sparganietum erecti*, *Phragmitetum australis*, *Phalaridetum arundinaceae* and *Polygono-Bidentetum tripartitae*. Plant associations of vegetation class *Potamogetonetea – Potametum nodosi* (4 taxa) and *Myriophyllo-Potametum* (3 taxa) are floristically the poorest and entirely made of native plant species. Plant associations of vegetation class *Phragmito-Magnocaricetea – Typhetum latifoliae* (34 taxa), *Sparganietum erecti* (33 taxa), *Phragmitetum australis* (24 taxa) and *Phalaridetum arundinaceae* (20 taxa) are composed of higher species number,

including invasive plants. Vegetation class *Bidentetea* is represented by only one association – *Polygono-Bidentetum tripartitae*, which is built of 24 taxa, with a share of 16.67% allochthonous species. Collected phytocenological data are going to be a good base for the future research of vegetation of lotic ecosystems in the southeastern Serbia.

Acknowledgements. This study was funded by The Ministry of Education, Science and Technological Development of the Republic of Serbia (contract No. 451-03-68/2022-14/200124 and No. 451-03-68/2022–14/200102).

Habitat diversity of serpentine area “Protected habitat Gostilj” in the Republic of Srpska (Bosnia and Herzegovina)

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The protected area “Gostilj” is located at the Ozren Mt. in the northern Republic of Srpska (Bosnia and Herzegovina). It was designated as “Category IV – Protected habitat” on 29 January 2022 with a total area of 131.97 ha with the main motive to acknowledge and protect the traditional practice of harvesting the medicinal plant *Teucrium montanum*, which, as an event, was included in the UNESCO Representative List of the Intangible Cultural Heritage of Humanity in 2018. Regardless of its small size, this area possesses respectable floristic and habitat diversity due to serpentine bedrock and pronounced relief. 29 relevés were collected in the field using the standard Central European phytosociological method. The classification was done according to floristic and ecological similarities between relevés, without using numerical classification methods. After analysis of data gathered in the field five, floristically and ecologically well-defined vegetation types were distinguished: (1) Ultramafic xeric rocky grasslands of Bosnia (*Polygonion albanicae* Ritter-Studnička 1970), (2) Meso-xerophytic basiphilous grasslands of the subcontinental regions of Central and southeastern Europe (*Cirsio-Brachypodium pinnati* Hadač et Klika in Klika et Hadač 1944), (3) Low heath on ultramafic substrates (*Erica carnea* community), (4) Relict *Pinus nigra* forests on dolomite and ultramafic substrates of the Dinarides (*Erico-Fraxinion orni* Horvat 1959), and (5)

Thermophilous Central European acidophilous oak forests (*Quercion petraeae* Issler 1931).

Diversity of the genus *Plantago* L. in herbarium BUNS

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Plantago L. is a cosmopolite genus of about 200 species of angiosperms, belonging to the family Plantaginaceae. BUNS is a herbarium of the University of Novi Sad, deposited at the Department of Biology and Ecology, and one of four registered and internationally recognized herbaria in Serbia. This paper is a significant result of the ongoing process of examination, revision, and digitization, and represents the collection of the genus *Plantago* in BUNS herbarium. A total of 863 herbarium sheets and 16 species (*P. altissima* L., *P. afra* L., *P. argentea* Chaix, *P. atrata* Hoppe, *P. coronopus* L., *P. holosteam* Scop., *P. indica* L., *P. lagopus* L., *P. lanceolata* L., *P. major* L., *P. maritima* L., *P. media* L., *P. maxima* Juss. ex Jacq., *P. reniformis* Beck, *P. schwarzenbergiana* Schur and *P. tenuiflora* Waldst. & Kit.) were recorded during revision. The specimens were collected between 1950 and 2021 from five European countries, but the majority of herbarium sheets were gathered in Serbia. The results of the revision confirm the occurrence of 13 species already reported for Serbia, but slightly change their known distribution patterns. Summarized results of the revision are given and they show a good level of correctly determined material.

Acknowledgements. The authors acknowledge the financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2022-14/200125)

**14th Symposium on the Flora of
Southeastern Serbia
and Neighboring Regions
Kladovo 26th-29th June, 2022**

**Ecology and Environmental
Protection**

INTRODUCTORY LECTURE

Metal hyperaccumulation in plants: State of knowledge and potential for future research

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Hyperaccumulation of metals and metalloids is a phenomenon related to a plant's ability to take up one or rarely multiple elements into its above-ground organs at concentrations several orders of magnitude higher than in non-accumulators. To date, the phenomenon has been discovered in > 700 plant taxa. Most of these have been found in the Brassicaceae family (> 100 taxa), especially in the genera *Odontarrhena* and *Noccaea*, which predominantly accumulate Ni, and to a much lesser extent Zn, Cd and Pb. Nickel is the most frequently accumulated element at concentrations above the nominal threshold of 1000 µg/g, and its hyperaccumulation has been detected in > 500 taxa from 40 families. Ultramafics are one of the most important natural resources of this element and a considerable number of Ni-hyperaccumulators occur on this substrate, and notably include the ultramafics of the Balkan Peninsula. The importance of hyperaccumulators for phytoremediation and phytomining technology drive the discovery of these exceptional species more than ever. In recent years, X-ray fluorescence spectroscopy has been developed for wide-scale practical use as a non-invasive technique to reveal the chemical composition of soils and plant materials (fresh or dry) and to rapidly detect yet more new hyperaccumulator species.

Acknowledgements. The Ministry of Education, Science and Technological Development of the Republic of Serbia supported this research (grant number 451-03-68/2022-14/ 200178 and Serbian-French Bilateral Project No. 337-00-08/2020-09/20)

ORAL PRESENTATIONS

Not so big, yet so important: First insight into the phytobenthic algal diversity of a small pond

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Small ponds represent precious habitats for a vast number of organisms, supporting at the same time other important ecological roles. However, knowledge on these often unfairly neglected waterbodies is scarce compared to large freshwater ecosystems. Hence, the aim of our study was to describe diversity of phytobenthic algae - diatoms and charophytes, of one small pond located in Ramsar site Labudovo okno (Vojvodina, Serbia). Samples were collected during period 2018-2021. Diatom community consisted of 43 genera. Most species indicated good or moderate water quality. *Navicula* (15) and *Nitzschia* (14) predominated in species number. Charophyte community consisted of 3 genera (*Chara*, *Nitella*, *Nitellopsis*) and 7 species. Diaspore bank analysis provided proof (gyrogonites) for presence of genus *Tolypella* as well. These remarkable results show that one small pond represents a home for almost one third of the recorded charophyte species in Serbia (many of which are rare and threatened) and indicate that in case of non-existing continuous monitoring, standard collection and determination of individuals should be accompanied by sediment collection and diaspore bank analysis in order to gain more realistic picture of charophyte diversity. We suggest detailed biodiversity study of this and other similar waterbodies, as they clearly deserve more scientific attention.

Acknowledgements. Our work has been kindly supported by Rufford foundation (Rufford 25789-1 and Rufford 34213-2 grant) as well as Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-9/2021-14/200178).

The role of polyphenols, sugars, and cell-wall associated polymers in desiccation tolerance of *Ramonda serbica*

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Resurrection plant *Ramonda serbica* Panc. survives long desiccation periods and fully recovers metabolic functions already one day upon watering. This study aimed to investigate the role of soluble sugars and polyphenols, as well as cell wall-associated polysaccharides and lignin in desiccation tolerance in *R. serbica*, an endemic species from the Balkan peninsula. We combined differential transcriptomics and proteomics, the analysis of soluble polyphenolics and sugars, as well as FTIR analysis of the cell wall polymers. Pectin, cellulose, hemicellulose, and xyloglucans were identified as polysaccharide components of the *R. serbica* cell wall and they decreased upon desiccation. Desiccation provoked cell wall remodelling related to the possible production of H₂O₂/HO via germin-like proteins and pectin demethylesterification. In addition, desiccation induced carbon recycling from starch to soluble sugar osmolytes, whose content significantly increased in desiccated leaves. These data support the importance of specific sugars and the plasticity of the cell wall as one of the major contributors to desiccation tolerance of resurrection species, contributing to further crop drought tolerance improvement.

Acknowledgements. This research was funded by the Science Fund of the Republic of Serbia-RS (PROMIS project LEAPSyn-SCI, grant no. 6039663) and by the Ministry of Education, Science and Technological Development, the Republic of Serbia (Contract No. 451-03-68/2022-14/200042, 2022).

Monitoring of air quality 1997-2020 in the urban area of Prokuplje (southeastern Serbia) using corticolous lichens

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The results of a study on the air quality using epiphytic lichens as bioindicators, on the urban area of Prokuplje, are reported. Investigation was done in 1997 for the first time, and 2020. In this work, to establish different air pollution levels, various lichen species have been used as bioindicators. The most frequent species in the year of 2020 were: *Phaeophyscia orbicularis*, *Physcia adscendens*, and *Xanthoria parietina*, like in 1997. An assessment of air quality was made by using the Index of atmospheric purity (IAP). Using the IAP values, it has been found that there are different air pollution zones: “*Lichen desert*” zone, “*Struggle zone*” and “*Normal zone*”. By comparing zone sizes, it seems that within the 1997–2020 period, when the explorations were conducted, there have been not any exceptional pollution recorded, thus could be indicating some air quality improvement and the moderate pollution in the city of Prokuplje. By comparing results from research 1997 and 2020, it could be supposed that the “*Struggle zone*” in Prokuplje decreased as a result of simultaneous impact of few factors - climatic change, reduce of enterprises activity and decrease of freight traffic but this assumption should be confirmed by further research.

Acknowledgements. This work was performed under the project of the Ministry of Education, Science and Development of Republic of Serbia OI 171025.

Monitoring of Invasive Plant Species in SRP Zasavica

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SNR Zasavica is also Ramsar site, IPA, IBA and PBA. A total of 626 species of vascular plants have been identified. The official list of higher plants from 2012 contains 65 allochthonous species, of which 44 are invasive. During 25 years, 85 allochthonous species have been recorded, of which 51 are invasive. Through field research (2010-2021) and revision of herbarium material, 29 new plant species were identified - 21 allochthonous and 7 invasive. Based on 11 years of monitoring, status of expansion was determined as: basic and progressive (low and hyper). Of 51 invasive plant species (IPS), basic spreading status has 25 species (4 new for the list), low progressive has 21 species (2 new) and hyper-progressive has 5 species (1 new). The degree of invasiveness is defined as: potentially invasive, sporadically invasive, and highly invasive. There were 21 potentially invasive (3 new), 24 sporadically invasive (4 new), and 6 species as highly invasive. For other species, no assessment of spreading or degree of invasiveness has been made, as there was one finding or they have been found in one year or in one locality only. The importance of IPS monitoring is in control of their spread and/or removal.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, Nature Conservation Movement Sremska Mitrovica, as well as the Plan and Work program of the Institute of Criminological and Sociological Research for 2022 and the Institute for Nature Conservation of Vojvodina Province.

Maxent modelling for predicting the potential distribution of an amphi-Adriatic plant *Festuca bosniaca* Kumm. et Sendtn. (Poaceae)

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Festuca L. is the most species-rich genus of the grasses in Europe. *Festuca bosniaca* (belonging to *F. varia* complex) is an Apennine-Balkan endemic species occurring in alpine and subalpine grasslands. We here investigated current and past (Last Glacial Maximum - LGM) habitat suitability of *F. bosniaca* using Species distribution modelling (SDM). Our models were built based on the collected occurrence points for *F. bosniaca* from various sources (a total of 103 points after filtering) and a set of eight selected environmental variables which included climatic and geomorphological predictors available for both periods. In addition, current habitat suitability was also predicted based on 13 selected predictors available exclusively for the current period, including additional variables that were not available for the LGM period. SDM was carried out using the Maximum Entropy method with 70% of the occurrences used for model training, and 30% of occurrences used for model evaluation. Projections for the LGM period were based on four general circular models (GCMs) (NCAR-CCSM4, MRI-CGCM3, MPI-ESM-P, MIROC-ESM) which were averaged into a consensus LGM projection. All the resulting models showed very good performance (AUC > 0.9) and the main environmental variables influencing habitat suitability of *F. bosniaca* were mean daily mean air temperatures of the wettest quarter (bio8), mean monthly precipitation amount of the warmest quarter (bio 19), mean daily mean air temperatures of the coldest quarter (bio11) and slope. In addition, current habitat suitability was also influenced by soil organic carbon content and number of snow days. Overall, predicted current distribution corresponded well to the known

occurrences of *F. bosniaca* on the Balkan and Apennine peninsulas, with some potential undiscovered populations in the area of southern part of the Scardo-Pindic mountain range and the north-western part of Apennine peninsula. LGM predictions pointed to larger suitable areas in the past, suggesting that *F. bosniaca* might have had a wider distribution during LGM compared to present.

Acknowledgements. This work has been supported by Croatian Science Foundation under the project UIP-2017-05-2882 (AmphiAdriPlant).

POSTER PRESENTATIONS

The use of macroinvertebrate to characterize some ecosystem attributes in springs of southeastern Serbia

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The macroinvertebrate communities in certain springs in Serbia were comprehensively studied from the taxonomic standpoint even thirty years ago, while the macroinvertebrate community was barely considered from the aspect of functional group analysis. The goal of this investigation was to determine the composition of functional groups in eight springs in southeastern Serbia. Functional Feeding Group (FFG) analysis is an important tool for evaluating the ecological condition of lotic ecosystems. The second objective was to determine whether it is justified to use the same approach for determining ecosystem attributes in spring ecosystems as in other sectors of the lotic ecosystem. The following ecosystem attributes based on FFG were determined: autotrophy/heterotrophy index (P/R), coarse particulate organic matter/fine particulate organic matter index (CPOM/FPOM), and top-down predator control (TOP-DOWN CONTROL). Within the sample of eight springs there were 22 species, which were identified and classified into appropriate functional groups. P/R values could be calculated for four springs. Three of them have shown autotrophic character. The values of the CPOM/FPOM index indicate that for all six springs the normal association of shredders is related to the functioning of the riparial system. Top-down control could be calculated for six springs. Of these, three have shown normal predator/prey balance. These two groups of springs (with disturbed and undisturbed predator-prey ratio) are statistically significantly different regarding temperature ($p=0.023$). The

group of springs with disturbed ratio had a higher average temperature in comparison to the group with undisturbed ratio. It may be assumed that change in temperature may be one of the causes of the disturbance of the predator/prey balance, which emphasizes the threat that global increase in temperature poses for spring ecosystems. In this study, it appears that use of FFG may be useful in determining some of the ecosystem attributes.

Influence of small hydro power plant on diatom community and water quality of the Ljuboviđa River (Serbia)

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Constant growth of human societies with electricity policies that imply environmentally sustainable resources represent one of the greatest challenges of this century. Aggressive policies in several European countries have contributed to proliferation of small hydro power plants (SHPs) since 1980s. About 27,000 are operating in Europe, of which about 90 in Serbia. The aim of this study was to assess the impact of SHPs to diversity, spatial and temporal distribution of diatom community, as well as water quality of the Ljuboviđa River based on diatom indices. Epilithic samples were collected four times during 2019 and 2020 from 5 sites along the Ljuboviđa River. SHP is located between the second and third site. Diatom community analysis yielded 150 taxa belonging to 48 genera. Influence of SHP on temperature and oxygen is noticeable, as well as on diatom species diversity in summer. *Achnantheidium minutissimum* and *Cocconeis euglypta* were dominant taxa at site after SHP, while *A. pyrenaicum* was mostly dominant at other sites. Diatom indices indicated high and good water quality. Only two indices, TID and TDI which provides information on the loading of aquatic ecosystems with nutrients, indicated moderate water quality of the Ljuboviđa River.

Acknowledgments. This work was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2022-14/200178).

Effects of NPK fertilization on absorption of Pb in *Miscanthus × giganteus* grown on flotation tailings

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Flotation tailings generated in mine industry remain uninhabited by plants for decades due to profoundly unfavorable conditions for plant growth, such as pronounced nutrient deficiency, high metal content and surface instability. As such, they are susceptible to water and wind erosion and represent the source of environmental pollution. *Miscanthus × giganteus* rhizomes were planted and grown for six months in the flotation tailings of the Zn-Pb-Cu mine “Rudnik” (Western Serbia), with and without NPK fertilization. The aims of this study were to assess the effects of fertilization on Pb uptake and distribution within the plant, and their influence on pigment contents and total antioxidative capacity in leaves. Concentrations of Pb detected in different plant parts, irrespective of the fertilization, showed that *M. × giganteus* is an excluder suitable for phytostabilization. Fertilizer improved Pb accumulation in roots and increased its concentration in stem when compared to non-fertilized plants. Significant reduction in chlorophyll content and increase in total antioxidant capacity were detected in all metal-stressed plants compared to the control. Fertilization increased pigment concentrations compared to non-fertilized plants. The obtained data show that fertilization improves *M. × giganteus* resilience to Pb-induced stress and its potential for phytostabilization of Pb polluted substrates.

Acknowledgements. This research was supported by The Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant no. 451-03-68/2022-14/200019 and 451-03-68/2022-14/200178).

Lecithine-based deep eutectic solvent in CaO-catalyzed ethanolysis of black mustard (*Brassica nigra* L.) seed oil

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Lecithin:glycerol (LEC:G) deep eutectic solvent (DES), lecithin and glycerol were tested as cosolvents in the heterogeneously-catalyzed ethanolysis of cold pressed black mustard (*Brassica nigra* L.) seed oil. The reaction was carried out in a batch stirred reactor under the following reaction conditions: temperature 70 °C, ethanol-to-oil molar ratio 12:1, CaO catalyst (previously calcined for 2 h at 550 °C) amount of 10 wt.% (to oil) and amount of cosolvent 20 wt.% (to oil) for 6 h. The control reaction was performed without the cosolvents. With all cosolvents, the fatty acid ethyl esters (FAEE) content exceeded 90% after 45 min, while after 90 min the obtained FAEE contents with LEC:G DES, lecithin and glycerol were 97.63, 97.38 and 97.62%, respectively. In the absence of any cosolvent, the reaction was rather slow, providing a FAEE content of 96.17% after 4 h. Another observance characterizing the reaction system with LEC:G DES was the fastest separation of the phases of the final reaction mixture (after 30 min), while for other reactions the required time was up to 12 h. The obtained results opened the way for further research regarding the application of lecithine-based DESs as cosolvents for the synthesis of biodiesel.

Acknowledgements. This work has been funded by the Republic of Serbia - Ministry of Education, Science and Technological Development, Program for financing scientific research work, number 451-03-68/2022-14/200133. This research is also a part of the Project 0-14-18 (Development, modeling and optimization of biodiesel production from nonedible and waste feedstocks) of the SASA Branch in Niš Serbia.

Nickel (Ni) accumulation in the cells of *Alyssum markgrafii* - ultrastructural changes

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Metals such as Ni, Cu, Zn, Mn are essential for normal plant growth, but in higher concentrations they are potentially toxic. Plants possess a range of potential cellular mechanisms that may be involved in the detoxification of toxic metals and thus tolerance to metal stress. In the present study we used transmission electron microscope to investigate location of Ni accumulation and possible effect on the ultrastructure of the cells of *Alyssum markgrafii*, a rare Balkan nickel hyperaccumulating species. The results showed that after three days, the cells which were exposed to Ni toxicity, were characterized with significantly ultrastructural alterations, compared to the control cells. Chloroplasts were removed from the plasmalemma into the cell interior near the nucleus. Electron-dense granules were localized in the vacuole and in the small vesicles. After five days to Ni exposed, it was obtained the reorganization of the vacuolar compartment. Instead one large vacuole, several smaller vacuoles were noted, chloroplasts and other organelles were removed from the plasmalemma near the nucleus into the center of the cell. Many reports showed that distinct toxic metals are stored at the different subcellular compartments; although Cd, Zn and Mo which were found mainly in the vacuole, Ni was primarily stored into the cytoplasm and chloroplasts, our results showed that Ni was found mainly in the vacuole and in the small vesicles near tracheids.

Acknowledgements. This work was funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia: 451-03-68/2022-14/ 200178

Metal accumulation in selected *Scleranthus* species (Caryophyllaceae) from different types of geological substrates in Serbia

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Scleranthus is known to be pseudometallophyte, but there are few studies on the metal content of its plant parts. In this study, the contents of macro- (N, P₂O₅, K₂O, Ca, Mg, Fe) and microelements (Zn, Mn, Cd, Co, Cr, Cu, Ni, Pb) of five *Scleranthus* populations and their soils were investigated. The aim was also to evaluate the adaptability of these populations to the levels of potentially toxic metals and the potential of using *Scleranthus* in phytoremediation and habitat restoration. Plants were collected from five localities in Serbia with different geological substrate (ultramafic and silicate). The analyses showed that most metal concentrations were in usual range. Manganese content in two populations was much higher, reaching toxicity levels, indicating physiological adaptations. Although the concentrations of Cr in above-ground plant tissues were lower than proposed hyperaccumulation threshold, clear tendencies toward active accumulation and translocation were observed in all five populations. The populations studied can be classified as excluders for most elements, but as soil concentrations of Cr were extremely low, Cr accumulation cannot be ruled out. *Scleranthus* is therefore not suitable for phytoextraction, but its potential for phytostabilization and habitat restoration should not be neglected.

Acknowledgements. This research was supported by The Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant no. 451-03-68/2022-14/200019 and 451-03-68/2022-14/200178).

Influence of Microcystin-LR on two phytoplankton species (*Nostoc sp.* and *Coelastrum sp.*)

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Microcystin-LR is the most toxic and most common variant of cyanotoxins. MC-LR can often be detected in aquatic systems, but its ecotoxicological effect on aquatic organisms, especially algae, is insufficiently known. The aim of this study was to examine the influence of ecologically relevant (10 µg L⁻¹) MC-LR concentration on two strains of algae. Effects of MC-LR on the growth of the green microalga *Coelastrum sp.*, and cyanobacterium *Nostoc sp.* were monitored. Growth of these two strains was monitored spectrophotometrically in order to determine the concentration of chlorophyll *a*. After 14 days of exposure, it was observed that MC-LR significantly stimulated the growth of *Coelastrum sp.* However, MC-LR had an opposite effect on the *Nostoc sp.* strain. It was noticed that the growth of *Nostoc sp.* was significantly slower in comparison to the control (without toxin). The results showed that MC-LR has an effect on algal growth, and that it is species-specific. This paper supports the hypothesis that microcystins may modulate algal growth and may suggest a better understanding of the interactions between microcystins and phytoplankton.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (No. contract 451-03-68/2022-14/200124).

Early detection and eradication of *Takahashia japonica* Cockerell in the city of Pula

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The Asiatic string cottony scale *Takahashia japonica* is a newly discovered invasive alien species in Croatia. Its first and only report in Croatia is from Pula in 2019. *Takahashia japonica* was found on six trees belonging to the genera *Acer*, *Morus*, and *Albizia*. Some trees have completely lost their leaves (*Albizia*), and others tend to defoliate. The species was spotted early enough for an eradication attempt. For winter spraying against overwintering forms of pests, 3% OVITEX was used. Treatment during the growing season (June, July) was performed with a combination of contact and systemic insecticides at intervals of 15 days. The achieved effect was infestation reduction on most trees (2021), but not the complete disappearance of the pest. Monitoring and treatment continued, so in April 2022, *T. japonica* was not found on the first six trees, but new sites of infection and hosts have been reported. If *T. japonica* continues to spread, it will be necessary to assess whether the species poses a low or high risk to indigenous flora and whether it affects native hosts in other Mediterranean countries with similar climatic conditions. Establishing efficient management measures to prevent the spread of the pest will also be necessary.

Pollen of allergenic plants in honey samples from Bosnia and Herzegovina

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Honey plants are characterized by specific chemical composition of nectar and pollen grains, which depends on the physiological characteristics of plant species, ecological conditions and anthropogenic pressure. In total, 100 honey samples were analyzed by the method according to the Rulebook on methods for the control of honey and other bee products of Bosnia and Herzegovina. The melissopalynological analysis included plant identification based on the micromorphological characters of pollen grains as well as the number of pollen grains for each identified plant. In total, in melissopalynological profiles 31,183 pollen grains were detected. Based on the micromorphological features, 48 plant species were identified, of which seven with allergenic potential. The proportion of pollen grains of allergenic plants was 18.01% which is 5,616 pollen grains. The presence of allergenic pollen in honey reduces the quality and health of honey due to specific substances such as Amb proteins from 1 to 10 (9,000 – 38,000 D), then highly allergenic antigens AgK, Ra3 and AgE (3,000 D) which causes various allergic reactions. Hence the choice of bee pasture in respect to its floristic composition and its distance from the pollution source are key parameters in creation of the honey quality.

Effect of different salts on the germination dynamics of *Salvia officinalis* L. seeds

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Seed germination is considered to be the most critical phase of plant under stress conditions. The effect of different salt concentrations of NaCl, KCl and CaCl₂ (25 mM, 50 mM, 75 mM) on seed germination of *Salvia officinalis* L. was

investigated. Seed germination characteristics were determined by measuring total germination percentage (GP), mean germination time (MTG), germination rate (RG) and germination uniformity (U). All applied treatments, except 75 mM CaCl₂, had a stimulatory effect on GP. The most pronounced effect on GP was achieved with 50 mM NaCl treatment, while the treatment with 75 mM CaCl₂ had a significantly lower GP compared to the control. In terms of time, the seeds germinated best with 50 mM KCl treatment. The values obtained for RG varied depending on the applied treatment. The most favorable effect on RG was observed with 75 mM KCl, while treatment with 50 mM KCl had a significant inhibitory effect compared to control seeds. At the same time, treatments with the lowest and highest germination rate were followed by the lowest and highest germination uniformity. It was concluded that the application of salt in appropriate concentrations can improve the germination performance and growth of *S. officinalis*.

Acknowledgements. This paper is supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, (Grant No: 451-03-68/2022-14/200122)

Detection of flowering plants in winter as a biological indicator of climate change

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Climate change affects species composition and dynamics across the planet. Phenological remarks are excellent biological indicators of climate change. Several studies have demonstrated phenological responses to climate change, such as earlier dates for bird migration, changes in species distributions, and earlier dates for flowering. The flowering time of plants is affected by solar radiation, temperature, precipitation, humidity and evaporation, cloudiness, insulation, air pressure, and wind. Our study explores the flowering phenology of Angiosperm urban flora in Belgrade during winter 2022, and its association with climate change. We recorded 40 species in bloom in uncommon flowering times, during December and January 2022. Detected flowering plants belong to families Asteraceae, Brassicaceae, Resedaceae, Malvaceae, Euphorbiaceae, Lamiaceae, Hypericaceae, Fabaceae, Polygonaceae, Caryophyllaceae, Boraginaceae, Violaceae, Caprifoliaceae,

Solanaceae, Asparagaceae, and Amaranthaceae. We are currently analyzing the climate data records for the territory of Belgrade over the last 50 years to detect the change in climate factors that caused this phenomenon. This study adds more evidence to the limited number of climate change response studies, related to Angiosperms flowering time, and presents a biological indicator of climate change in Belgrade.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (number 451-03-68/2022-14/200178).

Diatom community on natural and artificial substrates in soda pans in early spring

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Continental saline waters are unique habitats restricted to regions with specific geomorphological and climatic features (e.g. the Carpathian Basin with several large soda waterbodies). Lake Rusanda (Vojvodina, Serbia), divided by the road into Velika and Mala Rusanda, is an alkaline soda pan with the highest recorded salinity in Serbia. The aim of our study was to compare diatom communities developed on mud, reed and artificial substrates (brick wedge) of these extreme habitats. Diatom communities in two pans showed similar structure, but slightly different species succession. In Lake Velika Rusanda, *Nitzschia supralitorea* was a dominant species and the most successful colonizer irrespective of substrate type. The exception to this rule was epipelic community where individuals of *N.*

supralitorea were replaced by *Tryblionella hungarica* and *Surirella brebissonii* after initial sampling. In Mala Rusanda, after dominance of *Nitzschia supralitorea* at the beginning, populations of other diatoms such as *Surirella brebissonii*, *Craticula* sp. and *Nitzschia vitrea* increased steadily on mud surface. Similarly, in the epiphytic community the relative abundance of pioneer colonizing diatom *N. supralitorea* decreased, while population of *Halamphora veneta* strongly enlarged. Finally, after four weeks, brick wedges were covered by several well-developed diatom populations including *Navicula veneta*, *S. brebissonii* and *H. veneta*.

Acknowledgements. This study was supported by the Serbian Ministry of Education, Science, and Technological Development (number 451-03-68/2022-14/200026 and 451-03-68/2022-14/ 200178).

Drivers of epiphytic macroinvertebrate diversity along human pressure gradient in ponds

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It is unclear which environmental drivers are the most important in determining diversity and composition of epiphytic macroinvertebrate communities in ponds undergoing intensification of human impact. Here we tested the effects of different co-occurring human activities (i.e., agricultural land-use, waste disposal, highway proximity, and gravel exploitation) and of overall human-impact intensity (HII index) on the abundance, species richness, Shannon diversity and community composition of epiphytic macroinvertebrates in ponds, along with the effects of macrophyte growth forms, water chemistry, and fish predation. For this, 39 samples were collected in 2016 and 2017 from six ponds in south-eastern Serbia and one pond in north-eastern Croatia. We found that agricultural land-use, waste effluent,

and emergent macrophyte biomass negatively affected epiphytic macroinvertebrate abundance. Biomass of emergent macrophytes showed positive effect on Shannon diversity, while biomass of submerged macrophytes with fine and dissected leaves had positive effect on species richness. The HII index, highway proximity, and the biomass of emergent and submerged broad-leaved macrophytes were important determinants of epiphytic macroinvertebrate community composition. These results illustrate the importance of considering multiple stressors and macrophyte growth forms in assessment of epiphytic macroinvertebrate diversity in ponds and for their conservation and management practices.

Acknowledgements. This study was supported by the Serbian Ministry of Education, Science and Technological Development (Agreement number 451-03-68/2022-14/200124) and a bilateral cooperation scientific project “Trophic connections of freshwater ichthyofauna: fish diet in sustainable aquaculture” between Serbia and Croatia funded by the Serbian Ministry of Education, Science and Technological Development and Croatian Ministry of Science and Education. We thank students that helped in field and laboratory work.

Composition and structure of macroinvertebrate communities in two spring ecosystems in Southeastern Serbia

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Spring ecosystems in Serbia are still insufficiently studied considering their great importance. These ecosystems have ecological significance, show a number of specific features and represent ecotones. The aim of this research was to determine the composition and structure of the macroinvertebrate community in two spring ecosystems in Southeastern Serbia: the spring near the monastery Saint George and the spring Srećkovo Vrelo. The additional aim was to compare the composition and structure of the macroinvertebrate communities in the eucrenon and hypocreton areas in these springs in order to confirm the hypothesis that there is a differentiated zonation of these ecosystems. The macroinvertebrate community was collected by using the standard procedure, taking care to minimize damage to these ecosystems during the sampling process. Representatives of following groups: Ephemeroptera, Plecoptera, Trichoptera, Coleoptera, Diptera, Amphipoda, Arhynchobdellida and Basommatophora (Mollusca) were recorded in the springs. Most of these groups belong to insects. Representatives of Plecoptera and Diptera were the commonest as

they were recorded in each of the spring sectors (both in eucrenon and hypocreton). Comparing the diversity of the eucreton and hypocreton communities, it was determined that diversity values at both sites were higher in eucreton ($H^1=1.58$ and $H^2=1.37$) than in hypocreton ($H^1=1.46$ and $H^2=0.88$). In the first researched spring the number of taxa in eucreton was the same as in hypocreton, while in spring Srećkovo Vrelo the number of taxa in eucreton (8) was higher than in hypocreton (5). The results of this study indicate that there is some zonation reflected in differences in the composition and structure of the macroinvertebrate community (and differences in diversity), but this should be confirmed by additional extensive research that would also include a number of other springs in this area.

The impact of invasive species *Elodea nuttallii* (Planch.) H. St. John on morphological characteristics of *Potamogeton gramineus* L.

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Elodea nuttallii is a highly invasive species, recently added to the List of invasive alien species of Union concern. The aim of this study was to determine whether the presence of the invasive species *E. nuttallii* affects the morphoanatomical characteristics of the autochthonous species *Potamogeton gramineus*. A total of 34 morphoanatomical characters of *P. gramineus* collected from 6 localities in Vlasina Lake were analyzed. The morphometric data were analyzed by using standard univariate (Descriptive) and multivariate (Principal Component Analysis, Canonical Discriminant Analysis) analyses. The measured physico-chemical parameters of the water were similar in all sites. The results of descriptive statistics showed that characters “stoma surface area”, “stoma length”, “stoma width” and characters of epidermal structures had lower mean values, while character “width of stem aerenchyma” had higher mean values in samples where *E. nuttallii* was present. The results of multivariate statistics indicate that morphoanatomical characters of “length and surface area of floatant leaves” and “length and surface area of submersed leaves” contributed the most to the morphological variability of samples of *P. gramineus*. The results of CDA analysis based on the canonical scores for each individual have shown that six samples of *P. gramineus* formed two

morphologically completely distinct groups, which match the presence or absence of *E. nuttallii* at the site.

Acknowledgements. This study was funded by The Ministry of Education, Science and Technological Development of the Republic of Serbia (contract no. 451-03-68/2022-14/200124).

Assessment of wetlands trophic state using UAV photogrammetry (The Middle Danube, Serbia)

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This study aimed to determine macrophyte variables that reflect the trophic state of lentic ecosystems along the five Middle Danube wetlands in Serbia using UAV photogrammetry. Field work was carried out during the summer months of 2019 and 2020. Data for aquatic vegetation and water quality attributes were collected simultaneously at the 47 sampling sites (20 lentic water bodies). RGB UAV imagery was acquired by Phantom 4 FC330 (12.5MP) RGB camera within the altitude range 60-125 m. Obtained orthomosaics were processed using the object-

based image analysis to determine areas covered with different macrophyte functional groups. The cover value of macrophyte functional groups was further correlated with the water quality parameters within the polygons of different radiuses (2.5-30 m). Total cover of floating rooted vegetation was a positive predictor for dissolved oxygen, but the negative for orthophosphates. On the other hand, the total cover of free-floating vegetation showed a positive relationship with the total organic carbon, while the cover of filamentous algae correlated negatively with orthophosphates. Selected UAV-based vegetation variables are suitable for trophic state assessment of fluvial lakes and ponds along the Middle Danube floodplain.

Acknowledgements. This study was supported by the project of Provincial Secretariat for Higher Education and Scientific Research, Autonomous Province of Vojvodina, Republic of Serbia, no 142-451-2095/2022-01 - 'Trophic status assessment of the Danube floodplain using UAV photogrammetry', and by the Rufford grant, No 28388-1, 'Toward Cost-Effective UAV-Assisted Multimetric System for Detection of Freshwater Patches of High Conservation Value within the Danube Floodplain in Serbia'.

**14th Symposium on the Flora of
Southeastern Serbia
and Neighboring Regions
Kladovo 26th-29th June, 2022**

Nature Protection

INTRODUCTORY LECTURE

Invasive alien species in Serbia

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This paper presents 60 selected invasive alien plant species in the flora of Serbia. In addition to explaining what invasive species are and what is their negative impact on biodiversity, ecosystems, ecosystem services and human health, for each of the 60 species are given family names, most commonly used synonyms (according to Euro +Med Plant-Base), Serbian name, English name, description and origin of the species, habitat, distribution, control and suppression measures, as well as bibliographical references.

ORAL PRESENTATIONS

Findings of allochthone aquatic species *Cabomba caroliniana* A. Gray 1837 in Vojvodina and Mačva

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The first data on the presence of the allochthonous species *Cabomba caroliniana* A. Gray, 1837 in Serbia are in 2008, from Bačka, the DTD canal network (Vrbas-Bezdan canal) and at the locality Mali Stupar, Vrbas and Odžaci (Bečej-Bogojevo canal). During 2009-2020., in Vojvodina and Mačva, we encountered the presence of *Cabomba caroliniana* at the following localities: Jegrička Nature Park; Jarak-canal Jarčina; Glusci-canal Bitva; Šabac-Cerski marginal canal; canal near Drenovac. The collected herbarium material is kept in the private collection of the author. All the finds were in a canal network with water, in smaller or larger groups of several square meters. The densest population of this allochthonous species was recorded sporadically in almost the entire course in Jegrička from Gospođinac to near the mouth of the Tisza, and it was only found there in bloom. These are new data on the presence of *Cabomba caroliniana* in Serbia, which show its spread to Srem and south of the Sava to Mačva. Its spread is mainly through the canal network, which since 2015 after the floods in Serbia, more regularly cleaned of vegetation and sediment with increasing aridity accompanied by dry canals during the year can prevent its further spread.

New species in Zasavica flora in the period 2013-2021

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In the period 2013-2021 and by the revision of herbarium material from previous years, 87 new taxa were identified in the flora of Zasavica according to the reference list of vascular plants and mosses. Among the new taxa we have three

strictly protected *Alisma graminea*, *Asparagus pseudoscaberr*, *Gladiolus imbricatus* and six protected *Cardamine parviflora*, *Epipactis helleborine*, *Hypericum androsenum*, *Lilium martagon*, *Ranunculus flammula*, *Sternbergia colchiciflora*, 15 allochthonous of which 12 invasive (*A. githago*, *Armoracia rusticana*, *A. donax*, *Consolida orientalis*, *C. odoratus*, *D. inoxia*, *H. decapetalus*, *I. glandulifera*, *I. hederaceae*, *Typha laxmani*, *P. tomentosa*) and 10 ornamentals (*Amarantus foemina*, *A. donax*, *D. inoxia*, *Hyacinthus orientalis*, *F. alba*, *I. hederaceae*, *L. styracifolia*, *P. tomentosa*, *P. coronarius*, *S. canna*, *Sternbergia lutea*) that escaped from gardens or backyards. According to the endangerment, CR-EN (*A. pseudoscaberr*, *Viola stagniana*), CR-VU (*G. imbricatus*), EN (*C. parviflora*), EN-VU (*A. graminea*), VU (*Hypericum androsenum*, *R. flammula*, *S. colchiciflora*) and NT-LC (*Cyperus serotinus*, *E. helleborine*, *Neotia nidus-avis*, *Orchis tridentata*). Two new taxa have so far been published *Asparagus pseudoscaberr* and *Cyperus odoratus* as new and confirmed taxa for the flora of Vojvodina. Significant finds include *Sternbergia colchiciflora* - postglacial relict of light steppes, orchids: *Epipactis helleborine* and *Neotia nidus-avis*, which are less common in the plain flora, and water moss *Riccia sorocarpa*, the first find south of the Sava.

Special natural values and the concept of the outstanding natural landscape “Vardenik” protection

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The area of the Vardenik mountain is located in southeastern Serbia, on the territory of the municipality of Surdulica, within the spatial unit of Vlasina. In 2019, the Institute for Nature Conservation of Serbia conducted detailed field research in this area. In the course of this research it has been determined that the area of Vardenik is characterized by special natural values, on the basis of which the conservation study was prepared upon the research, which defined the area as a natural area in the category III – Outstanding Natural Landscape “Vardenik”. The conservation study presents the values of biodiversity, geodiversity and landscape diversity of the area, as well as the concept of protection, which has included the

results of research and specifics of the area planned for protection, all with the goal of conservation, protection, rehabilitation and revitalization.

Herbarium as a source of information on protected plant species: specimens of plant taxa included in CITES distributed in Serbia deposited in BEOU

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Detecting the decline of rare species before they become threatened or endangered is one of the major goals of conservation biology. Special attention should be given to species harvested from the wild, as downward pressure on natural populations is already known. We surveyed the collection at the Herbarium of the University of Belgrade (BEOU) in search of specimens of plant taxa listed in the Convention on International Trade of Endangered Species of Fauna and Flora on Appendix II that have been collected in the last 50 years. Organisations such as CITES, and the World Conservation Union consider a species extinct if it has not been observed in that period. Specimens of 55 taxa were found. No specimens of 12 taxa whose occurrence in Serbia is known from literature were found: *Dactylorhiza cordigera* subsp. *bosniaca*, *D. romana* subsp. *romana*, *D. × serbica*, *Gymnadenia odoratissima* subsp. *odoratissima*, *Herminium monorchis*, *Ophrys fuciflora* subsp. *fuciflora*, *O. sicula*, *O. sphegodes* subsp. *sphegodes*, *O. sphegodes* subsp. *taurica*, *Orchis mascula* subsp. *mascula*, *O. spitzelii* subsp. *spitzelii*, and *Spiranthes aestivalis*. Having in mind that collection bias can affect the amount and geographical representation of specimens, we would like to draw attention to these taxa and encourage their further studies.

Acknowledgements. Research was financed by the Institute for Nature Protection (JN No. OP 01/2015) and Ministry of Education, Science and Technological Development, Republic of Serbia (Contract reg. no. 451-03-68/2022-14/200383 and 451-03-68/2022-14/200178).

Contribution to the inventory of protected plant species in Nature Park Radan

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After field investigations during 2020 and 2021 an inventory of plant species significant for protection in Nature Park Radan was made. A total of 108 taxa were recorded on 506 microlocalities. Four taxa are listed in Habitats Directive (*Gladiolus palustris*, *Himantoglossum calcaratum* subsp. *rumelicum*, *Galanthus nivalis* and *Ruscus aculeatus*), four in Bern Convention (*G. palustris*, *H. calcaratum* subsp. *rumelicum*, *Typha shuttleworthii* and *Fritillaria montana*) and 22 in CITES. One taxon is considered extremely rare for Serbia (*Epipactis purpurata*), whereas six are considered potentially rare (*Lathyrus hallersteinii*, *Veronica verna*, *Vinca minor*, *Waldsteinia geoides*, *Helianthemum ledifolium* subsp. *ledifolium* and *Juncus thomasii*) and 76 rare. Seven taxa are Balkan endemics (*Armeria rumelica*, *Eryngium palmatum*, *Pastinaca hirsuta*, *Sedum stefco*, *Silene sendtneri*, *Stachys scardica*, and *Trifolium trichopterum*) and 37 are relict. Out of 76 taxa protected in Serbia 17 are strictly protected (*Anacamptis coriophora*, *A. laxiflora*, *Dactylorhiza saccifera* subsp. *saccifera*, *G. imbricatus*, *G. palustris*, *H. calcaratum* subsp. *rumelicum*, *Neotinea ustulata*, *Ophrys apifera*, *Orchis mascula* subsp. *mascula*, *Platanthera chlorantha*, *Pulsatilla montana*, *Ranunculus illyricus*, *S. stefco*, *S. urvillei*, *Prospero autumnale*, *Spiranthes spiralis*, and *T. shuttleworthii*).

Acknowledgements. State Enterprise “Srbijašume” and grants funded by Ministry of Education, Science and Technological Development No 451-03-68/2022-14/200178 and No 451-03-1/2022-14/4.

POSTER PRESENTATIONS

***Hypecoum pseudograndiflorum* Petrović (Papaveraceae), critically endangered plant species in the flora of Serbia – state of population, phytocoenological compliance and protection measures**

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This paper presents research on the critically endangered plant species of flora of Serbia – *Hypecoum pseudograndiflorum*, population status, phytocoenological affiliation, and protection measures at the only remaining locality in Serbia. This species grows on ruderal surfaces in a community with different species of ruderal plants. Based on the research results, it can be concluded that this species, according to current knowledge, is represented within micropopulations of different abundance, which are threatened with extinction due to the negative effects of anthropogenic factors and habitat disturbance in the future. Because of that, this species has been granted the status of critically endangered species in the flora of Serbia. The most effective measure of protection of *H. pseudograndiflorum* is protecting its habitats from the action of anthropogenic factors.

Acknowledgements. This study was funded by The Ministry of Education, Science and Technological Development of the Republic of Serbia (Contract no. 451-03-68/2022-14/200124).

Two species new for Ramsar site “Bardača Wetland” (Western Balkans) share the same habitat

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Ramsar site “Bardača Wetland” is situated in the northern part of the Republic of Srpska (Bosnia and Herzegovina). It is characterized by a variety of habitats, some of which are considered fragile. Such are the terrestrial habitats that occasionally transform into ephemeral ponds, usually after heavy rainfall, which have been the subject of our recent investigations. During the field research of “Bardača Wetland”, we found pleurocarpous moss *Drepanocladus aduncus* (Hedw.) Warnst. (Amblystegiaceae), that represents the first record for an investigated area. This species was found in Bajinci village on the sheep-grazed grassland, which is occasionally submerged in water. In the winter-spring season *D. aduncus* was the only represented moss species with high abundance. The same submerged grassland is also known as a habitat of several large branchiopod crustacean species, known as the flagship group for these ecosystems. After the experimental hatching of their resting eggs collected from the soil in the same habitat, we found species *Branchipus schaefferi* Fischer (Crustacea: Anostraca) as the first record for this area. For now, it seems that sheep-grazed grasslands in “Bardača Wetland” have been sustainably used by the local people. However, the shared habitat is potentially vulnerable and needs the measures of continuous monitoring.

Flora of Golina and Turjačka glama

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Stara planina is located in the southeastern Serbia. According to the highly expressed biological and geological diversity, diversity of landscapes and cultural and historical values, it is one of the most attractive mountains in Serbia. Regarding the floristic aspect, a large number of localities in the high mountain region of Stara Planina were explored - Arbinje, Draganište, Jabučko ravnište, Kopren, Vražja glava, Tri čuke, while localities in the hills of Stara Planina such as Golina and Turjačka glama were less researched. The paper presents the results of floristic research in the area of Golina and Turjačka glama, with the aim of inventorying vascular flora and mapping species of importance for protection according to national and international legislation. The field research has determined a total of 205 plant taxa, classified within 150 genera and 55 families. Ecological analysis has shown that the localities are dominated by the presence of herbaceous plants, i.e. hemicryptophytes (H). The floristic value of Golina and Turjačka Glama is reflected in the presence of rare and endangered species such as joint-pine (*Ephedra distachya* L.), winter aconite (*Eranthis hyemalis* (L.) Salisb.), lizard orchid (*Himantoglossum calcaratum* (Beck) Schltr.), dwarf iris (*Iris pumila* L.), Russian bugloss (*Echium russicum* J. F. Gmel.) and others.

Biodiveristy of fungal species from Tara Mountain

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The presence of fungal sporocarps of Tara Mountain was examined in the following localities: Mitrovac, Predov krst and Kaludjerske at each site during 2021. The identified species were recorded, photographed and marked in the GPS system. Based on the collected data, the following were formed: database of found species, collection of photographs and map/map of findings. Some of the samples were preserved as dry fruiting bodies, and deposited within the Fungarium FungiOrbis. A total of 296 finds and 191 species of fungi were recorded, 4 of which are on the list of Protected Wild Species of Plants, Animals and Fungi (*Boletus edulis*, *Lactarius deliciosus*, *Lactarius deterrimus*, *Russula cyanoxantha*), while 3 species: *Hericium alpestre*, *H. coralloides*, *Psilocybe serbica*) are on the list of Strictly Protected Wild Species of Plants, Animals and Fungi (Annexes I and II of the “Official Gazette of RS”, No. 5/2010 and 47/2011). Also, 6 species belonging to the indicator species of old and preserved forests (*Gaeastrum rufescens*, *G. striatum*, *H. alpestre*, *H. coralloides*, *Pycnoporellus fulgens*, *Xylaria polymorpha*) were found. Continuation of mushroom monitoring within the Tara National Park is extremely important since scarce data existed and the diversity is of utmost importance for Serbia.

Acknowledgements. This work was financially supported by the Ministry of Environment field research of Republic of Serbia, National Park Tara and Faculty of Sciences (contract No 47/2021).

**14th Symposium on the Flora of
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Kladovo 26th-29th June, 2022**

Genetics, Selection and Biotechnology

ORAL PRESENTATION

Determination of various enzymatic activities of *Saccharomyces cerevisiae* grown in Yeast - Potato Dextrose medium supplemented with oak (*Quercus robur*) leave debris

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The oak (*Quercus robur*) is one of the most important species of Gölköy campus of Bolu Abant İzzet Baysal University, Bolu, Turkey. It is one of the most endangered species of Serbia as well. To support the Zero-Waste policy of Turkey, the debris of oak might serve as a supplementary component and was subjected to an experiment for the growth of baker's yeast (*Saccharomyces cerevisiae*). For this purpose, the yeast extract-potato dextrose (YPD) growth medium was supplemented with 0.5% and 1% *Quercus robur* leaves with respect to control. The amylase, invertase, protease and cellulase activities of the medium were tested after subjecting the medium where yeasts were grown to centrifugation and microfiltration. It was found that the microfiltered extracts have a 30% increase in an invertase activity, which means that oak leave debris may serve as a promotor in biotechnological enzyme production from baker's yeast.

POSTER PRESENTATIONS

Genetic variation and relationship of spring *Camelina* accessions of different origin

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Camelina sativa (L.) Crantz, also known as “false flax” or “gold of pleasure”, is a self-pollinated, polyploid, annual oilseed that belongs to the Brassicaceae family. Over the last twenty years, it has re-emerged as a very promising multipurpose oilseed crop, with a high seed oil content rich in antioxidants and essential fatty acids. The genetic diversity within spring type *C. sativa* is rather low, compared to other oilseed crop species, so the aim of this study was to assess the genetic diversity of twenty spring camelina accessions of different origin and estimate their genetic relationship through SSRs. From each accession 45 individual samples were taken and analysed with three polymorphic SSR markers, P4C11, P6E4 and LIB19. A total of ten polymorphic bands were generated. Percentage of polymorphic loci, number of alleles, effective number of alleles, expected heterozygosity and Shannon’s information index were used to estimate genetic variation. The grouping of accession indicates that there was overlapping in certain breeding programs and exchange of breeding germplasm. The assessment of genetic diversity and estimation of genetic relationship, combined with phenotypic studies and performance in the field, can provide the useful information for further development of camelina breeding programs.

Organic sunflower honey from the area of Banat (northeastern Serbia) - physicochemical and microbiological characterizations

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Today, special attention is paid to organic honey due to increasing pollution and numerous toxins, and certified organic honey is described as having no chemical pollution, including that related to bee migration in search of good flowers that beekeepers do not directly control. This study aimed to characterize through analysis 5 samples of organic sunflower honey from Banat (Serbia): physicochemical quality parameters (moisture, HMF, diastase activity, free acidity, glucose and fructose content, sucrose and ash) and microbiological safety (presence of aerobic mesophilic bacteria, coliforms, lactic acid bacteria, molds and yeasts). Mean values obtained for physicochemical parameters are: 16.52% humidity, 8.17 mg/kg HMF, 10.8 diastasis activity, 24.07 meq/kg of free acidity, 60.8% of glucose and fructose 0.5% sucrose and 0.01% ash. The microbiota that was isolated from all the samples tested consisted of *Bacillus* spp. ranging from 0.50-0.55 x10⁻² cfu/g and *Saccharomyces* spp., ranging from 0.31-0.44 x10⁻² cfu/g. MALDI TOF confirmed preliminary identification to be *Bacillus pumilus*, while yeasts were identified as *Saccharomyces cerevisiae*. This research could contribute to the valorization of sunflower honey, which would lead to standardization and increase the production of this product.

An efficient *Agrobacterium tumefaciens* - mediated genetic transformation method for *Centaureum erythraea* via secondary somatic embryogenesis

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A genetic transformation method via secondary somatic embryogenesis is described for *Centaureum erythraea*. Cotyledonary somatic embryos (cse) induced on leaf explants were used for inoculation with *A. tumefaciens* strain GV3101 containing the binary vector pXK7S2D that provides kanamycin resistance. Inoculated embryos were cultured on MS medium enriched with 2,4-dichlorophenoxyacetic acid and *N*-(2-chloro-4-pyridyl)-*N'*-phenylurea that promote somatic embryogenesis, with addition of acetosyringone. Cse were transferred on induction medium supplemented with cefotaxime and 5 or 10 mg/L kanamycin for selection. Embryogenic tissue, induced on primary cse explants during the selection period in the dark, was transferred to hormone-free medium maintaining the same antibiotic combination. Morphologically normal secondary cse that survived kanamycin exposure were isolated and subcultured on hormone-free medium containing cefotaxime and IBA to enhance germination. Fully regenerated plants were analyzed by Phire PCR to determine the transgene presence. Transformation efficiency was higher on media with 10 mg/L kanamycin (17.64%) as compared to 6.67% efficiency obtained on 5 mg/L. To the best of our knowledge, this is the first report on centaury transformation via secondary somatic embryogenesis, which offers an alternative to leaf or root explant transformation and provides an additional tool for investigating *in vitro* developmental pathways in this plant species.

Acknowledgements. This work was funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia, Contract 451-03-68/2022-14/ 200007.

Micropropagation of *Clinopodium thymifolium* (Scop.) Kuntze (Lamiaceae)

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Clinopodium thymifolium (Scop.) Kuntze (syn. *Micromeria thymifolia* (Scop.) Fritsch) is a Balkan endemic species, traditionally used as a condiment and medicinal plant in the Mediterranean area. *Clinopodium* species were shown to produce considerable quantities (> 0.5%) of essential oils. The essential oil of wild-growing *C. thymifolium* possesses high antimicrobial activity. One alternative for the production of commercially important plant-derived metabolites, especially of rare plant genotypes, is *in vitro* plant tissue culture, given that the metabolic potential of *in vitro* shoot cultures can be manipulated by varying *in vitro* culture conditions. In view of the potential pharmacological and commercial value of *C. thymifolium*, the present study was initiated to propagate this aromatic plant species with the aim to increase the accumulation of biomass and the production of secondary metabolites. Shoots of wild-growing plants, dissected into one-node stem segments bearing two axillary buds, were used to establish *in vitro* cultures. Shoot multiplication was carried out on basal nutritional medium and on medium supplemented with various plant growth regulators at different concentrations. Nodal segments developed axillary shoots, and were successfully propagated on basal medium, whereas tested plant growth regulators differently affected their multiplication and biomass production.

Acknowledgments. This research was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia through Contracts Nos. 451-03-9/2021-14/200007 and 451-03-9/2021-14/200124.

Rhizosphere of sugar beet as a source of bacteria with plant growth-promoting and biocontrol properties

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Sugar beet (*Beta vulgaris* L.) is a very significant source of sugar and one of the most used crops in feed production. The importance of rhizosphere associated microorganisms on plant health is reflected in their impact on biotic and abiotic stress tolerance, biogeochemical cycling and growth promotion. In this study, we analyzed plant growth-promoting (PGP) and biocontrol properties of bacteria isolated from the rhizosphere of sugar beet. Among 78 tested isolates, 25 showed some of the PGP characteristics (7.7% were positive for siderophore production, and 25.6% for phosphate solubilization) and 49 had some of the biocontrol properties (9% were positive for exopolysaccharide production, 32% for amylase, 9% for protease, 14.1% for cellulase, 28.2% for mannanase production, 24.3% had antibacterial and 43.6% antifungal activity). The results indicate that certain strains can be used as biofertilizers and biocontrol agents for improving crop productivity.

***In-vitro* antioxidant and anti-inflammatory activities of CBD hemp seed oil**

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Cannabidiol (CBD) oil is made by adding an extract obtained from the leaves or flowers of the cannabis plant to various seed oils. In recent years, the use of this oil for the treatment of diseases such as epilepsy, migraine, Alzheimer's disease, chronic pain and inflammatory conditions has been studied. In this paper, the

antioxidant and anti-inflammatory activity of CBD oil prepared by dissolving ethanol cannabidiol extract in hemp seed oil (10% v/v) was investigated. CBD oil was a strong scavenger of DPPH and $\cdot\text{OH}$ radicals with EC_{50} of 5.99 mg/ml and 0.86 mg/ml, respectively. The total antioxidant capacity of CBD oil determined by the phosphomolybdenum method was also very high, 245.00 GAE. The anti-inflammatory activity of CBD oil was evaluated by inhibition of hemolysis and protein degradation. The CBD oil at a concentration of 150 ml/ml protected erythrocyte cell membranes from hemolysis by 51%, while degradation of bovine serum albumin (BSA) was inhibited by 43% when CBD oil was used at a concentration of 25 ml/ml. The presented results show that CBD hemp seed oil has good antioxidant and anti-inflammatory potential and further studies on animal models are needed to prove its activity *in vivo*.

Phytotoxic effect of aluminium on the early vegetation period of *Cucumis melo* L.

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The toxic effect of aluminium, one of the most abundant elements on the planet, is a significant factor that limits the growth and development of plants that inhabit acidic soils. As a consequence of its toxic effect on plants, the growth of the root system is primarily reduced or inhibited, as well as the activities of metabolic enzymes, which leads to developmental delays. The aim of this study was to analyze the effects of different concentrations of aluminium chloride solution (0.2, 0.4 and 0.8 mM) on the early vegetative development of melon (*Cucumis melo* L.) seedlings by using a rapid phytotoxicity test. Except morphometry, physiological and biochemical parameters were analyzed to assess the phytotoxic effect of aluminium. In response to the stressful effects of Al, the results showed that, with increased AlCl_3 concentration, the root length and photosynthetic pigments content decreased. The histochemical assay showed that the intake of aluminium is higher at a higher concentration of AlCl_3 . The results indicate that *C. melo* L. is sensitive to the presence of Al.

Effect of potassium on salinity tolerance in *Solanum lycopersicum* L. seedlings

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The aim of this pilot study was to examine the stress tolerance of the early vegetative phase of tomatoes caused by NaCl salts (70 and 140 mM) in the presence of potassium salts (9 mM). Previous studies suggest that KNO₃ promotes tolerance to various abiotic stressors, including salt-induced stress in later stages of various plant species, including tomatoes. The analysis included morphometric parameters: seedling height, leaf length and width, fresh and dry mass of seedlings, content of photosynthetic pigments and relative water content. Depending on stress levels, we noticed variable values among measured parameters.

**14th Symposium on the Flora of
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Phytochemistry and Phytotherapy

INTRODUCTORY LECTURES

***Primula* L. epicuticular waxes - an underexplored source of chemically diverse metabolites**

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Herein, the results of the first study of non-flavonoid constituents of aboveground surface-wax washings of *Primula veris* L. and *P. acaulis* (L.) L. (Primulaceae) are presented. Chromatography of the washings yielded fractions composed of *n*-, *iso*-, and *anteiso*-series of long-chained *syn*-1-phenylalkane-1,3-diyl diacetates, 3-oxo-1-phenylalkan-1-yl acetates, 1-phenylalkane-1,3-diones, 1-hydroxy-1-phenylalkan-3-ones, *sec*-alcohols (2- to 10-alkanols), fatty acid benzyl esters, and 2-alkanones, as well as *n*-, *iso*-, *anteiso*-, 2-methylalkanoic and 3-methylalkanoic acids; more than 120 of these constituents represent up to now unreported natural compounds. The structural/stereochemical elucidation was accomplished by the synthesis of authentic standards, derivatization reactions, the use of gas chromatographic retention data and detailed 1D and 2D-NMR analyses of the obtained complex chromatographic fraction. Both *Primula* spp. produce unusually high amounts of branched long-chained metabolites (>60%) except for the fatty acids where the percentage of branched isomers is comparable to the ones with *n*-chains. Noteworthy is the fact that long-chained α - and β -methyl substituted fatty acids were detected herein for the first time in the kingdom Plantae.

Acknowledgments. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (No. contract 451-03-68/2022-14/200124).

Insight into the structure and chemistry of glandular trichomes of selected *Micromeria* and closely related *Clinopodium* species (Lamiaceae): the *in vitro* culture approach

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Many of the species belonging to the Lamiaceae family are considered aromatic plants due to the presence of glandular trichomes, which have a distinct ability to synthesize, secrete or store large amounts of specialized metabolites that play a crucial role in mediating the plant – environment interactions. Secondary metabolites are biosynthesized as a defensive strategy of plants in response to natural perturbations, thus enabling them to adapt to the environmental stresses typical of each individual ecological niche. These compounds often have marked bioactive properties, rendering a commercial value to the plants that produce them. A number of biological effects have been associated with the main monoterpenoids detected in investigated *Micromeria* spp. and *Clinopodium* spp. essential oils. One alternative for the production of these bioactive metabolites is *in vitro* plant tissue culture. The present study was initiated to investigate the effects of *in vitro* culture on the secretion of leaf glandular trichomes, the main structures involved in the essential oil production. The glandular indumentum was studied by means of light microscopy and scanning electron microscopy in an attempt to correlate the phytochemical traits with the glandular trichome morphotypes of selected Lamiaceae species.

Acknowledgements. This research was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia through Contracts Nos. 451-03-9/2021-14/200007 and 451-03-9/2021-14/200124.

ORAL PRESENTATIONS

Phytochemical study on *Centaurea* species collected in Balkan peninsula

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Centaurea is one of the largest genera of the Asteraceae family from the taxonomic point of view. Depending on the type of classification used, the genus includes between 400 and 700 species; the primary centers of differentiation are eastern Anatolia and the Caucasus, while the Mediterranean and the Balkan peninsula constitute the secondary center. In Bulgaria, *Centaurea* is represented by 60 ssp. and is the genus that includes more endemic species. Many of these have long been used in traditional medicine to cure various ailments and several members of the genus have found a traditional use in Balkanian folk medicine. Given the considerable taxonomic complexity in defining *Centaurea* as a genus, the study of the morphological and phytochemical characteristics of the different species of *Centaurea* and Centaureinae is particularly interesting. In this communication, a review of the phytochemicals and the most relevant biological activities occurring in different *Centaurea* species from the Balkans will be provided, as well as new research on their essential oil. Among these, we will discuss the phytochemical composition and biological activity of *Centaurea gracilentata* Velen., a very rare endemic plant, typical of the Bulgarian flora, *Centaurea stenolepis* A. Kern., and *C. ovina* ssp. *besserana*.

Essential oils as green pesticides

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The problems of the environment and human health related to the use of synthetic and broad-spectrum insecticides have increasingly motivated scientific research on different alternatives and among these, the use of green systems, such as essential oils, have been explored. Several species of the Apiaceae and Asteraceae families are used in the industrial field for pharmaceutical, cosmetic, and food purposes. Different essential oils extracted from some species of these families have shown acute toxicity and repellent effects towards different insects. In our work, we investigated the toxic potential of *Calendula maritima*, *Laserpitium siculum* and *Ridolfia segetum* essential oils against pest species as *Sitophilus oryzae*, *Lasioderma serricornis*, *Rhyzopertha dominica*, *Culex quinquefasciatus*, and *Musca domestica*. The composition of oils was evaluated by GC×GC-MS. The toxicity Petri dish bioassays indicated that *C. maritima* oil killed a mean of 65.50% of *S. oryzae* and 44.00% of *R. dominica* adults, indicating a higher biocidal activity in comparison with *L. siculum* oil. Concerning the mosquitocidal efficacy, the *Ridolfia* EO showed noteworthy toxicity against *C. quinquefasciatus* and *M. domestica*, with a LC₅₀ of 27.1 and 10.5 μL L⁻¹, respectively. These EOs merits further investigation for the development of green insecticides to be used in real world conditions.

Green synthesis of iron nanoparticles using *Mentha piperita* L. extract and investigating its antioxidant properties

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In this study, the leaves extract was used for green synthesis of atomic iron nanoparticles. The antioxidant properties of leave extract and the extract containing iron nanoparticles was determined. A structural study of nanoparticles was characterized using scanning electron microscope (SEM). The antioxidant properties were observed in both leaf extract and nanoparticles. Addition of iron nanoparticles increased antioxidant properties of the extract. Structural study of iron nanoparticles using a scanning electron microscope showed that the shape of particles is spherical, and its average dimensions are 18-70 nm.

Production of a skin cream combined with *Pinus sylvestris*, olive oil, coenzyme Q and milled rice and its characterization

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The cosmetic products containing green chemicals, as well as skin-friendly natural cosmetics, are remarkable and an increasing trend. The whitening effect of rice flour; the cell renewal of coenzyme Q10; the moisturizing, feeding and antibacterial properties of the olive oil have an important role in designing natural cosmetic products. In our study, we tried to combine and obtain an edible cosmetic product by combining these three components. In addition, the scots pine (*Pinus sylvestris*) extract was used to increase the color, smell, density and antibacterial effect of the cream. *Pinus sylvestris* (Scots pine) is present in Turkish flora as well as in Serbian flora, mostly observed in the continental climate zone (southern part of the Republic of Serbia). In addition to the control group, rice flour-coenzyme Q10-olive oil and rice flour-coenzyme Q10-olive oil-yellow pine extract were taken into consideration. In the third group any microbial increase as well as no change for the

pH, viscosity, fat and protein content were observed, and almost appropriate cosmetic standards were obtained.

On the configuration and occurrence of cyclocuparanols: resolving a lasting discrepancy

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Cyclocuparanols are unique sesquiterpene alcohols with a tricyclic carbon skeleton and are mostly found in liverworts. A literature survey on these compounds revealed several conflicting reports on their structure, and even though these studies were published between 15 and 35 years ago, the contradictory findings were rarely addressed and never satisfactorily resolved. Having in mind the biosynthetic/biosystematic significance of cyclocuparanols (these compounds are major volatiles and chemical markers of several *Marchantia* species), and the conflicting information in the scientific literature, we decided to perform a thorough and systematic structural investigation of these compounds. During this work, all four diastereomeric cyclocuparanols were isolated from natural sources (one of them, 7-epimicrobiotol, represents a new natural product) and a combination of NMR analysis, spectral simulation, molecular modeling, chemical transformations, and chiral GC analysis was used to facilitate the elucidation process.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Contract Number 451-03-68/2022-14/200124).

Chemical composition of epicuticular waxes of *Liriodendron tulipifera* L. flowers and leaves

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Plant organs are covered with a cuticular wax, an extracellular hydrophobic layer, providing a balance of water loss, and protection against microbes, insects, UV radiation, etc. Waxes usually contain linear very-long-chain compounds: alkanes, alcohols, aldehydes, ketones, acids, and esters. *Liriodendron tulipifera* L., well known as the tulip tree or yellow poplar, is a tall, deciduous, long-lived broadleaf tree. *Liriodendron tulipifera* is used in traditional medicine by Native Americans for treating fevers associated with malaria. In Europe, *L. tulipifera* is grown as an ornamental tree in city parks. The chemical composition of the chloroform washings of *L. tulipifera* flowers and leaves was analyzed. Epicuticular waxes of *L. tulipifera* flowers, along with the most abundant constituent, palmitone, contained *n*-alkanes, (*E*)-*n*-alkenes, regioisomeric alk(en)als, alkanones, (*Z*)-alk(en)-1-ols, and 10/11-hydroxy-16-hentriacontanones. Double bond regiochemistry was inferred from MSes of dimethyldisulphide adducts. Where possible, the configuration was inferred from the NMR analysis of cyclopropanation adducts. GC-MS analysis of *L. tulipifera* leaf washings revealed that the main constituent was again palmitone, while separate GC-MS analyses of petals, sepals, and pistils with anthers, revealed palmitone to be predominant on the petal and sepal surfaces.

Acknowledgments. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (No. contract 451-03-68/2022-14/200124).

POSTER PRESENTATIONS

Sugars and organic acids content in unripe and ripe fruits of *Sambucus nigra*

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Elderberry (*Sambucus nigra* L.) is a common plant used for its medicinal and nutritional properties, as for the beverages, jams, liqueurs, flavourings etc. Plant material examined were leaves and fruits of wild edible, and cultivated elderberry plants ('Haschberg' and 'Ljubostinja' selections). Determination of organic acids and sugars was performed using high-performance liquid chromatography. Organic acids found in the tested fruit samples were citric, tartaric, malic, quinic, shikimic and fumaric acids, out of which quinic acid content was the highest in unripe, while citric acid content was the highest in ripe fruits. Wild plants had higher contents of organic acids in unripe fruits (16.7 g 100 g⁻¹dw) than cultivated ('Haschberg' 6.6, and 'Ljubostinja' 6.3 g 100 g⁻¹dw). 'Ljubostinja' selection had significantly higher organic acids content (10.2 g 100 g⁻¹dw) in ripe fruits compared to wild specimen and 'Haschberg' plants which had similar organic acids content (7.0 and 7.4 g 100 g⁻¹dw). The major organic acid in ripe elderberry fruits was citric acid. When it comes to sugars content the presence of sucrose, glucose, fructose and sorbitol was established. Wild specimen had significantly higher sugars content (2.2 in unripe, and 8.4 g 100 g⁻¹dw in ripe fruits).

Total and individual phenolics in wild and cultivated elderberry during development

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Compounds which add to bioactivity of elderberry (*Sambucus nigra* L.) are mostly phenolic compounds. One wild edible and two cultivated genotypes ('Haschberg' and 'Ljubostinja' selections) have been chosen. Leaves and fruits were collected in four stages (April-September). Total phenolics (TP) content was determined from MeOH extracts by Folin-Ciocalteu method while determination of individual compounds was performed using HPLC-DAD-ESI-MSⁿ analysis with a DAD at 280, 350 and 530 nm. TP content in leaves varied through developmental stages, being higher in II and III stage. Leaves and fruits (both unripe and ripe) of 'Ljubostinja' plants had higher content of TP compared to wild ripe fruits (1.5-fold). Leaves had caffeic acid derivatives (0.3-0.7% in wild, 0.2-0.3% in 'Haschberg' and 0.4-0.6% in 'Ljubostinja' in dry weigh) and caffeoylquinic acid derivatives, while fruits had more caffeoylquinic acid derivatives, particularly unripe fruits. The major phenolic acid present in leaves, especially during the II stage of development, was chlorogenic acid (approx. 4% dw) and the same was recorded in fruits (0.03% dw in unripe fruits of wild plants). Content of phenolic acids decreased during ripening of elderberry fruits and the similar was detected in the leaves.

Effect of the extraction method on chemical composition and biological activity of basil essential oils (*Ocimum basilicum* L.)

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The aim of the study was to investigate the effect of basil essential oil extraction method on its chemical composition, antioxidant and antimicrobial activity. The following extraction methods were used: microwave assisted solvent-free extraction, microwave assisted extraction and hydrodistillation by Clevenger. The result of the GC/MS analysis indicated the difference in the content of oxygen containing monoterpenes, especially linalool, depending on the extraction method. Other major components were methyl chavicol and germacrene D. The highest content of aromatic compounds was obtained by solvent-free extraction. DPPH test showed that the obtained essential oils could be good antioxidant agents, so the EC₅₀ values for all three obtained oils were in range 0.44 mg/ml to 2.68 mg/ml. The highest antimicrobial activity of the essential oils was expressed against *Escherichia coli* ATCC 25922, regardless of the extraction method. On the other hand, *Pseudomonas aeruginosa* ATCC 27853 and *Klebsiella pneumoniae* ATCC 700603 were the most resistant. The complex chemical composition of basil essential oils and good antimicrobial and antioxidant potential indicated the possible application for food protection and preservation.

Acknowledgements. This work was funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia, grant No. 451-03-68/2021-14/200133.

Mineral composition of aqueous extract of black locust (*Robinia pseudoacacia* L.) flowers obtained using microwave-assisted extraction

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The aim of this study was to determine the content of macro and microelements in the extract of black locust flowers using the inductively coupled plasma optical emission spectrometry (ICP-OES). The aqueous extract was prepared under the following conditions: extraction time of 5 min, microwave power of 466 W, and the liquid-to-solid ratio of 10 mL/g. The potassium concentration of 12.73 g/kg dry plant material (d.p.m.) was the highest compared to other macroelements. Sodium was the least represented macroelement (0.40 g/kg d.p.m.). Among microelements, zinc was the most dominant (0.11 g/kg d.p.m.). Their content was decreased in the following order: Zn > Al > Mn > Fe > Ba > Ni > Cu > Cr (only 1.72 mg/kg d.p.m.). The results indicated that the obtained aqueous extract is a source of macroelements, primarily potassium, but also zinc as the most common microelement. Potassium is necessary for the transmission of nerve impulses and the proper function of muscles and intestines, while zinc is important for the proper functioning of the immune system and cellular metabolism. The extract with this mineral composition can be considered useful and safe for human health.

Acknowledgments. The Republic of Serbia - Ministry of Education, Science and Technological Development, Program for financing scientific research work, number 451-03-9/2021-14/200133. Ivana Boskov is the recipient of the scholarship of the Ministry of Education, Science and Technological Development.

Do *Lysimachia vulgaris* methanol extracts have a DNA protective potential against oxidative damage?

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Lysimachia vulgaris L. (yellow or garden loosestrife) is a medicinal herb in the family Primulaceae that has been used in the treatment of fever, ulcer, diarrhea, dysentery, and wounds. It has been known as an analgesic, expectorant, anti-inflammatory, astringent, febrifuge, and demulcent agent. The present study aims to evaluate DNA protective properties of *L. vulgaris* aboveground part and root extracts against hydroxyl and peroxy radicals-induced DNA damage. Results indicate that the DNA protective potential of extracts at various concentrations (25, 50, 100, 200, and 400 µg/mL) was in a concentration-dependent manner, increased with the concentration. These findings revealed *L. vulgaris* methanol extracts as a potent source of antioxidant agents against hydroxyl and peroxy radicals.

Acknowledgements. This work was supported by the Serbian Ministry of Education, Science and Technological Development (Agreement No. 451-03-9/2021-14/200378 and Agreement No. 451-03-9/2021-14/200122).

***In vitro* protective potential of the *Lunaria annua* L. aerial parts and root extracts against DNA oxidative damage**

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Lunaria is a genus of flowering plants in the family Brassicaceae with five species, one of which is the *Lunaria annua* L. commonly called silver dollar, moonwort or honesty. It is harvested from the wild for local use as a source of food or materials for medicinal and cosmetic uses. A nervonic acid obtained from the *L. annua* seeds has been used as raw material in the pharmaceutical industry. The goal of the present study was to evaluate the protective effect of the aerial part and root methanol extracts of *L. annua* at various concentrations (25, 50, 100, 200, and 400 µg/mL) against hydroxyl and peroxy radicals-induced DNA damage. Both *L. annua* extracts showed DNA-protective effects in all tested concentrations, with the same ability to inhibit peroxy as well as hydroxyl radicals. These findings indicate that aerial part and root extracts of *L. annua* contain powerful antioxidant compounds that have the capacity to effectively neutralize highly reactive radicals.

Acknowledgements. This work was supported by the Serbian Ministry of Education, Science and Technological Development (Contract No. 451-03-9/2021-14/200378 and Contract No. 451-03-9/2021-14/200122).

Antimicrobial activity of oak moss resinoids (*Evernia prunastri*) on certain clinical isolates

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Infections caused by bacterial strains that show resistance to a large number of antibiotics are one of the leading problems today. The aim of this scientific research is to investigate new, natural resources with potential antimicrobial activity. The antibacterial activity of oak moss resinoids (*Evernia prunastri*) was investigated on clinical isolates of *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Pseudomonas aeruginosa* and *Escherichia coli*, by disk diffusion method. 10 µl of resinoid was applied to sterile disks with a diameter of 6 mm. The tested resinoid showed the most significant antibacterial activity against *Pseudomonas aeruginosa* (inhibition zone was 13 mm), slightly weaker against *Staphylococcus epidermidis* (8 mm), while the weakest against *Escherichia coli* and *Staphylococcus aureus* (7 mm). The results indicate that the tested resinoid of oak moss shows antibacterial effect on clinical isolates.

Chemical compositions and antioxidant activities of essential oils and their combinations, obtained from flavedo by-product of seven cultivars of Sicilian *Citrus aurantium* L.

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In this work, seven *Citrus aurantium* essential oils (EOs) derived from flavedo of cultivars ‘Canaliculata’ (C1), ‘Consolei’ (C2), ‘Crispifolia’ (C3), ‘Fasciata’ (C4), ‘Foetifera’ (C5), ‘Listata’ (C6), and ‘Bizzaria’ (C7) were investigated by GC-MS. D-limonene (33.35–89.17%) was the main monoterpene hydrocarbon, and α -pinene, β -myrcene, and β -linalool were identified in almost all samples. Among EOs, only C3 showed high quantitative and qualitative variability in its chemical composition. The chemical diversity of EOs was also demonstrated by PCA and HCA statistical analysis. Samples C2, C4, C5, C6, and C7 were statistically similar to each other, while C1 and C3 were characterized as having a different amount of other compounds and oxygenated monoterpenes, respectively, with respect to the other EOs mentioned. The antioxidant activity was studied by using a multi-target approach based on FRAP, DPPH, ABTS, and β -carotene bleaching tests. The global antioxidant score (GAS) revealed that among the tested EOs, *C. aurantium* ‘Fasciata’ EO had the highest antioxidant potential, whereas among combinations, the EO obtained by mixing C1C7 was the most active. Comparison by theoretical and real data on inhibitory concentration (IC₅₀) and FRAP values did not reveal any significant effect of synergism or antagonism of actions to be valid in all biological applied tests.

Chemical composition of commercial and isolated essential oils from *Tagetes* spp. (marigold) flowers

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According to the manufacturer's specifications, the commercial essential oil (*Tagetes Minuta* Flower Oil) was obtained by steam distillation. The plant material was cultivated in the gardens in village Manastirište (municipality of Vlasotince, southeastern Serbia). The essential oils (EOs) were isolated from fresh red and orange flower petals collected at the end of August (orange) and at the beginning of September (the red ones) by Clevenger type hydrodistillation. Their qualitative composition was determined by GC/MS and semi-quantitative composition by GC/FID method. The most abundant components in the commercial essential oil (relative amounts) were: (*Z*)- β -ocimene (45.5%), benzyl alcohol (22.8%), dihydro-tagetone (7.5%), and (*Z*)-tagetone (4.5%) while the ones isolated from orange and red flowers contained geranyl acetate (49.0% and 10.7%) and (*E*)-caryophyllene (9.4% and 28.7%) in the highest percentage, respectively. Some members of *Tagetes* spp. are known to be phototoxic. Namely, α -terthienyl, also called terthiophene (TTP) and 5-(3-penten-1-ynyl)-2,2-bithienyl are phototoxic compounds identified only in isolated EOs (4.4% and 7.7% from orange; 8.3% and 16.2% from red flower petals, respectively). Although the isolated EOs represent an important resource of geranyl acetate they should not be used as components in cosmetic products for applications on areas of skin exposed to sunshine.

Acknowledgment. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia under the Program of financing scientific research work, number 451-03-68/2022-14/200133.

The influence of the operation conditions on the yield, composition and antioxidant activity of ethanol extracts from cubeb pepper (*Piper cubeba* L.) fructus

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The aim of this work was to determine extraction operational conditions (ethanol concentration, solvomodul (ratio of plant material/solvent; m/v), extraction time, and extraction technique) that affect the yield of total extractive matter (TEM), composition, and antioxidant activity of cubeb pepper (*Piper cubeba* L.) fructus ethanol extracts. Total phenols and flavonoids in the extracts were determined by Folin Ciocalteu and AlCl₃ methods, respectively. The antioxidant activity of the extracts was determined by the DPPH test. Optimal extraction conditions by maceration at room temperature for obtaining a maximal yield of TEM were determined: 50% v/v ethanol, solvomodul 1:15 m/v, and extraction time of 180 min. Under the same conditions, the extract was obtained by reflux extraction at boiling temperature. Based on the obtained results it was found that the higher yield of TEM (20.47 g/100 g of plant material), total phenols (59.33 mg GAE/g of dry extract), and flavonoids (27.43 mg RE/g of dry extract) were determined in the extract obtained by reflux extraction. The extract obtained by reflux extraction showed better antioxidant activity (EC₅₀=0.126 mg/cm³) than the extract obtained by maceration (EC₅₀=0.200 mg/cm³). Cubeb pepper extracts represent natural antioxidant agents as alternative to synthetic antioxidants and potential raw materials for phytopreparations.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia under the Program of financing scientific research work, number 451-03-68/2022-14/200133.

Flavones content in *Salvia aethiopsis* L. ethanolic extracts

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The genus *Salvia* L., one of the biggest Lamiaceae family genera, has been used in traditional medicine for centuries. *Salvia aethiopsis* L., Mediterranean sage, is a plant species that grows sporadically in Serbia. *Salvia* species contain a large amount of essential oil, phenolic acids, flavonoids and terpenes. One of the most common flavonoids are flavones luteolin and apigenin, which have many pharmacological activities. The aim of this study is to determine the content of flavones in ethanolic extracts of *S. aethiopsis* obtained by different extraction techniques using ethanol in different concentrations. The above-ground parts of *S. aethiopsis* were collected in the full flowering phase in the vicinity of Niš. The powdered plant material was extracted with 96%, 80% and 60% ethanol, by ultrasonic extraction, maceration or digestion. The identification and quantification of flavones was performed using HPLC technique. Apigenin and luteolin, their -7-O-glucosides, and salvigenin as the dominant flavone, were identified in the extracts (2.34±0.08 – 9.48±0.11 µg/mg). The results showed that the extracts of *S. aethiopsis* contains a significant amount of flavones, therefore *S. aethiopsis* extracts could be a significant part of bioactive natural products.

Acknowledgements. The authors would like to thank the Ministry of Education, Science and Technological Development of Republic of Serbia (No: 451-03-68/2022-14/200113 and 451-03-68/2022-14/200003), and Internal project of Faculty of Medicine, University of Niš, Serbia, (No: 68).

UHPLC-DAD-ESI-MS analysis of the *Malus sylvestris* (wild apple) leaf infusion

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Wild apple (*Malus sylvestris*) is the only *Malus* wild species native to Europe which is a relative of cultivated apples. Wild apple is plant used in Serbia traditional medicine for the treatment of different diseases, such as urinary infection, diabetes, rheumatism, atherosclerosis, and hypertension. As a raw material, wild apple can be used for a production of nutraceuticals and cosmeceuticals since *Malus* wild species are rich sources of phenolic compounds with high antioxidant activity. In this study, the leaves from *Malus sylvestris* were picked in spring in Toplica District (Serbia, 43°06'28"N; 21°35'15"E). The infusion from dried and grounded leaves was made by using traditional way (1 tablespoon of dried herbs was poured over by 200 mL of boiling water). Qualitative analysis was done by Ultrahigh performance liquid chromatography – diode array detector – electrospray mass spectrometry (UHPLC–DAD–ESI–MS/MS) method. The analysis of *M. sylvestris* infusion primarily indicated the presence of flavonoids and derivatives (quercetin, quercitrin, isoquercitrin, hyperoside, quercetin pentoside, rutin), citric and quinic acid, phenolic acids such as protocatechuic acid, 3-*O-p*-coumaroylquinic, dicaffeoylquinic acid, chlorogenic acid and its isomer, (ester of caffeic acid and quinic acid), procyanidin B2, phloretin and phloretin-pentosyl-hexoside (phenols). The identified compounds confirmed different beneficial effects of wild apple leaf infusion from South Serbia region.

Acknowledgment. This work was supported by the Republic of Serbia – Ministry of Education, Science and Technological Development, Program for financing scientific research work, number 451-03-68/2022-14/200133.

Chemical and mineral composition of *Centaurium erythraea* infusion

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Small centaury (*Centaurium erythraea*) is medicinal plant from Gentianaceae family, widely distributed in Europe. It is one of the most widely used bitter herbs, medicinally important due to the production of bioactive secondary metabolites. The plant was harvested in the Stara Planina mountain during the flowering stage. The infusion was made by using traditional way (1 tablespoon of dried herbs was poured over by 200 mL of boiling water). Qualitative analysis was done by Ultrahigh performance liquid chromatography – diode array detector – electrospray mass spectrometry (UHPLC–DAD–ESI–MS/MS) method. The analysis of *C. erythraea* infusion primarily indicated the presence of secoiridoid glycosides (sweroside, gentiopicroside, secologanoside, swertiamarin), xanthenes and flavonoids. Mineral content of *C. erythraea*, the concentrations of Ag, B, Ca, Cd, Co, Cr, Cu, K, Mg, Fe, Li, Mn, Na, Ni, P, Pb, Ti, Si, Sr and Zn were analyzed by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry) method. The sample was prepared by wet digestion procedure before mineral analysis. Ag, B, Ca, Cd, Co, Cr, Fe, Mn, Ni and Tl were not detected in the samples. The most represented macro-elements are potassium (92.35 µg/ml) and phosphorus (69.775 µg/ml) while the most common micro-element is silicon (3.375 µg/ml). Among the heavy metals (Cu, Zn and Pb), zinc was the most represented (2.675 µg/ml). The obtained results suggest good quality of tea prepared from *C. erythraea*.

Acknowledgment. This work was supported by the Republic of Serbia – Ministry of Education, Science and Technological Development, Program for financing scientific research work, number 451-03-68/2022-14/200133.

Chemical profile, antimicrobial properties and toxicological evaluation of the essential oil of *Abies cephalonica* from Peloponnesus

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The present study focused on the essential oil (EO) of *Abies cephalonica* Loudon (Pinaceae) from Peloponnesus regarding its chemical composition, antimicrobial activity and toxicity toward crustaceans and insects. Monoterpene hydrocarbons strongly dominated in studied EO (91.7%) where β -pinene (35.5%), α -pinene (29.2%) and camphene (9.8%) were the major volatiles. Antimicrobial properties of *A. cephalonica* EO showed inhibitory action against all 17 investigated strains (ATCC and respiratory isolates) in the range of 0.62-20.00 mg/mL (MICs). The greatest sensitivity to EO was shown by *Staphylococcus aureus* 6538, *S. aureus* (from nose) and *Pseudomonas aeruginosa* (from sputum) with the same MIC value (0.62 mg/mL). The obtained results point to justified ethnopharmacological utilization of some fir EOs for the treatment of the respiratory infections, bearing in mind wide antimicrobial spectrum of *A. cephalonica* EO. In addition, tested EO showed strong toxicity in *Artemia salina* acute toxicity bioassay (LC₅₀=17.81 μ g/mL, after 24 h) as well as certain insecticidal activity by inducing significant pupal mortality and prolongation of developmental time in treated *Drosophila melanogaster* larvae.

Acknowledgements. This research was supported by Grant No 451-03-68/2022-14/200124 by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

Variability of phytochemicals in sweet corn (*Zea mays L. saccharata*) from Serbia

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A positive trend in the consumption of sweet corn in the human diet has been observed in the past ten years. The aim of this research was to examine variability of phytochemicals in four sweet corn hybrids. The content of phenolic acids and vitamin E was determined by HPLC-DAD/FLD, while the total phenolic (TPC) and total glutathione (GSH) content, as well as the total antioxidant activity (DPPH) was determined by spectrophotometry method. Significant variations for all analyzed phytochemicals between genotypes were observed. The highest content of vitamin E and $\beta+\gamma$ -T had hybrid ZP515su (30.09 $\mu\text{g/g}$) and (11.51 $\mu\text{g/g}$), respectively. The highest content of total phenolic acids was found in ZP553su (80.86 $\mu\text{g/g}$) and ferulic acid in ZP515su (23.28 $\mu\text{g/g}$). Hybrids ZP355su, ZP504su and ZP553su have the highest content of TPC (0.97 mg FAE/g), GSH (555,05 nmol/g) and DPPH (4,26 $\mu\text{mol TE/g}$), respectively. Compared to all hybrids, ZP515su possess lower content of all phenolic acid except ferulic acid, lower antioxidant activity and higher content of vitamin E, while ZP553su exhibited higher antioxidant activity, total phenolic acid, α -T and δ -T3 content. Obtained results indicate that sweet corn hybrids possess a high content of particular phytochemicals and can afford health benefits to consumers.

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

Lipids in tinder fungus, *Fomes fomentarius* (L.) Fr., Polyporaceae

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Tinder fungus, *Fomes fomentarius* (L.) Fr. (Polyporaceae), is a large, woody, perennial fungus. It is a plant pathogen which grows on the beech and other deciduous species as a parasite or saprophyte causing a heart rot of the wood. Some studies have shown that *F. fomentarius* has hypoglycemic, anti-nociceptive, anti-inflammatory, anti-infective and anti-tumor effect. Several classes of metabolites were identified: primary metabolites i.e., proteins, polysaccharides (β -glucans), polysaccharide-protein complexes, and secondary metabolites such as triterpenes and sterols, organic acids, benzofurans, coumarins, volatile components. GC/MS analysis of cyclohexane extract of fungus collected on mountain Avala in 2017 have shown the presence of sterols: ergosta-5,7,22-trien-3-ol (46.8%); ergosta-7,22-dien-3-ol (25.4%); ergosta-7,22-dien-3-on (15.9%); ergost-7-en-3-ol (fungisterol, kampesterol) (4.3%); 5,6-dihidro-3-ergosterol (5.5%). Fatty acids were also determined, including palmitic acid (C16:0) 34.0%, stearic acid (C18:0) 18.0%, linoleic acid (C18:2n6c) 10.8%, heneicosanoic acid (C21:0) (5.6%), behenic acid (C22:0) (10.9%), tricosanoic acid (C23:0) (18.4%) and lignoceric acid (C24:0) (2.3%). Cyclohexane extract has shown antibacterial activity against several bacterial strains including *Helicobacter pylori* and significant cytotoxic activity against HeLa cell line with an IC_{50} 25.10 \pm 7.16 (μ g/mL). These activities could be due to the presence of cytotoxic fatty acids.

Acknowledgements. This research was funded by the Ministry of Education, Science and Technological Development, Republic of Serbia through Grant Agreement with University of Belgrade-Faculty of Pharmacy No: 451-03-68/2022-14/200161.

Lipid peroxidation study of simple coumarins isolated from *Daphne mezereum* (Oleaceae)

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In addition to the argument on the use of *Daphne mezereum* as a medicinal plant, first documented in written in the 16th century, the medicinal importance of the plants belonging to the genus *Daphne* is proved by the large variety of different classes of natural products, especially coumarins, lignans, flavones, diterpenoids, steroids and guaianolides. Coumarins are compounds with extensive biologic activities, widely distributed both in human diet and therapeutics. Epidemiological studies have correlated the ingestion of coumarin based compounds in the diet with beneficial health effect mainly due to their antioxidant activity. Oxidative stress and resulting lipid peroxidation are involved in numerous pathological states which seriously impair the quality of life. For this reason, the role of antioxidants continues to attract much attention and the radical-scavenging capacity of many natural supplements and drugs has been extensively evaluated. In the present work, we have investigated the lipid peroxidation effect of two simple coumarins isolated from aqueous subfraction obtained from crude diethyl-ether macerate of *D. mezereum* flowers. Our research shown that umbelliferone (IC₅₀= 7.06 ± 2.59 mM) and herniarine (IC₅₀= 18.97 ± 1.31 mM) both decrease lipid peroxidation, but not as pronounced as the standardly applied antioxidants Trolox (IC₅₀= 22 ± 6 μM), caffeic acid (IC₅₀= 15 ± 3 μM) and quercetin (IC₅₀= 23 ± 6 μM).

Acknowledgements. The work was funded by the Ministry of Science and Technological Development of Serbia (Projects 451-03-68/2022-14/200113 and 451-03-9/2022-14/200124).

Antimicrobial effects of naturally derived hydroxychalcones

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Licorice (*Glycyrrhiza glabra* L. (Fabaceae)) is one of the most extensively used plants in traditional medicine. A number of studies have recently reinvestigated the pharmacological properties of the plant. Licorice contains many bioactive components including flavonoids, triterpene saponins and coumarins. Among the given classes, a *trans*-chalcone hydroxylated at C-2', -4 and -4', named isoliquiritigenin, is reported as a compound with multiple biological activities. Chalcones reportedly have potent inhibitory activities against bacteria that are pathogenic to humans. In contrast to synthetic or semisynthetic, only a few plant-derived compounds have been investigated. In the present study we have examined *in vitro* antimicrobial effects of isoliquiritigenin, isolated (extracted and purified) from the licorice (*Glycyrrhiza glabra*) root powder in a disc diffusion method against a panel of laboratory-controlled microorganisms consisted of two Gram-positive (*Bacillus subtilis* and *Staphylococcus aureus*) and two Gram-negative (*Escherichia coli* and *Salmonella typhimurium*) bacterial strains. To understand the relationship between structural-related properties and antimicrobial activity, we examined three more naturally occurring but for the purpose of the experiment chemically synthesized hydroxychalcones: 4'-hydroxychalcone, 4'-hydroxy-4-methoxychalcone and 2'-hydroxy-3,4-dimethoxychalcone. The assayed samples have shown selectivity at the tested concentration (1 mg/ml), not affecting Gram-positive but Gram-negative strains. The results provided evidence that the studied compounds might be a potential source of natural antimicrobial agents.

Acknowledgements. The work was funded by the Ministry of Science and Technological Development of Serbia (Projects 451-03-68/2022-14/200113 and 451-03-9/2022-14/200124) and Faculty of Medicine, University of Niš (Internal project No. 40).

***Heracleum ternatum* from Mt. Durmitor: furanocoumarins, polyphenols and antioxidant activity of leaf and flower extracts**

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In this work, composition and antioxidant activity of dry dichloromethane and methanol extracts of *Heracleum ternatum* Velen. (Apiaceae) leaves and flowers from Mt Durmitor (Montenegro) were investigated. Using LC-MS, five furanocoumarins were identified in leaf dichloromethane extract (accounting for 23.00 mg/g of dry extract) and eight in flower dichloromethane extract (60.47 mg/g). Dominant in leaf extract was heraclenin (11.64 mg/g), followed by imperatorin (5.90 mg/g), and in flower extract heraclenol (17.55 mg/g), followed by heraclenin (15.04 mg/g). LC-MS analysis revealed eight flavonol glycosides in leaf methanol extract (accounting for 16.18 mg/g of dry extract) and 11 in flower methanol extract (65.82 mg/g), as well as chlorogenic acid in both extracts (4.72 mg/g and trace, respectively). Among detected flavonoids, dominant was quercetin 7-*O*-rhamnosyl 3-*O*-glucoside (vincetoxicoside A; 7.95 and 16.77 mg/g), followed by biosides and triosides of kaempferol and methylquercetin. Content of total polyphenols, determined spectrophotometrically using Folin-Ciocalteu reagent, was 87.29 and 98.12 mg of gallic acid equivalents/g of dry methanol extracts. Among methanol extracts, polyphenol richer flower extract showed higher, spectrophotometrically determined, total antioxidant and anti-DPPH activities compared to leaf extract (FRAP=0.80 and 0.65 mmol Fe²⁺/g; DPPH SC₅₀=83.12 and 90.95 µg/mL). Dichloromethane extracts showed lower anti-DPPH activity (SC₅₀=860.58 and 515.76 µg/mL).

Acknowledgements. This research was funded by the Ministry of Education, Science and Technological Development, Republic of Serbia through Grant Agreement with University of Belgrade-Faculty of Pharmacy No: 451-03-68/2022-14/200161.

Composition comparison of thyme and lemon balm hydrolates and essential oils

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The popularity of hydrolates, by-products of hydrodistillation of aromatic plants, is on the rise since some hydrolates are used commercially, mainly in the food and cosmetic industries. This study aimed to analyze and compare the chemical compositions of two hydrolates and their corresponding essential oils. Thyme and lemon balm hydrolates were collected during the first hour of *Thymi vulgaris herba* and *Melissae officinalis herba* industrial hydrodistillation (TH and MH, respectively), and corresponding essential oils upon completion of these processes (TE and ME, respectively). Hydrolates were concentrated in diethyl ether, while essential oils were dissolved in diethyl ether before GC/MS analysis. The percentage composition of a particular component in the sample was determined based on the area percent report generated by Agilent ChemStation software. Thymol comprised around 90% of TH and carvacrol 7.5%, while in TE dominant compounds were thymol (< 50%), *p*-cymene and γ -terpinene. Geranial (13.8%) was followed by six compounds present in about 10% of the MH content. Geranial was also the most abundant compound in ME, followed by citronellal and *E*-caryophyllene. Despite the shown differences, the dominant class of secondary metabolites was the same in both hydrolate/essential oil pairs (terpenes for MH/ME, and aromatic phenols for TH/TE).

Acknowledgements. This research was supported by the Ministry of Education and Science of the Republic of Serbia (Grant No. 451-03-68/2022-14/200113 and 451-03-68/2020-14/200133 - Project assigned to the Faculty of Technology, Leskovac, University of Niš, researchers' group, TR 34012) and the Faculty of Medicine University of Niš Internal Scientific Project No. 15.

Content of metals, total phenols, flavonoids and antioxidant potential of plant organs of the species *Sanguisorba minor*

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In this study, we aimed to determine the bioaccumulation potential of heavy metals and the antioxidant activity of total phenols and flavonoids of the root, herb and flowers of *Sanguisorba minor*. The tested plant species in this paper were collected from tailings. The content of heavy metals in different parts of the plant was determined by atomic absorption spectrophotometry. Three solvents were used to obtain root, herb and flower extract: methanol, ethyl acetate and acetone. The content of TPC was determined by the Folin-Ciocalteu method, and the content of TFC was determined by the $AlCl_3$ method. The antioxidant activity was determined spectrophotometrically using with 2,2'-diphenyl-1-picrylhydrazyl. The plant accumulates large amounts of Zn, Ni and, Cu in the root, stem and, leave, and Mn, Cr and, Pb in the whole plant. Methanol extract has the highest content of TPC in flowers, acetone extract has the highest content of TFC in flowers and, ethyl acetate extracts have the lowest content of TPC in roots and TFC in the stem and leave. The highest values of antioxidant activity were in methanol extract in the flower. *Sanguisorba minor* has a scientific justification as a medicinal plant species if collected from uncontaminated habitats.

GC-MS profile of herbal mixture used in Balkan peninsula to eliminate the kidney stones

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Herein, chemical profiling of the headspace volatiles (HS) of herbal mixture used in Balkan peninsula to eliminate the kidney stones and its individual mixture components (*Juniperus oxycedrus* L. berries, inner bark of *Betula pendula* Roth. and

grains of *Avena sativa* L.) were done by GC/MS analyses. Additionally, essential oils composition of *J. oxycedrus* berries and herbal mixture was done, also by GC/MS analyses. The main HS volatile compounds of *J. oxycedrus* berries were monoterpenes (98.1%) with β -mircene as the most abundant (65.4%). Sesquiterpenes compose the major part of HS volatiles of *A. sativa* grains (51.6%) among them germacrene D (46.5%) was the main compound. Aliphatic aldehydes and alcohols (75.6%) were the main HS volatiles of *B. pendula* and only monoterpene was β -pinene (6.6%). β -mircene was the main component of essential oils of the berries and herbal mixture (37% and 32%) accompanied by α -pinene (13% and 4.1%), β -caryophyllene (8.7% and 12.7%) and germacrene D (7.7% and 12.1%), respectively. Similarly, the main volatiles of herbal mixture were β -mircene (71.8%), α -pinene (17.2%), β -pinene (1.2%) and germacrene D (1.1%).

Acknowledgements. This research was supported by the Ministry of Education, Science and Technological Development of Serbia (Agreement No 451-03-9/2022-14-200124). The results presented here are part of the submitted manuscript (NPX-22-0001).

Anti-alpha amylase activity of *Macrolepiota procera* (Scop.: Fr.) Sing.

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The parasol mushroom *Macrolepiota procera* (Scop.:Fr.) Sing, Lepiotaceae, is a highly valued edible type of fungi. Its top is an egg-shaped, gray to brown hat, covered in peal-like marks. This mushroom resides on a layer of decomposing leaves in all types of the forests, appearing solitary or in small groups from late summer to autumn. Besides good taste, it has good nutritional and medicinal value. So far, scientific studies on *M. procera* have shown its antihypertensive, antioxidative, antiproliferative and cytotoxic abilities. Inhibitory effect against alpha-amylase, total polyphenolic content and antiradical scavenging activity of methanol extracts prepared from dry mushroom from local market in Belgrade was the main goal of this study. Alpha-amylase inhibitory assay was assessed spectrophotometrically with 3,5-dinitrosalicylic acid reagent. Total polyphenolic content and antiradical activity in methanolic extract was determined using common Folin-Ciocalteu method and DPPH assay. Concentration of methanolic extract that inhibited 50% alpha-amylase (IC₅₀) was 0.66 mg/mL. The content of polyphenols in methanolic extract was 13.07±0.24 mg of gallic acid/g dry extract. The concentration that neutralizes 50% DPPH radicals was 466.45±5.52 µg/mL, which

was weaker antiradical activity than standard antioxidants vitamin C (IC₅₀ 3.8 µg/mL) and quercetin (IC₅₀ 2.75 µg/mL).

Acknowledgements. This research was funded by the Ministry of Education, Science and Technological Development, Republic of Serbia through Grant Agreement with University of Belgrade-Faculty of Pharmacy No: 451-03-68/2022-14/200161.

Distribution of inflorescence headspace volatiles in fifteen *Achillea* taxa from Serbia

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This work presents a chemotaxonomic study on inflorescence headspace volatiles (HSVs) of fifteen *Achillea* taxa, including thirteen from section *Achillea sensu lato* and two taxa from the section *Anthemoideae* from Serbia. Generally, the major HSVs were 1,8-cineole, trans-sabinyl acetate, β-pinene, chrysanthenone, *cis*-thujone and camphor. In most of the analyzed taxa, oxygenated monoterpenes represented the dominant class, while the content of monoterpenes hydrocarbons was lower, except for *A. lingulata*. The approximate content of these two classes was observed in HSVs of *A. millefolium*, *A. chrysocoma* and *A. collina*. Therewith, sesquiterpenes were very low in content or absent, while high content of unsaturated hydrocarbon santolina triene was characteristic for HSVs of *A. millefolium*. The relative contents of HSVs (≥5%) were subjected to the agglomerative hierarchical cluster analysis (AHC). The obtained results showed that there was no clear differentiation between sect. *Achillea* s.l. and sect. *Anthemoideae* based on inflorescence HSVs. Besides, the position of three studied hybrid taxa was not clear enough, but it is interesting to note that they formed common cluster together with one of the presumed parent species.

Acknowledgements. This research was supported by Grant No 451-03-68/2022-14/200124 by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

Phytochemical screening and evaluation of DPPH antioxidant potential of selected *Daphne* (Oleaceae) species from Serbia

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Numerous studies have highlighted the health benefits of antioxidants and their role in the prevention of diseases resulting from oxidative damage including atherosclerosis, diabetes mellitus and neurodegenerative disorders. *Daphne* plants have significant importance being used in traditional medicine for their antimicrobial, anticancer, anti-inflammatory, antitussive and anti-rheumatic properties. As proven, some of these conditions may be related to oxidant stress. To the best of our knowledge, no investigation about the antioxidant power on diethyl-ether flower (DEF) extracts of *Daphne* plants has been reported. Purpose of the study was to prepare DEF extracts by maceration of *D. blagayana*, *D. cneorum*, *D. koshaninii* and *D. malyana* flowers, to perform a preliminary phytochemical screening for the presence of coumarins, total phenols and flavonoids. To characterize the antioxidant properties potential of the extracts, the antioxidant activity was assessed by 1,1-diphenyl-2-picrylhydrazyl (DPPH) assay, expressed as Trolox equivalent (TE). This screening revealed the presence of coumarins, phenols (2.7-9.2 mg of gallic acid equivalents/g) and flavonoids (15.8-102.4 mg of rutin equivalents/g). Present study showed that with antioxidant activity greater (*D. cneorum*, IC₅₀=4.6±0.7 µg/ml, TE 1.8 µg/ml) or comparable (*D. malyana*, IC₅₀=7.9±0.9 µg/ml, TE 1.0 µg/ml) to that of standard antioxidant Trolox, *D. cneorum* and *D. malyana* extracts can be considered as good sources of natural antioxidants for potential medicinal applications.

Acknowledgements. Part of the work was done in Laboratorio di Chimica Medica, Dipartimento di Medicina, Chirurgia e Odontoiatria, Facoltà di Medicina e Chirurgia Università degli Studi di Milano, during the research stay of Prof. J. Lazarević, founded by the Ministry of Science and Technological Development of Serbia (project 451-

03-821/2012-14). The authors also acknowledge Faculty of Medicine, University of Niš (Internal project No. 40) funds.

Antimicrobial activity of different hydrolates against selected bacterial strains

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The circular economy trend is leading to an increase in interest in co-products in the essential oil industry, such as hydrolates. Hydrolates are products of condensation obtained after an essential oil distillation isolation procedure. Due to a large number of documented biological effects, their use in the pharmaceutical industry is constantly growing. This study aimed to test and compare the antimicrobial activity of six hydrolates (obtained after hydrodistillation of *Melissae officinalis herba*, *Daucus carotae semen*, *Thymi vulgaris herba*, *Lavandulae officinalis flos*, *Hyssopi officinalis herba*, and *Chamomillae romanae flos*) towards bacterial strains (*Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Enterococcus faecalis*). Four dilutions of each sample were tested in microdilution assay and the results were expressed as minimal inhibitory concentrations (v/v%). MIC values were 100 (v/v%) for all hydrolates against all tested strains, except hydrolate of thyme, which exhibited strongest antimicrobial activity (MIC values were 50 (v/v%) against *Escherichia coli*, *Staphylococcus aureus*, and *Enterococcus faecalis*). Since these hydrolates are potential antimicrobial agents, additional studies are needed to describe their activity in more detail.

Acknowledgements. This research was supported by the Ministry of Education and Science of the Republic of Serbia (Grant No. 451-03-68/2022-14/200113) and the Faculty of Medicine University of Niš Internal Scientific Project No. 15.

Correlation between the essential oils' composition and the geographical distances of selected *Artemisia* species growth sites' - Mantel test[#]

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The chemical compositions of the essential oils of seven *A. alba* Turra samples and twelve samples of each *A. absinthium* L., *A. annua* L., *A. vulgaris* L., and *A. scoparia* Waldst. & Kit. from Serbia were studied and chemometrically processed using Mantel test to determine if the chemical composition distance between populations of *Artemisia* collected from different soil types, determined by World Reference Base for Soil Resources (WRB), is related to the geographical distance. The chemical composition distance was measured as a difference in individual component frequencies among various *Artemisia* samples, as well as a difference in frequencies of the classes of compounds, while the geographical distance was based on the distance in longitude and latitude between the sites of interest. Mantel test revealed that the matrices for *A. vulgaris*, as well as for *A. scoparia* are correlated as the computed two-tailed *p*-values (0.0273 and 0.0295, respectively) are lower than the significance level $\alpha=0.05$, so there is a correlation between different samples within *A. vulgaris*, as well as *A. scoparia* and the geographical distances of the localities from which these samples were collected. On the contrary, Mantel test for classes of compounds concluded that their distances and geographic distances are not correlated.

Acknowledgments. The research was supported by Ministry of Education, Science and Technological Development of the Republic of Serbia (Project No. 451-03-68/2022-14/200124).

[#]The results presented here are the part of the published work: J. Serb. Chem. Soc. 86 (12) 1259–1269 (2021)

Herbal products used in the Sokobanja municipality

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Analysis of the herbal product usage among the population is a good starting point to find a new medicinal species or new applications for well-known species. The municipality of Sokobanja is a spa town located in the Zaječar District of the eastern Serbia. The survey has been conducted in a period of three months by a pre-compiled questionnaire. A total of 66 surveys were collected (37 men and 29 women, aged 3 to 88). Examinees use phytopreparations to prevent and treat many diseases, while three indications are the most frequently mentioned. Both men and women used herbal products to treat venous insufficiency and the plant species found in all mentioned products was *Citrus x aurantium* L. Men from this area most often used herbal products that help with benign prostatic hyperplasia. These products contain the following plant species: *Brassica napus* L., *Cucurbita moschata* Duchesne, *Serenoa repens* (W. Bartam) Small. Among the female population, herbal preparations were most often used in the treatment of respiratory infections. For this indication, the most commonly used products contained *Glycyrrhiza glabra* L., *Origanum vulgare* L. and *Althaea officinalis* L. Overall, there is a significant trust on efficacy of herbal medicine in the Sokobanja municipality.

Acknowledgments. The authors are grateful to the Ministry of Education, Science and Technological Development of the Republic of Serbia for financial support (Grant 451-03-68/2022-14/200113).

Total phenolic and ellagic acid content in *Rosa arvensis* leaves and hips extracts

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Species of the genus *Rosa* L. are known traditional medicinal plants with fruits of economic importance. The production of teas, dietary supplements, as well as jams and juices is achieved using fresh or dried rosehips. As known antioxidants, phenols and ellagic acid were analysed in wild-growing *R. arvensis* which could be potentially new sources of these compounds. In this work, contents of total phenolic (TPC) and ellagic acid (EA) in extracts obtained from leaves and hips separated into pericarps and nuts were studied. The 70% ethanolic extracts were prepared using ultrasonic-assisted extraction. TPC was evaluated spectrophotometrically, while EA was separated and quantified using high-performance liquid chromatography (HPLC) coupled with a photodiode array detector (DAD). Among tested samples, the highest TPC was determined in leaves at 206.0 mg GAE/g of dry extract, while extracts obtained from pericarps and nuts had the lower values of 54.3 mg and 111.3 mg GAE/g of dry extract, respectively. The results of HPLC analysis revealed notable EA content and its highest amount (490 ng/g dw) was quantified in the leaf extract. The presented results showed a high level of phenolics in *R. arvensis* extracts, approving its usability as a good source of natural antioxidants.

Acknowledgments. The authors are grateful to the Ministry of Education, Science and Technological Development of the Republic of Serbia for financial support (Grant 451-03-68/2020-14/ 200178).

Antineuroinflammatory and neuroprotective activities of ethanolic extracts of commercial Lamiaceae medicinal plants from Serbia

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Numerous representatives of the Lamiaceae family have been used in traditional medicine around the world since ancient times. This study was aimed to determine the antineurodegenerative, antineuroinflammatory and neuroprotective activities of ethanolic extracts of *Glechoma hederacea*, *Hyssopus officinalis*, *Lavandula angustifolia*, *Leonurus cardiaca*, *Marrubium vulgare*, *Melissa officinalis*, *Mentha × piperita*, *Ocimum basilicum*, *Origanum majorana*, *O. vulgare*, *Rosmarinus officinalis*, *Salvia officinalis*, *Satureja montana*, *Sideritis scardica*, *Teucrium chamaedrys*, *T. montanum*, *Thymus serpyllum*, and *T. vulgaris* from Serbia. Antineurodegenerative activity was determined by the inhibition of two enzymes – acetylcholinesterase and tyrosinase. Antineuroinflammatory activity was detected using LPS-activated BV2 cells, while neuroprotective activity was tested on SH-SY5Y neurons using supernatant transfer model. Most extracts had similar or stronger antineurodegenerative activity compared to the positive controls, galantamine and kojic acid. All ethanolic extracts significantly increased the viability of activated BV2 cells and decreased the production of reactive oxygen species and nitric oxide, while also exhibiting a significant neuroprotective effect on SH-SY5Y neurons. Integrated biomarker response analysis showed that *S. officinalis* ethanolic extract had the best overall activity, followed by *R. officinalis* extract. The obtained results indicate that the tested Lamiaceae species from Serbia are promising candidates for further investigation of neuroprotective agents.

Acknowledgments. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (No. 451-03-68/2022-14/200178).

Radical scavenging capacity and total phenolic content of *Ajuga laxmannii* (Murray) Benth.

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Ajuga laxmannii (Murray) Benth. (Lamiaceae) is an herbaceous plant, distributed in dry regions of Central and Southeast Europe. It's traditionally used as a galactagogue and for the treatment of inflammation and respiratory infections. The aim of this study was to analyze antioxidant capacity and total phenols and flavonoid contents (TPC and TFC) of 70% ethanol extract of this species. All measurements were performed spectrophotometrically. The antioxidant potential was evaluated using the DPPH and ABTS radical scavenging method. Butylated hydroxyanisole (BHA), α -tocopherol and L-ascorbic acid were used as reference standards. The results obtained by the DPPH test indicated IC₅₀ values of 0.564 mg/ml, while IC₅₀ using the ABTS test was 1.810 mg/ml. They were compared to the control substances which indicate activity of BHA (IC₅₀=0.129; IC₅₀=0.090 mg/ml), α -tocopherol (IC₅₀=0.152; IC₅₀=0.310 mg/ml) and L-ascorbic acid (IC₅₀=0.067; IC₅₀=0.110 mg/ml), respectively. TPC at 101.068 mg GAE/g DW and TFC at 48.946 mg QE/g DW were in correlation with their high antioxidant capacity. These findings indicate that ethanol extract obtained from aerial parts of *A. laxmannii* possessed significant radical scavenging activity and suggest that it could be recognized as potential source of antioxidant ingredients for the food and pharmaceutical industry.

Acknowledgments. The authors are grateful to the Ministry of Education, Science and Technological Development of the Republic of Serbia for financial support (Grant 451-03-68/2020-14/ 200178).

Herbal medicinal products in hypertension and dyslipidemia therapy: a cross-sectional study among the adults from the Niš region

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Arterial hypertension and lipid metabolism disorder are widespread non-infectious diseases of modern humanity, which could lead to cardiovascular and cerebrovascular complications. In recent years, a lot of effort has been put into finding new plant species with antihypertensive and lipid-lowering effects. The aim of this study is to determine the attitudes and knowledge of patients on the use of herbal products in the treatment of hypertension and dyslipidemia, in the territory of Niš, Serbia. Examination of patients' attitudes was carried out using the survey technique in written form in public pharmacies, as well as using the online form of the questionnaire (a cross-sectional study). The statistical package SPSS 20.0 was used for data processing. The obtained results showed that most participants did not use herbal products in the treatment of hypertension and dyslipidemia. Statistical analysis showed a significant correlation between age and education of participants with the use of herbal preparations. Garlic and artichoke were the most used herbs in the above indications. Despite considering herbal products as relatively safe and effective in combination with conventional therapy, patients should be educated and directed to healthcare professionals, who have sufficient knowledge on the use, dosage, and safety of herbal medicinal products.

Acknowledgments. The research was supported by the Serbian Ministry of Education, Science and Technological Development (Grant no. 451-03-68/2022-14/200003 and 451-03-68/2022-14/200113).

***Achillea pseudopectinata* essential oil: chemical composition, antimicrobial activity and toxicity toward crustaceans**

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This is the first study on chemical composition, antimicrobial activity and toxicological evaluation of the essential oil (EO) of *Achillea pseudopectinata* Janka (Asteraceae) from Serbia. The studied EO was strongly dominated by oxygenated monoterpenes (95.4%) with camphor (49.9%) and 1,8-cineole (16.0%) as the major compounds. Antimicrobial activity of *A. pseudopectinata* EO was investigated against 16 microbial strains (ATCC and respiratory isolates) of several human pathogenic species and obtained values showed that the most sensitive strains were *Staphylococcus aureus* 6538, *S. aureus* (from nose), *Bacillus cereus* 11778 and *Escherichia coli* (from sputum) with the same MIC value (0.63 mg/mL). On the other hand, it was notable that the EO of *A. pseudopectinata* failed to show any inhibitory activity in the tested concentration range (up to 5 mg/mL) against *Pseudomonas aeruginosa* 9027. Regarding toxicological evaluation, tested EO showed strong toxicity in *Artemia salina* acute toxicity bioassay (LC₅₀=68.21 µg/mL, after 24 h). Accordingly, *A. pseudopectinata* EO could be considered as a potential candidate for further, more specific bioassays with potential for developing pesticide and antitumor natural products.

Acknowledgements. This research was supported by Grant No 451-03-68/2022-14/200124 by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

The essential oil of *Melissa officinalis* L. (Lamiaceae): structural elucidation and acute toxicity of new acetals

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Melissa officinalis L. (Lamiaceae), lemon balm, is a plant species widely distributed throughout Europe and is valued by the Balkan peoples due to its sedative, antispasmodic, digestive, antimicrobial, and antiviral properties. A detailed GC-MS analysis of the chemical composition of the essential oil of lemon balm revealed the presence of 6 compounds that were, according to their mass spectral fragmentation, tentatively identified as acetals of isomeric *p*-mentha-3,8-diols and citronellal, neral, or geranial. To determine the exact structure of these minor essential-oil constituents, 6 compounds (4 completely new) were synthesized starting from *trans*- and *cis*-*p*-mentha-3,8-diols, citronellal, and a mixture of citrals. All synthesized compounds were spectrally and/or chromatographically characterized. GC-MS in combination with NMR analyses of the compounds provided proof of the identity of the mentioned *M. officinalis* constituents. To assess the safety of these naturally occurring acetals, the acute toxicity of these compounds was assessed in the *Artemia salina* model. The obtained results suggest that the intake of these compounds in naturally available amounts, on their own, would probably not represent a risk to human health.

Acknowledgements. This work was funded by the Ministry of Education, Science and Technological Development of Serbia (grant No. 451-03-68/2022-14/200124).

Diethyl-ether flower washings of four *Dianthus* taxa (Caryophyllaceae): Identification of new natural products

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Some carnation species (*Dianthus* spp., Caryophyllaceae) exhibit strong resistance to drought stress that is connected with increased surface wax formation. Wax composition is unknown for the majority of *Dianthus* taxa and up to now analyses of wax constituents were done only for two *Dianthus* taxa (*D. caryophyllus* and *D. cruentus*). Herein, mass spectra (MS), gas chromatographic data (GC(RI)), synthesis, flesh-dry chromatography, and chemical transformations of crude extracts (synthesis of dimethyl disulfide adducts), enabled the identification of more than 250 constituents of diethyl-ether washings of fresh flowers of 4 different *Dianthus* taxa (*D. integer* Vis. subsp. *minutiflorus* (Halacsy) Bornm. ex Strid., *D. deltoides* L., *D. superbus* L., and *D. petraeus* Waldst. & Kit.) from Serbia. The analyzed wax samples contained, along with the dominant ubiquitous long-chain n-alkanes, (*Z*- and (*E*)-alkenes, aldehydes, and diketones, a homologous series of n- and branched (*iso*- and *anteiso*-) long-chain benzoates. Twenty identified benzoates represent new natural products in Plantae that could be excellent chemotaxonomic markers for *Dianthus* species.

Acknowledgements. This work was funded by the Ministry of Education, Science and Technological Development of Serbia (grant No. 451-03-68/2022-14/200124).

Antistaphylococcal activity of *Thymus vulgaris* and *Origanum vulgare* essential oils: time-lapse kinetics, antibiofilm activity and synergistic potential

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Staphylococcus aureus is one of the most frequent human pathogens, whose high virulence and severity of chronic infections are related to their ability to produce biofilms. In the present study, antimicrobial potential of oregano and thyme essential oils on the planktonic growth of *S. aureus* clinical strains (isolated from nose, throat and wound), as well as the effect of the oils on the biofilm production, compared with conventional antibiotic streptomycin were investigated. In addition, time-lapse kinetics and combinations of individual oils with streptomycin were investigated for synergism against the selected staphylococcal strains. The results showed high potential of both oils where minimal inhibitory values ranged between 0.078 and 2.50 mg/ml, while biofilms were reduced up to 96%. In the case of biofilms, the reverse concentration dependency has been observed. Time-lapse kinetics showed recovery of some strains after 4 h of contact with the oils, but these strains demonstrated significantly reduced growth in comparison to the control. All mentioned assays showed slightly higher efficacy of oregano essential oil. Calculated FICs showed either synergistic or additive effect of all tested combinations (thyme-oregano, thyme-streptomycin, oregano-streptomycin), with the thyme-streptomycin as the most efficient one. All mentioned results point to a very high potential of both oils to be used as an adjuvant agent for control of human staphylococcal infections.

Acknowledgements. The work was supported by the Ministry of Education, Science and Technological Development of Serbia (contact number: 451-03-68/2022-14/200124).

Chemical investigation of *Microbiota decussata* diethyl-ether extract

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The phytochemical profile of *Microbiota decussata* was investigated by GC, GC-MS, and NMR and compared with a previously published study. Hedycaryol, which was the major alcohol constituent reported by the Russian group was absent from our sample; instead, all but one sesquiterpenol-containing chromatographic fraction were dominated by thujopsan-2 α -ol, which constituted around one-third of the total mass of the extract. Also, while Raldugin and co-workers could not detect any presence of diterpenoids, 10% of the extract we isolated was comprised of tatarol, along with minor amounts of ferruginol. Microbiotol (accounting for 5% of the extract) was isolated as the most polar compound and its relative and absolute configurations were thoroughly investigated by NMR and chiral GC.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Contract Number 451-03-68/2022-14/200124).

A comparative study on marjoram essential oils from southeastern Serbia and Egypt

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The composition of two commercial marjoram (*Origanum majorana*) essential oils from southeastern Serbia and Egypt was investigated by GC and GC-MS. Terpinen-4-ol and γ -terpinene were the major volatiles in both oils and constituted around 50% of the oils (calculated from GC peak areas). The oils were, however, very different in their content of *cis*- and *trans*-sabinene hydrate, two commercially important monoterpenes. The Egyptian oil contained 12.1% of *trans*- and 3.5% of *cis*-sabinene hydrate, while Serbian oil contained a total of 7.2% of *cis*- and *trans*-sabinene hydrates in a 1:1.7 ratio. Interestingly, we found that the literature NMR data on these compounds were mostly incomplete and usually

lacked a thorough multiplet analysis. For that reason, we also performed a complete and comprehensive ¹H and ¹³C NMR assignment of sabinene hydrates, that includes *J*-values obtained by computer spin simulation and molecular modeling.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Contract Number 451-03-68/2022-14/200124).

***Scilla bifolia* L. wax is a source of rare alkane-1,3-diols**

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A series of rare long-chain 1,3-alkane diols (C₂₂-C₃₀ and C₃₂) was isolated from *Scilla bifolia* washings. The identification initially proved quite challenging due to a rare phenomenon—long-chain alkane-1,3-diols reacted quantitatively with polydimethylsiloxane (from the GC phase) at high temperatures during gas chromatography, giving the corresponding cyclic dimethylsilyl derivatives. The 1,3-regiochemistry of the isolated long-chain diols was resolved after trimethylsilyl derivatization experiments and was further corroborated by NMR spectra (in particular HMBC) as well as computer spin simulation of the ¹H NMR spectrum. The distribution of the homologs in the series had a maximum at the C₂₄ diol, which comprised 37.7% of the TMS derivatized fraction. The retention indices of TMS derivatives provided in this work should greatly facilitate future detection and identification of these compounds.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Contract Number 451-03-68/2022-14/200124).

Antifungal and anti-biofilm activity of *Thymus serpyllum* essential oil against *Aspergillus* otomycosis

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The species *Aspergillus niger complex* and *Aspergillus flavus complex* are one of the most common molds that are causative agents of otomycoses. The aim of this study was to determine the biofilm production ability of species isolated from relapsing infections, as well as to evaluate antimicrobial and anti-biofilm potential of the *Thymus serpyllum* essential oil. A microdilution method was used to determine the minimal inhibitory concentrations (MICs) and minimal fungicidal concentrations (MFCs). The isolates were tested to biofilm-producing ability using the method described by Pierce and Kvasničková with slight modifications, and all tested strains had the ability to produce biofilm. The essential oil of *Thymus serpyllum* showed a high antifungal activity with MICs in the range from 0.625 to 5 mg/ml and MFCs from 0.625 to 10 mg/ml. The oil also showed a high anti-biofilm activity by inhibiting the biofilm production in the range from 3.63 to 93.09%. Therefore, the thyme essential oil presents a promising agent that might be considered as an adjunctive therapy in the treatment of otomycoses caused by *Aspergillus niger complex* and *Aspergillus flavus complex* strains.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Contract Number 451-03-68/2022-14/200124).

Antimicrobial, anti-virulence and synergistic potential of *Citrus aurantifolia* essential oil against *Klebsiella* spp. and *Escherichia coli* clinical isolates

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Klebsiella spp. and *Escherichia coli* belong to the family Enterobacteriaceae. These species are common causative agents of urinary tract and nosocomial infections. The virulence of these species is related to its capability to form biofilms. The aim of this study was to evaluate the antibacterial, anti-virulence and synergistic potential of *Citrus aurantifolia* essential oil against *Klebsiella* spp. and *E. coli*. Minimal inhibitory concentrations (MICs) of essential oil were determined by microdilution method and further used to study the type of interaction (synergism, additive, antagonism, or indifference) between the oil and antibiotic ciprofloxacin. The anti-virulence activity of the essential oil was tested on biofilm production and degradation of mature biofilms. Lime essential oil has shown a high antibacterial potential (0.625-2.5 mg/ml) as well as synergistic and additive effect in combination with the ciprofloxacin. The results showed a potent anti-biofilm activity of the oil by inhibiting up to 78.72% of the biofilm production. The reduction of 2.09-62.68% was measured after application of the oil to mature biofilm. Based on obtained results, it can be concluded that lime oil presents promising supporting agent for treatment of the infections caused by these microorganisms.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Contract Number 451-03-68/2022-14/200124).

Contents of phenolic acids and flavonoids in *Satureja kitaibelii* Wierzb. ex Heuff. extracts

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Satureja kitaibelii Wierzb. ex Heuff. is considered to be a species endemic to the Central Balkans within the polymorphic species *Satureja montana* L. It is known for its numerous therapeutic effects, which are associated with the presence of polyphenolics and essential oil components. The aim of the study was to determine the content of phenolic acids and flavonoids using high performance liquid chromatography (HPLC) in the methanolic, ethanolic and aqueous extract. The above-ground parts of the plant were collected during the full flowering phase, in the area of Kamenica, near Niš. The extraction of plant material was carried out by the method of maceration with absolute methanol and concentrated ethanol. An aqueous extract was prepared by total evaporation of water from the hydrolate, obtained during the isolation of the essential oil by hydrodistillation. The presence of rosmarinic and caffeic acids, apigenin, luteolin, salvigenin, apigenin-7-*O*-glucoside and luteolin-7-*O*-glucoside were noticed in the extract. Apigenin, salvigenin and apigenin-7-*O*-glucoside were predominant in the ethanolic, luteolin in the aqueous, and luteolin-7-*O*-glucoside, along with rosmarinic and caffeic acids, in the methanolic extract. The results of the study show that *S. kitaibelii* could have a prominent place in modern phytotherapy as part of new herbal medicines.

Acknowledgements. The authors would like to thank the Ministry of Education, Science and Technological Development of the Republic of Serbia (No: 451-03-68/2022-14/2000113 and 451-03-68/2022-14/200003) and the Internal project of the Faculty of Medicine, University of Niš, Serbia (No: 68).

Chemical composition of essential oil of *Malabaila aurea* (Sm.) Boiss fruits

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Malabaila Hoffm. is a small genus of the Apiaceae (Umbelliferae) family that is distributed from the East Mediterranean to Central Asia and Iran. *Malabaila aurea* (Sm.) Boiss., a Balkan endemic species, can be found in Albania, Bulgaria, Greece, Montenegro, North Macedonia, and Croatia. *Malabaila aurea* is a slightly aromatic plant, and the essential oil of this taxon from North Macedonia has never been investigated. In this study, we wish to report the chemical composition of the essential oil of fruits of *M. aurea* obtained by hydrodistillation. The plant material was collected in May 2017, near Gevgelija, a city in the southeast of North Macedonia. The yield of the essential-oil sample was 0.2%, based on the weight of air-dried plant material. The GC-MS analysis allowed the identification of ca. 20 components in the essential oil of the fruits, representing ca. 98% of the total GC-peak areas detected. The main component of the *M. aurea* essential-oil sample showed that octyl butanoate was the major constituent (88.5%), while minor constituents were *n*-octanol (3.3%), hexyl butanoate (0.7%), α -humulene (0.5%), myristicin (2.3%), decyl butanoate (0.3%), apiole (2.4%).

Acknowledgments. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (No. contract 451-03-68/2022-14/200124).

Structure elucidation of new tiglic acid esters from *Bupleurum falcatum* L.

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Species of the genus *Bupleurum* L. (Apiaceae) have been used in traditional medicine for more than 2,000 years, with the best-documented species being *B. chinense* DC. (*B. falcatum* L., synonym). *Bupleurum falcatum* is a perennial representative of this genus, also found in the literature under the synonym *B. sibthorpiatum*, although according to Flora of Serbia these are two different plant taxa. There are many phytochemical studies of *B. falcatum*, while *B. sibthorpiatum* is mentioned only once in a work reporting the chemical composition of its essential oil. In this work, we performed a detailed analysis of the diethyl-ether extract of *B. falcatum*, which was subjected to various chromatographic separations, and the structures of the isolated constituents were elucidated by spectroscopic means and chemical transformations. Structural elucidation and complete NMR spectroscopic assignments were conducted using iterative ¹H NMR full spectral simulations. This resulted in the identification of new polyunsaturated esters of (5*E*,7*E*,9*E*,11*Z*)-tetradeca-5,7,9,11-tetraen-1-ol or (5*E*,7*E*,9*E*)-tetradeca-5,7,9-trien-1-ol, and tiglic acid. In order to confirm the structure of the isolated ester of the trienic alcohol, the NMR spectra of this compound were compared with those of Tung (*Vernicia fordii*) oil in which the most abundant compound is the ester of a homolog of this alcohol.

Acknowledgments. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (No. contract 451-03-68/2022-14/200124).

Chemical composition and prebiotic effect of the fruit of *Prunus spinosa* L., Rosaceae

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The blackthorn is widespread across temperate Europe and also occurs in the Near East and Africa. The fruit is traditionally used in the treatment of digestive, respiratory and kidney disorders. The aim of the study was to investigate composition and the antibacterial activity of methanol extract of blackthorn fruit, and potential prebiotic effect on selected probiotic microorganisms. The blackthorn fruit is a rich source of vitamin C (5.3 mg/100 g, determined by titration) as well as Ca, Mg and P (106.7; 42.0 and 43.2 mg/100 g, respectively, determined by ICP-OES). The total phenolic content was 1,235 mg gallic acid/100 g (FC method). Hydroxycinnamic acid derivatives (caffeoylquinic and feruloylquinic acids), flavonoids (glycosides of quercetin, methylquercetin and kaempferol) and anthocyanins (glycosides of cyanidin and peonidin) were tentatively identified by LC-DAD-ESI-MS. The antimicrobial activity on eight laboratory control strains of bacteria was not pronounced (MIC 1.25->5 mg/ml). On the other hand the extract (0.3-5.0 mg/ml) exhibited significant prebiotic effect on investigated probiotic strains of *Lactobacillus* spp., *Saccharomyces boulardii* and their mixtures. The stimulation of growth was in the range 4.0-52.8% in concentration dependent manner. In conclusion, significant prebiotic activity of blackthorn fruit confers new insight in blackthorn health benefits.

Acknowledgments. This research was funded by the Ministry of Education, Science and Technological Development, Republic of Serbia through Grant Agreement with University of Belgrade-Faculty of Pharmacy No: 451-03-68/2022-14/200161.

Isolation and identification of secondary metabolites from *Bupleurum affine* Sadler

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Bupleurum L. is one of the largest genera belonging to the family Apiaceae (Umbelliferae). The genus is almost exclusively native to Europe and eastern Asia. Some of the species are well-known for their over 2000-year long use in traditional Chinese medicine: “liver tonics”, the treatment of fever producing infections, etc. Prompted by the rich ethnopharmacological usage of the taxa belonging to this genus, and the lack of data on the secondary metabolites of *Bupleurum affine* Sadler, also known under the synonyms *B. breviradiatum*, *B. dichotomum* and *B. gerardii*, we decided to investigate the chemical composition of the diethyl-ether extract of this taxon, wild-growing in Serbia. The extract was obtained by maceration of the dried umbels with schizocarps in diethyl ether. This extract was subjected to various chromatographic separations, and the structures of the obtained pure constituents were elucidated by spectroscopic means. Structural elucidation and complete NMR spectroscopic assignments were conducted using iterative ¹H NMR full spectral simulations. This resulted in the identification of several new compounds: four polyunsaturated esters, one γ -butyrolactone, as well as one lignan.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (No. contract 451-03-68/2022-14/200124).

Isolation and identification of secondary metabolites from *Acorus calamus* L.

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In this study three acorenone-type and one asarone-type *Acorus calamus* L. (Acoraceae) rhizome essential oils were analyzed by GC-MS. Some of the samples were obtained by hydrodistillation, others were purchased, while the acorenone-type oils were further individually subjected to dry-flash chromatography. The following

pure sesquiterpenoids were isolated by subsequent silica-gel column chromatography: preisocalamendiol, isocalamendiol, shiobunone, isoshiobunone, and acorenone. Their structures were elucidated by spectral means (MS, 1D- and 2D-NMR). Also, a complete assignment of ¹H- and ¹³C-NMR spectra of these compounds was performed, as well as a spin simulation of selected ¹H-NMR spectra, which allowed their relative configuration to be confirmed, as well as their most stable conformation determined. Preisocalamendiol and isocalamendiol were treated with *p*-toluenesulfonic acid and dehydrated with phosphoryl chloride. The products of these reactions, isomeric products of water addition and dehydration, were also detected in our samples of the essential oils.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (No. contract 451-03-68/2022-14/200124).

Study of the reaction of *p*-cymene with hydrogen peroxide in trifluoroacetic acid and its usage for the identification of *Doronicum columnae* Ten. secondary metabolites

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Essential oils of many plant species contain phenolic compounds, among which the best-known ones are the regioisomeric monoterpenes thymol and carvacrol, present in a large number of taxa of the families Asteraceae and Lamiaceae. The essential oil of *Doronicum columnae* (Asteraceae), in addition to these two compounds, contains other regioisomers of isopropylmethylphenols and various derivatives, ethers and esters. The goal of this work was the identification of these compounds in the mentioned essential oil, as well as the synthesis of some of the possible regioisomeric phenols, their ethers and esters. Due to the complexity of the essential oil of *D. columnae*, the oil was initially directly chemically transformed and the products were further analyzed. For the synthesis of regioisomeric phenols, and their derivatives, a reaction of *p*-cymene with trifluoroacetic acid, obtained *in situ* from trifluoroacetic acid and hydrogen peroxide, was used, as it yielded a mixture of isomers of isopropylmethylphenols present in the essential oil. All of the products, and constituents of the essential oil, as well as the obtained derivatives, were analyzed by GC-MS and NMR spectroscopy.

Acknowledgments. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (No. contract 451-03-68/2022-14/200124).

Essential oil composition of different parts of *Artemisia absinthium* and its antibacterial activity against phytopathogenic bacteria

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The composition of essential oil (EO) from different parts of *Artemisia absinthium* L. (Asteraceae), from Serbia, was analyzed. Shoots without leaves and inflorescences (SWLI), leaves (L), and inflorescences (I) were subjected to hydrodistillation. Chemical analysis was done by gas chromatography/mass spectrometry (GC-FID/GC-MS). The microdilution method was used to determine the minimum inhibitory concentration (MIC) and the minimum bactericidal concentration (MBC) of the EOs against five Gram-negative and one Gram-positive phytopathogenic strains. In total, 17 compounds were identified in SWLI, 18 in I, and 11 in L, representing 37.85%, 71.57%, and 97.06% of the total oil, respectively. The principal constituent in all three EOs was *trans*-thujone (SWLI - 23.56%, L - 60.41%, and I - 46.16%). According to the MIC assay the most susceptible strains were *Xanthomonas campestris* pv. *campestris*, *Erwinia amylovora* and *Rathayibacter tritici*, causative agents of black rot, fire and spike blight. The strongest activity was shown for SWLI EO against *E. amylovora* (0.03 mg/mL) whilst the same MIC values were observed for L EO against *E. amylovora* and *R. tritici* (0.09 mg/mL). The equal activity for the all three EOs tested was detected against *X. campestris* (0.13 mg/mL).

Acknowledgments. Financial support was provided by the Ministry of Education, Science and Technological Development of the Republic of Serbia (451-03-68/2022-14/200178).

NMR metabolomics study of the desiccation and recovery process in the resurrection plants *Ramonda serbica* and *Ramonda nathaliae*

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Ramonda serbica and *R. nathaliae* are resurrection plants that have the remarkable ability to survive the complete desiccation during periods of drought and rapidly revive when rewatered and rehydrated. To investigate metabolic changes during their desiccation and recovery process NMR-based metabolomics approach coupled with multivariate data analysis was utilized to identify the metabolomes of the plants from 90 biological replicates. The NMR metabolomics profiles of *R. serbica* and *R. nathaliae* were subjected to multivariate data analysis. PCA was performed, which resulted in eight principal components (PCs) in both models, explaining 77.0% of the total data variance in the model with *R. serbica* samples, and 79.5% of the variance in the model with *R. nathaliae* samples. Using NMR experiments, the content of the two most dominant polar components found in the leaves of these two plants was determined. Sucrose and the polyphenolic glycoside myconoside were predominant in almost equal amounts in all samples studied, regardless of their water content at sampling. Using of 1D and 2D NMR experiments the main components have been successfully identified. Also, it was necessary to isolate and purify the myconoside to confirm the structure.

Acknowledgments. This work was financially supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grants No. 451-03-68/2022-14/200026 and 451-03-68/2022-14/ 200178).

Chemical profile of *Chaerophyllum temulum* L. headspace volatiles obtained from different plant organs

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The present study was carried out in order to determine the difference in the chemical composition of the headspace (HS) volatiles of *Chaerophyllum temulum* L. obtained from fresh inflorescences, stems and roots using HS-GC-MS. The plant material was harvested at the flowering stage in May 2014, in the region of Niš and the voucher specimen was deposited in the Herbarium Moesiacum Niš under the acquisition number 9371. The fresh plant was divided into parts and they were analyzed immediately after harvest. Number of identified compounds in HS1 (inflorescences), HS2 (stems) and HS3 (root) samples were 33, 25 and 27, respectively; representing 98.3%, 98.6% and 98.6% of total headspace volatiles. In all samples, the most dominant components were monoterpene hydrocarbons. β -Phellandrene was the major constituent of the inflorescences representing 31.7% of the total volatiles. The most abundant constituents of fresh stems volatiles were β -phellandrene (30.7%) and myrcene (18.1%). The other notable compound in these samples was (*E*)- β -ocimene which was present with a contribution of 16.1% and 11.1% in HS1 and HS2 samples, respectively. It is interesting that β -phellandrene and (*E*)- β -ocimene which make up over 40% of the aerial parts of the plant, that they were not even detected in the root sample. On the other hand, the roots were characterized by a high amount of α -pinene (75.1%), which was also detected in the aerial parts samples, but in significantly lower concentration. Beside the main compounds which were different for the aerial parts and roots, the root sample also had a lower content in sesquiterpenes compared to the stems and the inflorescences (1.9% vs. 16.3% and 17.4%, respectively). These results contribute to the fact that the composition of the volatiles obtained from aerial parts and the roots can be quite different.

Acknowledgements. The authors are grateful to the Ministry of Education, Science and Technological Development for the financial support through the grant No 451-03-68/2022-14/200124.

Phytochemical analysis of the *Elaeagnus angustifolia* L. flower hexane extract

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Elaeagnus angustifolia L., commonly called Russian olive, silver berry, oleaster, Persian olive, or wild olive, or commonly referred to as dafina in Serbia, is a species of *Elaeagnus*, native to western and central Asia. It is now also widely established in Europe and North America as an introduced species. Its fragrant flowers are used in perfume industries. The fruits are edible but they also found application in pharmacy and in folk medicine. Flowers of the plant species *E. angustifolia* was collected in May 2017, at the urban area of the city of Niš. Fresh chopped flowers (5 g) were submerged with 50 ml of hexane (HPLC purity). The mixture was then treated in an ultrasonic bath for 30 minutes and left in a dark place for the next 48 hours. The extract was filtered and stored in a cool and dark place until analysis. Chemical composition of the hexane extract was analyzed by the GC-MS. The most abundant class of compounds are carboxylic acids and its derivatives (esters) with a share of 79.2%. Oxygenated sesquiterpenes are present in a small percentage (0.3%), while hydrocarbon sesquiterpenes and monoterpenes are present in traces. Other compounds are present in a share of 17.0%. The most common identified components are: (*Z*)-ethyl-9-octadecenoate with a share of 18.0%, (*E*)-ethyl cinnamate with a proportion of 17.8%, nonacosane 10.1%, eicosyl benzoate 7.8% and hentriacontane whose share is 5.1%. The most abundant components are the same ones that dominate in the essential oil, but the important difference is that the hexane extract has a higher percentage of non-terpene compounds, mostly alkanes. The reason for this difference in chemical composition is that hexane, a low polarity extraction solvent, has successfully extracted components of lower polarity and higher molecular weights, which are not at all, or are isolated to a lesser extent in the essential oil.

Acknowledgements. The authors are grateful to the Ministry of Education, Science and Technological Development for the financial support through the grant No 451-03-68/2022-14/200124.

Comparison of phenolic profiles of *Satureja kitaibelii* Wierzb. ex Heuff. and *Satureja montana* L. (Lamiaceae)

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Satureja kitaibelii Wierzb. ex Heuff. (Rtanj tea) has distinct morphology and distribution which separate it from highly polymorphic *S. montana* L. In this work, we investigated phenolic composition of *S. kitaibelii* and compared it to that of *S. montana*. Flowering aerial parts of four *S. kitaibelii* samples were collected in Serbia and Bulgaria and one commercial sample of Rtanj tea was obtained from Serbia. Three samples of *S. montana* were collected in North Macedonia and Serbia and the fourth one was cultivated sample. Herbs were extracted with 50% ethanol. Dry extract solutions were analyzed by liquid chromatography with UV and MS detection. Rosmarinic acid (RA) and clinopodic acid O (CAO) were quantified using RA as the external standard. All extracts were characterized by presence of phenolic acids, RA (16.5-47.9 mg/g) and CAO (1.6-29.3 mg/g, calculated as RA), and flavonoids. The extracts of *S. kitaibelii* distinguished by high contents of both RA and CAO, which were present in similar quantities within each extract. On the other hand, extracts of *S. montana* contained at least 3 times less CAO than RA. The obtained results further confirm distinct properties of *S. kitaibelii* and give additional arguments to its status as a separate species.

Anticandidal activity of *Centaurea glaberrima*

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The anticandidal activity of extracts of *Centaurea glaberrima* Tausch (Asteraceae) from Montenegro was analyzed. Aerial parts were extracted three times by maceration combined with ultrasonication using different ratio of 96% ethanol:*n*-butanol (9:1, 7:3, 1:1, 3:7, and 1:9). The microdilution method was used to examine antimicrobial activity of extracts against *Candida albicans*, *C. auris*, *C. parapsilosis*, and *C. tropicalis* reference strains. All five extracts exhibited moderate activity with the same minimum inhibitory concentrations (MIC) against tested yeasts. The most susceptible yeast was *C. parapsilosis* (MIC 0.25 mg/mL), followed by *C. albicans* and *C. tropicalis* (MIC 1 mg/mL), while *C. auris* was the least susceptible (MIC 2 mg/mL). These results show that the different ratio of ethanol and *n*-butanol in the solvent mixture did not influence anticandidal activity. To the best of our knowledge, this is the first study of biological activity of *C. glaberrima*.

Acknowledgements. This research is funded by the Serbian Ministry of Education, Science and Technological Development [No. 451-03-68/2022-14/200178 and 451-03-68/2022-14/200007]

Two new abietane diterpenes from *Lycopus europaeus* L. fruits

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Lycopus europaeus L. (gypsywort) is a perennial plant native to Euroasia that is reputed to have diverse medicinal applications. In our previous study, we found an antimicrobial phenolicabietane-type diterpene, euroabienol, possessing an unusual

oxygenation pattern of the C ring, in a relatively high amount (1%, w/w) in the fruits of this plant species. A GC-MS analysis of the original dichloromethane extract of the fruits of *L. europaeus* also revealed the presence of several other minor diterpenoids related to euroabienol. This provoked us to perform a re-investigation of the chromatographic fractions containing the mentioned diterpenoids. After multiple chromatographic separations (on SiO₂ and Sephadex L-20), we isolated two new compounds that were identified as 11-deoxyeuroabienol and 3 β -acetoxyeuroabienol on the basis of detailed NMR and MS analyses. It would be interesting to determine whether these slight structural variations will cause significant changes in the observed bioactivity of the parent euroabienol.

Acknowledgements. The work was supported by the Ministry of Education, Science and Technological Development of Serbia under Grant No. 172061 (contract number: 451-03-68/2022–14/200124).

Antioxidant activity and vitamin C content of different red currant (*Ribes rubrum* L.) juices

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Red currant (*Ribes rubrum* L.) is a berry with significant nutritional value, whose fruits have been used as food and medicines. The polyphenolic compounds and vitamin C presence make them good antioxidants. Vitamin C acts as an immune stimulant and regenerates glutathione, so it's important to know vitamin C content in the red currants juices (RC). The aim of this study was to determine the content of vitamin C before and after reduction, as well as the antioxidant activity (AO) of the 6 varieties of RC juices. The used varieties were: Redpoll, Rolan, Jonkheer, Stanza, Rondon and Makosta. Vitamin C was determined by HPLC. DPPH test was used for AO. The results showed that the highest vitamin C content had the Redpoll juice (33.14±2.21mg/100g before and 66.52±2.9 mg/100g juice after reduction), and the lowest by Stanza (3.21±0.1 mg/100g before and 6.23±0.28 mg/100g juice after reduction). The strongest AO exhibited the Redpoll juice (IC₅₀=1.76±0.25 mg/ml)

and the weakest by Rolan ($IC_{50}=6.65\pm 0.84$ mg/ml). Determination of vitamin C content and AO in RC juices showed that Redpoll juice expressed the best results. The results of this study show the benefits of implementing RC and its products in the diet and can be used for selection of high-quality varieties.

Acknowledgements. This research was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant no. 451-03-68/2022-14/200113 and 451-03-68/2022-14/200003). The authors are also grateful for the financial support of the Internal project of Faculty of Medicine, University of Niš, named “Phytochemical and pharmacological investigation of selected medicinal plant species of families Lamiaceae, Rosaceae and Apiaceae”, No.68.

NO-scavenging capacity of *Helichrysum italicum* essential oils and two italdiones

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Herein, the *in vitro* NO-scavenging ability of two *Helichrysum italicum* (Roth) G. Don (Asteraceae; immortelle) essential oils and two synthetic italdiones, 4,6-dimethyloctane-3,5-dione and 4,6,9-trimethyldec-8-ene-3,5-dione (β -diketones found only in immortelle), was evaluated. The essential oil at non-cytotoxic concentrations (≤ 10 μ g/mL) is known to significantly suppress NO production in rat peritoneal macrophages. A chromatographic fraction of the oil containing italdiones displayed similar activity (*ca.* 65%) at all tested concentrations. Some β -diketones could act as potent NO scavengers, hinting at the possible reason for the observed decrease in NO production. In this work, the cell-free assay where NO was generated from sodium nitroprusside and quantified by the Griess reaction was used. At higher concentrations, the effect of both β -diketones and the oils was negligible, while at 1 μ g/mL they reduced the amount of released NO by *ca.* 10%. The antioxidant capability of β -diketones is associated with the corresponding keto-enol tautomer, and the poor NO-scavenging effect of the herein studied β -diketones could be explained by the low equilibrium relative amount of the keto-enol form under physiological conditions. Quercetin, used as the positive control, manifested a similar effect at lower concentration (5%), while at 10 μ g/mL displayed considerable NO-scavenging ability (46%).

Acknowledgements. The work was supported by the Ministry of Education, Science and Technological Development of Serbia under Grant No. 172061 (contract number: 451-03-68/2022–14/200124).

Nutritional and phenolic profile of edible mushroom *Armillaria mellea* (Vahl) P. Kumm. (1871)

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The aim of this work was to investigate nutritional profile of edible autochthonous mushroom species *Armillaria mellea* in relation to proteins, amino acids, fatty acids and mineral composition, as well as phenolic profile. Total protein content in the analyzed fungal species was 12.39%. Twenty four protein fractions obtained by electrophoresis were identified in a range from 6 to 63.3 kDa. Chip-based separations showed the presence of protein fraction with molecular weight of 19 kDa that was the most abundant (30.19%). The total essential and non-essential amino acid contents were 25.48 and 85.14 mg/g d.w., respectively. Among the essential amino acids, leucine was the most abundant. Fatty acid composition of *A. mellea* showed that monounsaturated fatty acids (MUFA, 43.62% of total FA) and polyunsaturated fatty acids (PUFA, 34.87% of total FA) predominated over saturated fatty acids (SFA, 21.51% of total FA). The dominant fatty acids were oleic acid (36.04%), linoleic acid (34.30%), and palmitic acid (13.28%). The most abundant macroelement in *A. mellea* was potassium, followed by copper, magnesium and calcium, while zinc dominated in microelements. Three phenolic compounds were quantified in ethanolic extract of *A. mellea* HPLC – DAD with the highest amount of catechin and gallic acid reaching 0.6361 mg/g d.w. and 0.0188 mg/g d.w., respectively. According to the obtained nutritional and phenolic profile of fungal species *A. mellea* originated from Serbia (proteins, amino acid composition, fatty acid profile, and mineral composition), this mushroom can be considered a functional food and can be used in a form of dietary supplement or spice in a regular diet.

Acknowledgements. This work was financially supported by the Ministry of Education, Science and Technological Development, Republic of Serbia (Project No. 451-03-68/2022-14/200222).

The new data on the variability of essential oil of *Teucrium montanum* L. from Balkan Peninsula

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Teucrium montanum L. is a semi-woody, evergreen small shrub, widely distributed in Europe occurring from the seacoast to the subalpine and alpine belts. The study aimed to investigate and compare the chemical composition of essential oil of aerial parts of *T. montanum* from 24 populations collected from West, Central, and South West Balkans. The essential oils were obtained by hydrodistillation and qualitative and quantitative analysis was performed by GC-FID and GC-MS. The dominant compounds were oxidized sesquiterpenes (24.83–85.75%), then sesquiterpene hydrocarbons (3.00–62.81%), and oxidized monoterpenes (0–27.78%). Cluster analysis revealed 10 clearly separated groups. First group (Žumberak) is completely separated and characterized by high germacrene-D-4-ol (63.17%), the second (Gjergjevice) by high shyobunol (51.23%), the third (Vratna) by high (dehydro)-sesquicineole-acetate (45.29%), the fourth (Ostrovice) by high *epi*- α -cadinol (36.80%), the fifth (Nera canyon) by high limonene (36.65%), sixth group (Orovica, Sićevo, Galičica) by high *cis*-sesquisabinene hydrate (18.73–29.05%), seventh group (Štrpce, Dobrilovina) by high γ -cadinene (13.43–23.06%), eighth group (Tara, Durmitor, Biokovo, Fužine) by moderate germacrene-D-4-ol (19.76–23.44%), and the ninth large group (Potoci, Lovćen, Orjen, Premantura, Vodice, Pletvar, Senj, Oštarije, Trebinje, Korita) by germacren D (6.15–33.87%). Such a high variability needs more research to define relationships among populations.

Acknowledgements. This research was funded by the Ministry of Education, Science and Technological Development, Republic of Serbia through Grant Agreement with University of Belgrade-Faculty of Pharmacy No: 451-03-68/2022-14/200161.

Chemical composition and antioxidant potential of *Teucrium scorodonia* L. (Lamiaceae) from Serbia

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The wood-sage (woodland germander) *Teucrium scorodonia* L. is widespread in European Atlantic coast and in the western part of Central Europe, with some isolated populations in Mediterranean. Recently discovered population on the territory of Serbia, in the valley of Štavica river (vicinity of Loznica), represents the most eastern enclave in the species range. Preliminary chemical analysis of aerial flowering parts and its dried ethanol and hydroethanol (70% v/v) extracts, and assessment of antioxidant potential of selected (hydroethanol) extract were performed. Using appropriate spectrophotometrical methods, total polyphenols in herb (3.48%, expressed as pyrogallol), ethanol and hydroethanol extracts (100.05 and 96.65 mg gallic acid equivalents - GAE/g), tannins in herb (0.96%, expressed as pyrogallol), ethanol and hydroethanol extracts (11.86 and 12.31 mg GAE/g), flavonoids in herb, ethanol and hydroethanol extracts (0.19%, 0.83% and 0.74%, expressed as hyperoside) were quantified. Also, in ethanol and hydroethanol extracts dihydroxycinnamic acid derivatives were determined (8.96% and 8.37%, expressed as acteoside). By LC-MS, in selected (hydroethanol) extract, four flavonoid and five phenylethanoid glycosides were detected; verbascoside (acteoside) was identified and quantified (4.42%) using external standard. This extract exhibited significant total antioxidant activity (1.37 mmol Fe²⁺/g) and moderate anti-DPPH potential (SC₅₀=51.28 µg/mL).

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of Republic of Serbia through Grant Agreement with University of Belgrade, Faculty of Pharmacy (Grant No 451-03-68/2022-14/200161).

Antimicrobial activity and chemical composition of *Helichrysum italicum* essential oil on isolates of the *Staphylococcus aureus* and isolates of the genus *Candida*: time-lapse kinetics and antibiofilm activity

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The emergence of pathogens that develop resistance to widely used antimicrobial drugs has become a global public health issue. Therefore, the development of new antimicrobial agents is a desirable approach in the research of scientists around the world. In this study, antimicrobial activity of immortelle (*Helichrysum italicum* (Roth) G. Don, Asteraceae) essential oil was tested against the reference strains and isolates of *Staphylococcus aureus* (ATCC 6538 and 11 clinical isolates) and yeasts *Candida albicans* (ATCC 24433 and 11 clinical isolates). The essential oil was chemically characterized by GC-MS analysis, where sesquiterpenes and monoterpenes were found to be the major compounds of the oil. Antimicrobial activity results showed moderate potential of the oil against the isolates of staphylococci and candida, where minimal inhibitory values ranged from 0.156 to 5.00 mg/ml and 0.312-5.00 mg/ml, respectively. The determined MIC and ½ MIC values were further used to explore the effect of the oil over time and to investigate its antibiofilm activity. Based on the obtained research data, where significant reduction of biofilms was observed, further studies should focus on more detailed information on immortelle essential oil mechanism of action against microorganisms and their biofilms and to pinpoint the compounds responsible for these effects. In this way, a solid foundation for using this essential oil as an agent for supplementary therapy of staphylococcal and candidal infections might be provided and further developed.

Acknowledgements. The work was supported by the Ministry of Education, Science and Technological Development of Serbia (Contract number: 451-03-68/2022-14/200124).

Intestinal bioavailability of total glucosinolates and phenolics from broccoli sprouts: Impact of high growing temperature

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The goal of our study was to evaluate the effect of high (HT: 38 °C day/33 °C night) and regular (RT: 23 °C day/18 °C night) growing temperature on the bioavailability of total glucosinolates and phenolics from broccoli (*Brassica oleracea* L. convar. *botrytis* (L.) Alef. var. *cymosa* Duch) sprouts upon final, intestinal, phase of *in vitro* simulated human digestion. The extracts were prepared from freeze-dried plant material using boiling (100 °C) water followed by incubation on rotary extractor for 1 hour at 23 °C. The results showed that HT negatively affected the intestinal bioavailability of total glucosinolates from broccoli sprouts, i.e. their concentration was decreased to 47% of the initial concentration (non-digested extract). On the other hand, RT did not change the bioavailability of total glucosinolates significantly ($p \leq 0.05$). Total phenolics bioavailability was not affected neither by HT, nor by RT condition; in both cases it was very high (>90%). These results show that glucosinolates of broccoli sprouts are significantly more susceptible to HT than total phenolics, and suggests future more detailed analyses of *Brassicaceae* microgreens phytochemical temperature susceptibility/resistance.

Acknowledgements. This work was financially supported by the Croatian Science Foundation research project IP-2020-02-7585 “Indirect Effect of Global Warming on Mammals Physiological Parameters via High Temperature-Stressed Plant Diet (TEMPHYS)”.

Antimicrobial and synergistic effects and chemical composition of the selected essential oils on clinical isolates of the genus *Candida*

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Species of the genus *Candida* are the most frequently isolated fungi from human infection samples. Among them, *Candida albicans* represents the most common cause of human fungal infections. Based on the most recent literature data, an increasing number of the non-*Candida albicans* *Candida* species are recognized as agents that cause human candidoses. Recently, an increase in resistance to many antimycotic drugs is reported widely, primarily due to their long-term use in the treatment of candidoses. Accordingly, in our paper, we investigated the type of interaction of the selected essential oils with each other and in combination with the widely used antimycotic, nystatin. The essential oils were chemically characterized by using the GC-MS method. The effect of oils on planktonic yeast cells has been determined by the microdilution method, and the results indicate significant anticandidal activity of all tested agents (minimal inhibitory values ranged from 0.312 to 5.00 mg/ml). Based on the obtained results, a notable synergistic activity of the tested oils in mutual combination, as well as with nystatin has been observed. In accordance with the above, one can conclude that there is possibility of potential application of the investigated essential oils as a complementary therapy for candidosis.

Acknowledgements. The work was supported by the Ministry of Education, Science and Technological Development of Serbia (Contract number: 451-03-68/2022-14/200124).

Time lapse kinetics of sage and winter savory essential oils and combined oils effects against *Pseudomonas aeruginosa* clinical isolates

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Incorrect and overused antimicrobial therapy in the treatment of human infectious diseases has led to the development of bacterial resistance to many conventional antibiotics, which represents a global health issue. Therefore, it is necessary to find new antimicrobial substances which will help in the treatment of infections caused by multiresistant strains. The aim of the present study was to evaluate the time-lapse activity of the *Salvia officinalis* and *Satureja montana* essential oils and to investigate the effect of combined oils against *Pseudomonas aeruginosa* clinical isolates. Inhibition of bacterial growth was observed during the first 21 h of the treatments, after which very slight recovery was detected in some strains. The obtained growth curves showed a reduction in the number of bacterial cells in the range of 31-100% when winter savory oil was applied, and in the range of 48.5-100% after application of sage oil. Sage and winter savory oils achieved a synergistic effect in 2 isolates, while additive interactions were observed in 4 isolates. The FICs showed indifferent effect in 50% of the tested isolates and antagonism in 2 isolates. The observed results showed time-lapse efficacy of tested oils, while combination of these two oils require caution due to possible antagonism.

Acknowledgements. The work was supported by the Ministry of Education, Science and Technological Development of Serbia (contract number: 451-03-68/2022-14/200124).

Chemosystematic significance of triterpenes from dichloromethane extracts of 28 *Hieracium* L. species from the Balkan Peninsula

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The genus *Hieracium* L. s. str. (Cichorieae, Asteraceae) is one of the most taxonomically complex genera of flowering plants. Chemosystematic significance of triterpenes especially for Asteraceae genera is scarcely assessed. The subject of this research are 28 *Hieracium* species from Balkan Peninsula (mostly collected at Mt Durmitor, Montenegro): 12 principal belonging to sections *Pannosa*, *Naegelianae*, *Drepanoidea* and *Villosa*, and 16 hybridogenous originated from the species from those four sections and *Glauciformia*, *Hieracium*, *Prenantheoidea* and/or *Italica*. Previously, in dried dichloromethane extracts of flowering aerial plant parts, α -amyrin and α -amyrin acetate, as well as β -amyrin, β -amyrin acetate and/or lupeol acetate were identified and quantified using GC-FID-MS. The aim was to evaluate chemosystematic significance of these five triterpenes using multivariate statistical methods (principal components analysis-PCA and non-metric multidimensional scaling-nMDS). Statistical analysis supported the current taxonomical classification of the investigated species, despite overlapping of certain groups. In PCA, all five triterpenes significantly contributed to the differences between the species. Moreover, lupeol acetate could be a significant chemosystematic marker for the most of principal species belonging to the section *Pannosa*, as well as for some hybridogenous species between *H. gymnocephalum* Gris. ex Pant. and the members from the other sections.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of Republic of Serbia through Grant Agreement with University of Belgrade, Faculty of Pharmacy (Grant No 451-03-68/2022-14/200161).

Chemical composition and antidiabetic properties of *Rubus serpens* extracts

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One of the most frequently occurring human diseases nowadays is diabetes that is preventable to a large extent with lifestyle changes. Many *Rubus* species are highly valued medicinal plants due to presence of bioactive phenolic compounds. They are used in a folk medicine against diabetes. However, there are no literature data regarding chemical composition and antidiabetic activity of *R. serpens*. *Rubus serpens* is wild-grown crawling blackberry of European forests. The presented study aimed to determine phenolic composition and estimate antidiabetic properties of *R. serpens* aqueous and ethanol leaf (LW, LE) and flower extracts (FW, FE). Leaf extracts contained higher amounts of phenolic acids (LW 548 µg/g, LE 1719 µg/g) than fruit extracts (FW 503 µg/g, FE 236 µg/g). However, anthocyanins were found only in fruit extracts (FW 2.13 mg/g, FE 24.66 mg/g). The most dominant phenolic acids in LW were gallic, chlorogenic and caffeic; in LE gallic, chlorogenic and protocatechuic, while in FW and FE gallic, protocatechuic, p-hydroxy-benzoic and cyanidin-3-glucoside. The examined extracts of *R. serpens* successfully inhibited α -amylase and α -glucosidase, digestive enzymes linked to diabetes. All extracts have been shown as significantly more potent inhibitors of α -glucosidase in comparison to Glucobay®, officinal medicine for diabetes. The obtained results justify the use of *R. serpens* in prevention of diabetes. Further research should be focused on identification of particular phenolic compounds in *R. serpens* extracts which express antidiabetic properties.

Acknowledgements. The authors are grateful to the Ministry of Education, Science and Technological Development of Republic of Serbia (Project No 451-03-68/2022-14/200178).

***Rubus praecox* - Antioxidant activity of ethanol extracts**

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Rubus praecox is a vigorous, deciduous shrub widespread in Europe. The berry, leaves and roots have been used in traditional medicine due to their anti-inflammatory, antiviral, antimicrobial and antiproliferative activity. Blackberries fruit are consumed worldwide because of their good taste and numerous health benefits. In this study, we analyzed polyphenol and flavonoid content and antioxidant activity of ethanol extracts from root, stem, leaf and fruit of *R. praecox* from Divcibare (Serbia). The radical scavenging capacity was estimated against 2,2-diphenyl-1-picrylhydrazil (DPPH) and 2,2-azino-bis(3-ethylbenzthiazoline-6-sulfonic acid) (ABTS) assays. The total phenol content in the extracts was determined using Folin-Ciocalteu reagent and amounts ranged from 97.6 mg GAE/g dw (extract of fruit) to 272.6 mg GAE/g dw (extract from leaf). The concentration of flavonoids varied from 28.2 QE/g dw (extract of fruit) to 63.5 QE/g dw (extracts of the root). The highest antioxidant activity against DPPH showed root extract (IC₅₀ 27.26 µg/mL). The values of ABTS scavenging activity ranged between 102 and 180 mg AA/mL. The root extract showed the best scavenging activity. According to the given results, extracts of *R. praecox* possessed remarkable antioxidant potential. Therefore, they could be recognized as natural antioxidants, but further investigations are recommended.

Acknowledgements. The authors are grateful to the Ministry of Education, Science and Technological Development of Republic of Serbia (Project No 451-03-68/2022-14/200178).

Metal bioaccumulation and translocation potential of species *Phragmites australis* (Cav.) Trin. ex Steud on mine tailings rudnik DOO “Rudnik” (Republic of Serbia)

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This study aimed to determine the concentrations of some metals (Mn, Ni, Fe, Cu, Zn, Cr, Ca, Mg, Pb, Cd) in the soil and plant species *Phragmites australis* (Cav.) Trin. ex Steud. on the tailings of the mine DOO “Rudnik”. In the investigated soil, the concentration of Pb was above the maximum allowable, limit and remediation values, while the concentrations of Cu, Zn and Cr were above the maximum allowable and limit values, and Cd was above the limit value for given metal (prescribed in regulations of the Republic of Serbia). Also, the Cu and Pb concentrations in the soil were above the limit value for these metals determined in the Directive of the European Union. The concentrations of Mn, Ni, Fe, Zn, Cr, Mg, Pb and Cd were highest in the root of species *P. australis*, Cu in the inflorescence and Ca in the leaf. The obtained results indicate potential application of underground parts and stem of *P. australis* that naturally grows on the mine tailings in the phytoextraction of the Fe, as well as the aboveground parts of this plant species in the accumulation of Ni, Cr, Mg and Cd.

Acknowledgements. This work was funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia, Contract: 451-03-68/2022-14/ 200122.

Biological activity of ‘anti-diabetic’ herbal mixture and five medicinal plants methanolic and ethanolic extracts

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Reactive oxygen species have an important role in the development and progression of many diseases, as well as diabetes. This problem might be ameliorated by implementing functional food such as medicinal plants in everyday diet. This study is aimed to evaluate and compare the influence of methanol and ethanol extraction on the antioxidant, cytotoxic and anti-cytotoxic activity of the traditionally used herbal mixture as well as its constituents: *Rubus fruticosus* and *Vaccinium myrtillus* leaves, *Potentilla erecta* roots, *Geum urbanum* aerial parts, and *Phaseolus vulgaris* pods. The antioxidant activity of tested extracts was determined by the DPPH radical scavenging assay. Their cytotoxicity and anti-cytotoxicity were evaluated using RBCs haemolytic and antihaemolytic tests. The highest antioxidant activity in both DPPH and RBCs antihaemolytic assays was shown by methanol extract of the herbal mixture. This extract was significantly more potent than the reference, butylated hydroxyanisole in the DPPH test, and ascorbic acid in the RBCs antihaemolytic experiment. At the same time, even high concentrations of this extract had a very weak cytotoxic activity, suggesting a strong conclusion that the methanol extract of this herbal mixture might be a valuable candidate for future use in the industry of nutritional supplements.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, Grant No. 451-03-68/2022-14/200124.

Traditionally used polyherbal mixture ameliorates diabetes-related spleen damage in a rat model of type 2 diabetes

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As being a rich source of antioxidants, plants supported diet could reduce high level of hyperglycemia. For years now, in our country the polyherbal mixtures, have been used traditionally as part of diabetic diet. In our study, we tested polyherbal mixture made of *C. intybus*, *C. erythrea*, and *P. erecta*. In the *in vitro* study we established total phenolic compounds and flavonoids, as the main antioxidative agents of plants, and antihemolytic activity of polyherbal mixture. Presence of high concentrations of total phenolic compounds and flavonoids were established by decoctions analysis. The results of antihemolytic test suggest protective effect on erythrocytes membrane thanks to high total phenolic and flavonoids concentrations. In the *in vivo* study we investigate potential protective effect on spleen tissue of alloxan monohydrate-induced diabetic Wistar rats. The diabetic animals were treated with insulin glargine (13 IU/kg) and decoctions concentrations 2.5, 5, 10 and 15 g/kg and glimepiride as one of the type 2 anti-diabetic remedy. After 2 weeks of treatment, the number of splenic macrophages with hemosiderin deposits were determined. Results showed statistically significant decreased number of splenic macrophages of 15 and 10 g/kg treated groups. Based on the results, it can be concluded that higher decoction concentrations have a protective effect on spleen tissue.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, Grant No. 451-03-68/2022-14/200124.

Antioxidative, antidiabetic and cytoprotective activity of two polyherbal mixtures and five medical plants traditionally used in type 2 diabetes therapy

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As a continuation of our search for the most potent polyherbal mixture used as an ethnopharmacological remedy for diabetes, this study aimed to evaluate and compare the biological activities of aqueous extracts of two polyherbal mixtures and their individual ingredients: *Potentilla erecta* and *Taraxacum officinale* roots, *Artemisa absinthium*, *Betula pendula* and *Rosmarinus officinalis* leaves. Antioxidant activity was evaluated using the DPPH test. Antidiabetic activity was assessed using the α -amylase inhibition assay. Cytoprotective activity and potential cytotoxicity were estimated using the RBCs antihaemolytic test. Antioxidative and antidiabetic activity was positively correlated with total phenol and total flavonoid content of all the tested extracts. Both polyherbal mixtures' extracts had high antidiabetic activity. Moreover, their antioxidant and cytoprotective activity were higher than the reference butylated hydroxytoluene ($p < 0.001$). The highest cytoprotective activity had Polyherbal mixture-II (75 $\mu\text{g/ml}$). The lowest cytoprotective activity had *P. erecta* extract (75 $\mu\text{g/ml}$), which was even cytotoxic in most of the tested concentrations. Of both tested polyherbal mixtures extracts, higher antioxidant, antidiabetic, and antihaemolytic activity was observed in Polyherbal mixture-II one ($p < 0.001$). These findings suggest that polyherbal mixture-II might be a valuable candidate for future use as an additional treatment for diabetes type 2.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, Grant No. 451-03-68/2022-14/200124.

**14th Symposium on the Flora of
Southeastern Serbia
and Neighboring Regions
Kladovo 26th-29th June, 2022**

**Agriculture, Forestry and Landscape
Architecture**

INTRODUCTORY LECTURE

***Picea abies* (L.) H. Karst. morphological characteristics variability in the climate change conditions on Čemernik mountain**

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This research analyses the morphological and dendrometric characteristics of three 97 years old European spruce trees, on Čemernik mountain, in the municipality of Crna Trava, where European spruce is not autochthonous. The examined parameters were compared with 5 test European spruce trees, aged about 50 years, which are grown in the population, within a radius of 100 m, in identical environmental conditions. The results of this study confirm the excellent vitality of hundred-year-old trees at the researched location, which can be brought into direct correlation with the current climate changes. The selected trees have confirmed the best combinatorial ability, which is why they stand out as a good base for selection and production of planting material for establishing purpose culture, afforestation, application in landscape architecture, and also for timber production. The research confirmed that the analysed hundred-year-old spruce trees are in excellent condition and high decorative value, with a crown formed from the ground, which is why they are proposed for protection as a natural monument of botanical character.

Acknowledgements. The Ministry of Education, Science and Technological Development is financing the scientific research work of the University of Belgrade, Faculty of Forestry in 2022 on the basis of the Agreement on the realisation number: 451-03-9 / 2022-14 / 200169.

ORAL PRESENTATIONS

Growth characteristics of sessile oak (*Quercus petraeae* (Matt.) Liebl., Fagaceae) young crop in conditions of small size regeneration areas

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In accordance with the biology of sessile oak that implies shade tolerance and the ability to regenerate in the closed stand canopy conditions in the monodominant sessile oak forests in Serbia, the natural regeneration of stands is mainly based on beforehand, spontaneously formed young crop and its gradual release from shade of the secondary species and mother trees by means of regeneration cuts on the areas of various size. In the conditions of small size regeneration areas on a site of a mesophilous variant of monodominant sessile oak forest (*Quercetum petraeae* Čer. et Jov. 1953. s.l) in the area of northeastern Serbia, a morphometric analysis was conducted on sessile oak young crop that was formed after successive mast years (2002, 2005, 2009 and 2011). In the oldest found young crop that was formed in the closed canopy conditions, the above-cotyledon-axis was on average 9.0 cm tall in the first year of its development while at age 15 years it was 55.0 cm with a root collar diameter of 6.3 mm. The morphology of the seedlings was typical of shade conditions (sciomorphic). The current annual height increment in the unchanged canopy conditions in the period from the 2nd to the 9th year of age was 1.0–2.6 cm. When the canopy conditions were changed, from 10th to 15th year, the current annual height increment was 1.4–10.9 cm. In the conditions of small size regeneration areas, the sessile oak young crop shows a specific norm of reaction of height growth in the first and in the following years of development and the main height growth type was one-flush growth.

Acknowledgements. This work was funded by the Ministry of Education, Science and Technological Development, Republic of Serbia (Contract No. 451-03-9/2022-14/200169; 451-03-68/2022-14/200197; 451-03-68/2022-14/200053; 115001/2022).

The distribution of Tree-of-Heaven (*Ailanthus altissima* (Mill.) Swingle, Simaroubaceae) in the Area of “Đerdap National Park”

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Tree-of-Heaven is an invasive tree species that disturbs the biodiversity and is particularly important in protected areas. On the basis of its investigated spatial distribution in the “Đerdap National Park”, Tree-of-Heaven is most represented on the edges of the National park, close to Danube, where the anthropogenic influence is most pronounced. Having in mind that the roads and watercourses are the main corridors for expansion of invasive tree species and that the full length of the borders of “Đerdap National Park” are matching these corridors, it can be assumed that Tree-of-Heaven was present in the area since the XIX century as the species was used for reforestation of Ramsko-Golubačka and Deliblato Sands that are in the upstream part of the Danube close to the “Đerdap National Park” borders. Due to the construction of the state road (“Đerdapska magistrala”) along the borders of the National park, Tree-of-Heaven gradually colonized the rocky road cuts going from lower towards higher attitudes. It can be expected that Tree-of-Heaven will be permanently present in the area in the upcoming period as the terrain of the rocky road cuts is unapproachable and recently colonized by Tree-of-Heaven. Significant individual or group distribution of Tree-of-Heaven in the area of “Đerdap National Park” is recorded close to and in the area of the protection regime I, on localities of great scientific importance such as “Kanjon Boljetnske reke” and “Lepenski vir”.

Individual trees that have 55.0 cm diameter at breast height and height of 25.5 m, point out to their presence in the area for decades. For now, the expressed dendrodiversity and the fully closed canopies of the surrounding forest stands are disabling the expansion of this invasive species to the area of forested hilly and mountainous hinterland of the National park.

Acknowledgements. This work was funded by the Ministry of Education, Science and Technological Development, Republic of Serbia (Contract No. 451-03-9/2022-14/200169; 451-03-68/2022-14/200197; 451-03-68/2022-14/200053). The research was funded by the project financed by Public Enterprise “Đerdap National Park” (Contract No. 1836 from 15.04.2021.).

POSTER PRESENTATIONS

Stem anatomy related to lodging resistance of *Vicia* species

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Many breeding programs of forage legumes are directed towards an improvement of lodging resistance. The objective of our research was to determine stem anatomical traits related to lodging in two *Vicia* species (*V. sativa* L. and *V. pannonica* L.) during two-year experiment. Classic anatomical and stereological analyses at five positions along the stem were performed. Volume densities of stem tissues were calculated, and tissue proportions assessed along the stem maturity gradient. Special focus was given to tissues with the highest potential impact on lodging (mechanical and vascular tissues). Histological bases of lodging resistance were determined in these two forage crops. *Vicia sativa* had less developed mechanical tissues and significantly larger central cavity, compared to *V. pannonica*. Its mechanical strength relied on larger number of vascular bundles. *Vicia pannonica* was characterized by better-developed parenchyma and collenchyma, as well as smaller central cavity. The obtained results will be further correlated with lodging index and their application in improvement of lodging resistance discussed.

Seed priming mediated germination improvement physiological performance of radish (*Raphanus sativus* L.) seedlings

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One of the pre-germinative treatment which achieves germination dynamics and plant performance by modulating metabolic activity in seed before radicle growth is seed priming. This method can potentially improve development characteristics of a many cultivated plants. In this paper we investigated the effects of seed priming on certain physiological parameters of radish seedlings (*Raphanus sativus* L.), including protein and pigments content, phenol and flavonoids concentration and antioxidant activity. Radish seeds were affected by different priming treatments – hormoprining, haloprining, redox priming and hydropriming. The obtained results showed that hormoprining had a dominant effect on chlorophyll and carotenoids content, protein content and concentration of flavonoids. Haloprining with $MgSO_4$ as agents, had the most significant effect on concentration of phenol compounds, while haloprining with KNO_3 , was the most favorable for antioxidant activity. In addition, hormoprining with ascorbic acid as agents, had a significant effect on antioxidant activity, too. This study confirmed that the application of appropriate priming treatments can considerably improve the physiological characteristics in radish, which emphasizes the potential implication of priming technology in plant production. Due to the increased content of phenols and flavonoids, as well as antioxidant activity, an improvement in radish tolerance to environmental stressors can be expected.

Acknowledgements. This investigation was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No: 451-03-68/2022-14/200122).

***Populus x euramericana* tension wood as a model for selection of microscopic methods for rapid screening of cell wall structure in the analysis of plant stem properties**

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The plant cell wall (CW) is a cell compartment lying outside the plasma membrane forming a continuum throughout the plant body. The composition of CWs varies between plant species and cell types, while changes in CW constituents occur as a result of growth and developmental processes, or as a response to various environmental stimuli. In the herein study, we present a selection of microscopic methods for rapid, relatively simple, and low-cost visualization of CW structure/composition in tissues of stems in trees, shrubs, or herbs. Selected microscopic methods imply the use of unfixed, intact, both fresh and dried, plant tissues for the analysis, as well as free-hand or microtome sectioning. UV microscopy, phloroglucinol-HCl and toluidine blue O staining, SEM microscopy, and RAMAN microspectroscopy, separately or in combination, can provide valuable information in plant ecology, plant physiology studies, or for applications in agronomy and forest products industry. As a model, stem samples of juvenile *Populus x euramericana* trees exposed to severe long term static bending were selected: tension wood fibers (gelatinous fibers, specialized sclerenchyma cells) could be considered as representatives of CWs with the most complex structure, while the genus *Populus* is considered as a model woody Angiosperm.

Acknowledgements. This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (contract no. 451-03-68/2022-14/200053; 451-03-68/2022-14/ 200178; 451-03-68/2022-14/200116).

Characterization of Mung bean (*Vigna radiata* L.) seeds: antioxidant activity, chlorophyll and carotenoid content

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Mung bean (*Vigna radiata* L.) is a leguminous plant with high nutritional value, traditionally known as a functional food. Legume seeds are a rich source of proteins, vitamins, minerals, and essential amino acids but also contain bioactive components and polyphenols which possess a high antioxidant capacity. Pigments content (chlorophyll *a* and *b*, carotenoids) was determined as good parameter for estimation of seed quality and an indicator of tolerance to different types of stress. The antioxidant activity of the seeds was determined using DPPH (2, 2-diphenyl-1-picrylhydrazyl) assay. The concentration of chlorophyll *a* and *b* and carotenoids were determined by a spectrophotometric method. Obtained results indicate a higher content of chlorophyll *a* than chlorophyll *b*, 0.352 µg/ml and 0.220 µg/ml respectively, while total carotenoids content was 0.108 µg/ml and DPPH radical scavenging activity was 54.52% ± 1.77. The advancement in this research lies in collecting information about bioactive compounds, such as chlorophylls and carotenoids, that are useful in improving the functional and antioxidant properties of quality seeds used in daily diet.

Acknowledgements. This work was funded by grant no. 451-03-68/2022-14/200053 provided from the Ministry of Education, Science and Technological Development of the Republic of Serbia.

Novel approach to control and suppress invasive weeds in the urban area of Novi Sad

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Ragweed and other allergenic plants occurring on public lawns in Novi Sad have been managed through an integrated system of monitoring and control for the past 15 years. New techniques in the suppression of invasive weeds include the sowing the combination of competitor species such as: *Festuca rubra*, *F. arundinacea*, *F. pratensis*, *Lolium perenne*, *Poa pratensis*, *Phleum pratense*, *Arrhenatherum elatius*, *Trifolium arvense*, *T. subterraneum* i *Lotus corniculatus*. While forming urban lawns, untreated pedological substrate from surrounding areas is a leading source of invasive weeds. Monitoring of such soil since the year 2014 resulted in over 100 different weed species detected, while their number was 41 in lawns containing selected competitor species. Results show that a specific sowing mixture decreases the occurrence and the number of invasive weed species over time, mainly due to the developed root system and suitable phenology. Additionally, such lawns improve the physical and chemical quality of the soil, increasing its socioeconomic value and function.

**14th Symposium on the Flora of
Southeastern Serbia
and Neighboring Regions
Kladovo 26th-29th June, 2022**

**Zoology (Animal and Plant
Interactions)**

ORAL PRESENTATIONS

Plant material in chub (*Squalius cephalus* L., Cyprinidae) diet

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The ichthyofauna of the Zapadna Morava River (308 km in length) includes 28 species belonging to 9 families, predominated by the family Cyprinidae. Over the last decades, the fish fauna has dramatically changed due to deteriorated water quality, river bed regulation, allochthonous fish propagation and other factors. The chub (*Squalius cephalus* L.) is a cyprinid fish widely distributed in European freshwaters. This species is the only predatory fish species abundantly present in most of the Zapadna Morava River profiles. A total of 101 chub individuals (aged 0+ to 9+) were sampled for feeding analysis during the period 2000–2018. The analysis of the gut content throughout the year showed that macrozoobenthos (Trichoptera, Odonata, Ephemeroptera and Diptera larvae) was the most important trophic component (43.3% of the trophic spectrum), followed by plants (20.7%), detritus (13.5%), terrestrial insects (12.6%) and fish (4%). Juvenile nutrition was plankto-phyto-zoophagous in character. In individuals aged 0+, over 80% of the gut content was composed of diatoms (Bacillariophyta). In addition to a high percentage of Bacillariophyta, the gut content of juveniles aged 1+ was found to contain filamentous Chlorophyta and macrophytes. Older juveniles (aged 2+ and 3+) and adults consumed macrozoobenthos, terrestrial insects and other animal components.

Acknowledgements. This research was part of Project 451-03-68/2022-14 of the Ministry of Education, Science and Technological Development of Serbia.

Preliminary investigation of tadpoles diet of species *Rana temporaria*, *Rana dalmatina*, *Bufo bufo* and *Bufo viridis* from different localities in Serbia and determination of presence of microplastics

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It is believed that most anuran larvae, tadpoles, are omnivorous. However, this claim has not yet been fully accepted because the trophic status of many tadpoles has not been precisely determined. In this research, 110 tadpoles, of four anuran species, from 13 localities in Serbia were analyzed. The intestinal contents were analyzed to assess nutrition, while the presence of microplastics was analyzed using the method described by Hu et al. (2018). After the analysis, it was determined that the largest percentage of tadpoles diet consists of silicate algae from the genera *Achnantidium*, *Navicula*, *Tribonema* and *Gomphonema*, as well as detritus. In some species, representatives of Euglenophyta from the genus *Phacus* have also been observed. Except this, the remains of invertebrates that could not be determined were also present in the material. Microplastic analysis proved the presence of particles in all investigated samples. The data obtained on the composition of the tadpoles diet represent preliminary results and can be the basis for further research of diet and determining the type of tadpoles diet. The presence of microplastics in tadpole samples from different localities in Serbia represents preliminary results due to which it is necessary to continue extensive research at several levels.

Acknowledgements. This work was funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia. 451-03-68/2022-14/ 200122.

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of Southeastern Serbia
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**CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд**

581.9(4-924.64)(048)

581.5(4-924.64)(048)

615.322:582(4-924.64)(048)

SYMPOSIUM on the Flora of Southeastern Serbia and Neighbouring Regions (14 ; 2022 ; Kladovo)

[Book of] Abstracts / 14th Symposium on the Flora of Southeastern Serbia and Neighboring Regions, Kladovo, 26th to 29th June, 2022; [organizers] Department of Biology and Ecology, Faculty of Sciences and Mathematics, University of Niš Institute for Nature Conservation of Serbia ; [editors Vladimir Randelović ... [et al.]].

- Niš : Department of Biology and Ecology, Faculty of Science and Mathematics, University ; Belgrade : Institute for Nature Conservation of Serbia, 2022 (Beograd : Grafik Centar). - 216 str. ; 21 cm

Tiraž 210. - Registar.

ISBN 978-86-6275-140-9 (FSM)

а) Флора -- Балканско полуострво -- Апстракти б) Биљне заједнице -- Балканско полуострво -- Апстракти в) Лековите биљке -- Балканско полуострво -- Апстракти

COBISS.SR-ID 68500489



ISBN xxx-xx-xxxx-xxx-xx