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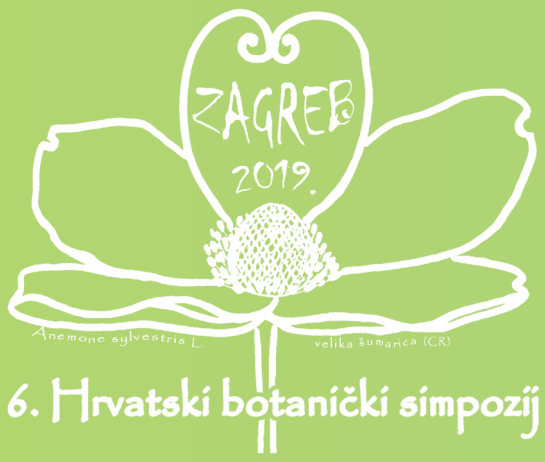

6. HRVATSKI BOTANIČKI SIMPOZIJ 2019.

6th CROATIAN BOTANICAL SYMPOSIUM 2019

zagreb - croatia

6. HBS 2019.

ŠESTI HRVATSKI BOTANIČKI SIMPOZIJ

Sixth Croatian Botanical Symposium

2019

KNJIGA SAŽETAKA

BOOK OF ABSTRACTS

ŠESTI HRVATSKI BOTANIČKI SIMPOZIJ

Sixth Croatian Botanical Symposium

S MEĐUNARODNIM SUDJELOVANJEM

with international participation

ZAGREB, 30. KOLOVOZA – 1. RUJNA 2019.

Zagreb, Croatia, August 30 - September 1, 2019

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ŠESTI HRVATSKI BOTANIČKI SIMPOZIJ 2019.

Sixth Croatian Botanical Symposium 2019

KNJIGA SAŽETAKA

BOOK OF ABSTRACTS

PREDGOVOR

Poštovane kolegice i kolege,

evo nas na **6. Hrvatskom botaničkom simpoziju**. Opet smo u Zagrebu. Ponovno ćemo ne samo puno učiti i naučiti, nego i uživati u zagrebačkim ulicama i parkovima.

Ove je godine na programu **26 predavanja i prikaz 39 postera**. **Ukupan broj autora je 204**. Usmena izlaganja članova Algološke sekcije bit će, također, dio programa *7th European Phycological Congress* kojega je organizirala izv. prof. dr. sc. Zrinka Ljubešić i Hrvatsko botaničko društvo (Zagreb, 25.–30. kolovoza 2019.). Sažetci svih izlaganja nalaze se u ovoj Knjizi sažetaka. Mnoga od tih izlaganja bit će, uvjeren sam, objavljena kao cjeloviti radovi u raznim časopisima.

Kao **pozvani predavači** na 6. Hrvatskom botaničkom simpoziju nastupit će prof. dr. sc. **Marko Sabovljević** iz Beograda (Srbija) te dr. sc. **Sanja Kovačić**, dr. sc. **Ivana Rešetnik**, dr. sc. **Jadranka Stojanovski** i dr. sc. **Dunja Šamec** iz Zagreba.

Najveći broj izlaganja odnosi se na taksonomska i floristično-vegetacijska istraživanja. Ovogodišnji simpozij popraćen je s nekoliko zbivanja kojima je cilj ukazati i rješavati probleme te tako osigurati bolje korištenje baze podataka hrvatske flore (***Flora Croatica Database***). Uz to, ponosno najavljujemo prezentaciju djela ***Flora Croatica*** autora prof. dr. sc. **Tonija Nikolića** te nakladnika izdavačke kuće Alfa d.d., Zagreb.

Organiziran je i okrugli stol **Zbirke** kako bi ukazali na probleme upravljanja zbirkama i njihovog financiranja.

Ovim putem pozivamo sve sudionike 6. Hrvatskog botaničkog simpozija da nam se 1. rujna 2019. pridruže na izletu na Mrežnicu.

Eto, drage kolegice i kolege, dobro došli u Zagreb, na naš **6. Hrvatski botanički simpozij**. Uvjeren sam da ćemo i nakon ovogodišnjeg druženja biti bogatiji i spremniji za nove znanstvene izazove.

Hrvatsko botančko društvo
prof. dr. sc. *Nenad Jasprica*, predsjednik

PREFACE

Dear Colleagues,

On behalf of the Croatian Botanical Society, I would like to welcome you to the Sixth Croatian Botanical Symposium. We are in Zagreb again. We will not only learn, but also enjoy and explore the streets and parks of the city of Zagreb.

This year the program includes **26 oral** and **39 poster** presentations. **The total number of authors is 204**. Oral presentations of the Croatian Phycology Section will be given within 7th European Phycological Congress organized by Professor Zrinka Ljubešić and Croatian Botanical Society (Zagreb, August 25–30, 2019). Abstracts of all presentations may be found in this Book of Abstracts. Many of these presentations will be, I'm convinced, published as full articles in various scientific journals.

Our invited plenary speakers include Professor **Marko Sabovljević** from Belgrade (Serbia) and Drs. **Sanja Kovačić**, **Ivana Rešetnik**, **Jadranka Stojanovski** and **Dunja Šamec** from Zagreb.

The largest number of presentations belongs to the group of the taxonomic and plant systematic studies, and floristic and vegetational studies. The Symposium is accompanied by several events aimed at addressing problems of using the **Flora Croatica Database**. Additionally, we proudly announce the presentation of books **Flora Croatica** written by Professor Toni Nikolić, and published by Alfa d.d, Zagreb.

The Round Table **Collections** is also organized to highlight the problems of managing collections and their financing.

Finally, all participants of the Sixth Croatian Botanical Symposium are kindly invited to join us for one-day trip to the Mrežnica River on 1st September 2019.

Dear colleagues, again – warm welcome to Zagreb and I wish you fruitful and constructive meetings and a productive exchange of ideas. I'm convinced that after this gathering we will be even more ready for new scientific challenges.

Croatian Botanical Society
Professor *Nenad Jasprica*, President

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Hrvatsko botaničko društvo

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Croatian Botanical Society

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PROGRAM

PROGRAMME

PETAK, 30. KOLOVOZA 2019. / FRIDAY, AUGUST 30, 2019.

10:45 – 11:00 Opening Ceremony (Oleander Room)

Oleander Room

Moderator / Chair: **I. Rešetnik**

11:00 – 11:30 **Plenary 1**
M. Sabovljević: Next-generation conservation: A bryological approaches

11:30 – 12:00 **Plenary 2**
D. Šamec: The use of metabolomics in plant chemotaxonomy: current challenges and future opportunities

12:00 – 13:00
T. Nikolić: *Flora Croatica Database*, current state and future perspective

13:00 – 14:00 Ručak / Lunch

14:00 – 15:00
T. Nikolić: Books presentation: *Flora Croatica* (Alfa d.d.)

15:00 – 19:00
Poster Session with refreshments
Moderatori / Chairs: **D. Tafra, M. Vukojević**

All posters should be mounted from 10:00 till 14:00. Posters will be removed at 19:00.

Paris Room
Oral presentations of the Croatian Phycology Section will be given within 7th European Phycological Congress.

14:30 – 14:45
I. Soža, A. Ostojić, S. Sviben, N. Jantol, M. Mucko, Z. Ljubešić: Phytoplankton diversity in shallow eutrophic Makirina Cove and Morinje Bay (the eastern Middle Adriatic)

14:45 – 15:00
A. Car, D. Hafner, I. Dupčić Radić, S. Ljubimir, N. Jasprica: Marine benthic diatoms response to the trophic conditions of marine lake (Lokrum island, the southeastern Adriatic Sea coast)

15:00 – 15:15
L. Kanjer, K. Filek, A. Matek, R. Majewska, B. Van De Vijver, M. P. Ashworth, R. Gračan, B. Lazar, S. Bosak: Diatom genus *Poulinea* as epibiont on Adriatic loggerhead sea turtles

Poster flash talk presentations (to a maximum of 2 slides):

15:20 – 15:25
J. Arapov, M. Bužančić, S. Skejić, A. Bakrač, M. Straka, Ž. Ninčević Gladan: Distribution and caclification index of coccolithophore *Emiliania huxleyi* with the respect to seasonal variations

15:25 – 15:30
N. Bek, D. Špoljarić Maronić, T. Žuna Pfeiffer, R. Nikolašević, R.-A. Davidović, M. Šag, A. Galir Balkić, F. Stević, A. Kezerle: Early spring microphyte composition in Lake Jošava (eastern Croatia)

SUBOTA, 31. KOLOVOZA 2019. / SATURDAY, AUGUST 31, 2019

Emerald Room

Moderator / Chair: **A. Alegro**

08:30 – 09:00 **Plenary 3**

I. Rešetnik: Phylogeography of Amphi-Adriatic plant groups

09:00 – 09:15
W. K. Rottensteiner: Preliminary works on a "Flora of the island of Krk" in the Kvarner Bay

09:15 – 09:30
N. Vuković, V. Šegota, A. Alegro, A. Rimac, N. Koletić, V. Hršak: Ongoing discoveries of rare plants in Croatia

09:30 – 09:45
N. Jogan: Misconceptions of invasive alien species. Are we always aware of them?

09:45 – 10:00
B. Frajman, P. Schönswetter: Disentangling relationship in three different *Euphorbia* groups (Euphorbiaceae) from the Balkan Peninsula

10:00 – 10:30 Stanka / Coffe break

Moderatori / Chairs: **S. D. Jelaska, S. Bogdanović**
10:30 – 11:00 **Plenary 4**

J. Stojanovski: Open Science myths and misconceptions

11:00 – 11:15
P. Vizec, V. Šegota, N. Vuković, M. Bučar, M. Justić, A. Vukres, N. Valjak, D. Levačić, L. Flanjak, V. Matijević; D. Dragun: Floristic mapping of the island of Zlarin (northern Dalmatia)

11:15 – 11:30
A. Alegro, V. Šegota, A. Rimac, N. Koletić, N. Vuković, B. Papp: Vegetation of tufa barriers in Plitvička jezera Lakes

11:30 – 11:45
D. Purger, J. Deme, D. Krstonošić, M. Ćuk: Dry pioneer grasslands of sand and shallow skeletal soils (*Koelerio–Corynephoretea canescentis*) along the Drava River

11:45 – 12:00
V. Hršak, V. Šegota, Z. Sedlar, A. Rimac, A. Alegro, D. Marguš: Rising from the ashes – four-year field experiment of plant recolonization after controlled fire (National Park "Krka", Croatia)

12:00 – 12:15
N. Jasprica, M. Milović: The vegetation of the Ston saltern (Southern Adriatic coast, Croatia)

12:15 – 12:30
L. Perković, S. D. Jelaska: Bohemian knotweed *Reynoutria* × *bohemica* Chrtek et Chrtková seems to be more a physical bully than a chemical weapon specialist

12:30 – 12:45
A. Terlević, S. D. Jelaska: Chainsaw and axe still has the highest impact on temperate forest flora in Medvednica Mt., Croatia, over a 20-year period

12:45 – 13:00
S. Vitko, Ž. Vidaković-Cifrek, A. Škiljaica, M. Jagić, N. Bauer, D. Leljak-Levanić: The effect of elevated temperature on oxidative stress in *Arabidopsis thaliana* with modified *BPM* genes expression.

13:00 – 14:00 Ručak / Lunch

Moderatori / Chairs: **M. Milović, M. Pandža**

14:00 – 14:30 **Plenary 5**

S. Kovačić: "Učilište, a ne plandovalište": 130 godina Botaničkog vrta Prirodoslovno-matematičkog fakulteta Sveučilišta u Zagrebu

14:30 – 14:45
I. Belamarić, D. Vladović: Flora and vegetation of Stinice-Pijat area in Split (Dalmatia, Croatia)

14:45 – 15:00
R. Šoštarić, N. Telenta: Archaeobotanical research of the prehistoric site Donja Dolina

15:00 – 15:15
B. Salopek Sondi: *Acta Botanica Croatica,* current state and future perspectives

15:15 – 15:30
N. Kletečki, A. Belančić: Primjena Skype i dokumentarnih filmova u nastavi prirode

15:30 – 15:45
D. Prlić: Izrada, koncept i primjena priručnika za terensku nastavu iz ekologije biljaka i geobotanike

15:45 – 16:00
S. Essert: Kako uključiti psa pomagača u nastavu s botaničkim temama

16:00 – 16:30 Stanka / Coffe break

16:30 – 17:30
Okrugli stol / Round Table: Zbirke / Collections
Moderatori / Chairs: **I. Rešetnik, N. Jogan**

17:30 – 18:30
Closing remarks
Moderatori / Chairs: **A. Alegro, S. Bogdanović, N. Jasprica, N. Jogan, Z. Ljubešić**

NEDJELJA, 1. RUJNA 2019. / SUNDAY, SEPTEMBER 1, 2019.

Jednodnevni izlet / One day trip - CBS barbecue

SAŽETCI

ABSTRACTS

USMENA IZLAGANJA

ORAL PRESENTATIONS

VEGETATION OF TUFA BARRIERS IN PLITVIČKA JEZERA LAKES

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

[1]Division of Botany, Department of Biology, Faculty of Science, University of Zagreb, Marulićev trg 20/II, HR-10000 Zagreb, Croatia (antun.alegro@biol.pmf.hr, vedran.segota@biol.pmf.hr, anja.rimac@biol.pmf.hr, nikola.koletic@biol.pmf.hr, nina.vukovic@biol.pmf.hr)
[2]Hungarian Natural History Museum, Könyves Kálmán krt. 40, 1087 Budapest, Hungary (papp.beata@nhmus.hu)

The Plitvice Lakes represents a system of 16 larger and several smaller cascading lakes interconnected by numerous waterfalls. All these tufa barriers are overgrown with dense vegetation, which was studied using phytosociological methods. In total 44 species of bryophytes and 52 vascular plants were recorded, out of which 26 bryophytes and 40 vascular plants are constantly present in 90 vegetation relevés. The vegetation is mainly characterized by dominance of bryophytes over vascular plants, and constant species composition. Four main bryophyte species are *Palustriella commutata*, *Eucladium verticillatum*, *Hymenostylium recurvirostrum* and *Pellia endiviifolia*. The most abundant and constant species of vascular plants is *Petasites kablikianus*, present in almost all vegetation plots. This species occur only in the Plivice Lakes within Croatia, which make this vegetation unique and peculiar. Nevertheless, three main types of vegetation are differentiated: 1) species poor vegetation of non-shaded waterfalls mostly with high water velocity, 2) vegetation of shaded waterfalls with weaker water flow, and 3) species rich vegetation of moist rocks outside direct or constant influence of running water. All these vegetation types belong to the moss rich vegetation of carbonate springs of montane and subalpine belts of Europe, belonging to the alliance *Cratoneurion commutati*. However, due to the complex system of lakes and waterfalls, very large surfaces covered by this vegetation, species richness and their high abundances, Plitvice Lakes represent one of the most important diversity and distribution centres in Europe regarding the tufa vegetation, and are of the highest conservation value.

Keywords: bryophytes, *Cratoneurion*, karst, plant diversity, Southeastern Europe

FLORA AND VEGETATION OF STINICE-PIJAT AREA IN SPLIT (DALMATIA, CROATIA)

Belamarić, I.[1], Vladović, D.[2]

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[2]Natural History Museum and Zoo, Kolombatovićevo šetalište 2, HR-21000 Split, Croatia (dalibor@prirodoslovni.hr)

In an ongoing fieldwork, the authors aim to assess the current situation of the flora and vegetation in the locality between the Shipyard and the North Port, the last remaining significant green area in the northern part of the Split Peninsula. The upcoming changes in the General Urban Plan of the City of Split will affect this area. We will use our analyses of the habitat conditions and the existing vegetation to suggest the guidelines for preservation of valuable habitat types within the soon-to-be-transformed area.

Keywords: endangered species, floristic survey, habitat preservation, landscape maintenance, phytosociology

MARINE BENTHIC DIATOMS RESPONSE TO THE TROPHIC CONDITIONS OF MARINE LAKE (LOKRUM ISLAND, THE SOUTHEASTERN ADRIATIC SEA COAST)

Car, A.[1], Hafner, D.[2], Dupčić Radić, I.[1], Ljubimir, S.[3], Jasprica, N.[1]

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[2]Bartulovici 4, HR-20357 Blace, Croatia (dubhafner@gmail.com)
[3]Matije Gupca 5, HR-20000 Dubrovnik, Croatia (stijepo@gmail.com)

The colonization of diatoms in the periphytic community and development of diatom assemblages on an immersed artificial substrate (glass) with various physicochemical properties were examined in a shallow marine lake. The experiment was carried out for 25 weeks from April to October 2016 in the oligotrophic round shaped marine lake named Mrtvo more (Croatian: „Dead Sea“) situated on the southern part of the island Lokrum near Dubrovnik (South Adriatic), Croatia. The objectives of this study were to determine the weekly difference in abundance and composition of benthic diatom community on artificial glass slides. To assess the degree of eutrophication trophic index-TRIX was determined. The investigated area was oligotrophic to eutrophic (TRIX: 2.65 – 6.44). Decreased nutrient concentrations were noted during spring. From the end of June (coincidence with the beginning of swimming season in Mrtvo more for 2016) till the middle of July, Mrtvo more had mesotrophic state, while from the end of July till middle of September, the Lake was eutrophic. In the spring and autumn the lake was oligotrophic. The Mrtvo more hosts a diatom flora with high total species richness (286 diatom taxa belonging to 72 genera). An increase in species diversity index from middle of July was noted and the maximum occurred in August 2016. Strong relationships between environmental variables and diatom assemblages were found and shifts in dominance at the species level were visible.

Keywords: Bacillariophyta, benthos, biodiversity, Croatia, environmental parameters

KAKO UKLJUČITI PSA POMAGAČA U NASTAVU S BOTANIČKIM TEMAMA

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Zadnjih desetljeća znanstvenici su brojnim istraživanjima dokazali pozitivan utjecaj pasa na djecu i odrasle osobe prilikom rehabilitacijskih, terapijskih i edukacijskih procesa. Upravo je stoga u svijetu pa i u Hrvatskoj sve prisutnije korištenje pasa u raznim ustanovama poput škola, bolnica, knjižnica, rehabilitacijskih centara, staračkih domova i drugdje. Prisustvo terapijskih i pomagačkih pasa na korisnike djeluje na način da kod njih smanjuje stres, budi pozitivne osjećaje, podiže motivaciju za izvršavanjem zadanih zadataka, potiče empatiju, a stvorena dobra atmosfera poboljšava usvajanje novih vještina i znanja kod korisnika. U Hrvatskoj trenutačno ne postoji zakonski regulirana edukacijska aktivnost uz pomoć životinja, no sve je više ravnatelja škola, vrtića i sličnih ustanova koji dopuštaju ulaz školovanim psima u njihove prostore s ciljem obrade novih nastavnih sadržaja s učenicima ili pak inovativnog i dinamičnog ponavljanja već obrađenih nastavnih jedinica. Sa svojim sam psom pomagačem do sada odradila oko 70 grupnih i individualnih radionica, a otprilike polovica njih bila je edukacijskog karaktera. Premda botaničke teme nisu najčešće teme koje se obrađuju sa psima pomagačima, u svom ću izlaganju pokazati da su i one vrlo dobar poligon za upotrebu pasa. Na primjeru radionice održane za 15 učenika četvrtog razreda OŠ Suvag s temom „Životni uvjeti biljaka“ objasnit ću kako se može školovanog psa primjerenog temperamenta uključiti u obrađivanje botaničke teme, koji su najveći izazovi na takvim radionicama te zašto učenici profitiraju od takvog vida nastave. Radionicu su anonimno ocijenili učenici i učiteljice, a uvid u rezultate ankete jasno ukazuje na pozitivne strane korištenja psa u nastavi.

Ključne riječi: terapijski psi, edukacija, školska djeca, motivacija, učenje

DISENTANGLING RELATIONSHIPS IN THREE DIFFERENT *EUPHORBIA* GROUPS (EUPHORBIACEAE) FROM THE BALKAN PENINSULA

Frajman, B., Schönswetter, P.

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Euphorbia is one of the largest genera of flowering plants including more than 2150 species. Most species in Europe belong to *Euphorbia* subgen. *Esula*, which is sister to three other subgenera. It comprises roughly 480 species and represents the most significant radiation of the genus in temperate areas of the Old World. One of the centres of diversity of this subgenus in Europe is the Balkan Peninsula, for which around 70 species have been reported, but the evolutionary origin of several of them remains poorly understood and their taxonomic status unresolved. We will present the outcomes of past and ongoing studies on evolution and diversification of several *Euphorbia* species from the Balkan Peninsula, based on DNA sequencing, AFLP fingerprinting, relative genome size measurements, chromosome number estimations and morphological analyses. More specifically, the diversification and evolution of several species groups will be presented. In *E. myrsinites* the major genetic breaks follow mountain ridges in the southern Balkan Peninsula, whereas the Adriatic Sea represent a secondary break. In *E. glabriflora* and *E. spinosa* genetic and morphological diversifications do not correspond to current taxonomy and both taxa should be treated as subspecies. In the *E. verrucosa* alliance the southern Balkan populations are genetically and morphologically divergent and should be treated as *E. montenegrina*.

Keywords: endemic species, molecular phylogenies, morphometry, taxonomy.

RISING FROM THE ASHES – FOUR-YEAR FIELD EXPERIMENT OF PLANT RECOLONIZATION AFTER CONTROLLED FIRE (NATIONAL PARK "KRKA", CROATIA)

Hršak, H.[1], Šegota, V.[2], Sedlar, Z[3], Rimac, A.[2], Alegro, A.[2], Marguš, D.[4]

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[2]Division of Botany, Department of Biology, Faculty of Science, University of Zagreb, Marulićev trg 20/II, HR-10000 Zagreb, Croatia
[3]Croatian Natural History Museum, Demetrova 1, HR-10000 Zagreb, Croatia
[4]Public Institution National Park Krka, Trg Ivana Pavla II. 5, HR-22000 Šibenik, Croatia

Large areas of National park "Krka" used to be covered with dry rocky grasslands, used for centuries as pastures and maintained by permanent coppicing and occasional burning. The abandonment of this traditional land use in the second half of the 20th century caused major changes through encroachment of pastures by shrubs and trees. The aim of this study was to understand the dynamics of plant recolonization on grasslands and provide a sustainable model for habitat maintenance by monitoring the effects of controlled fire. Two closed transects of eight and nine 10 × 10 m subplots were regularly monitored three times a year, starting from 2015, before first burning, using Braun-Blanquet extended scale. The results have shown that in the first year after the fire, the vegetation structure is unstable exhibiting "non interactive species equilibrium", when annual ruderal species prevail in flora composition. However, during second and third year "interactive species equilibrium" was established, when typical grassland species start to dominate and the number of species drastically increased in comparison to the pre-fire condition. Simultaneously, deciduous shrubs and trees started to recover from the underground plant parts. In contrast, *Juniperus oxycedrus* and *Pinus halepensis* do not show such renewal, but establish exclusively from new seedlings. Interestingly, there is also high variability in recolonization and flora structure with respect to previous plant cover, e.g. the slowest recolonization rate is evident at the spots of burnt juniper shrubs, where grass species show remarkably poor ability to enter this microhabitat.

Keywords: burning, habitat maintenance, pastures, rocky grasslands, sustainable model

THE VEGETATION OF THE STON SALTERN (SOUTHERN ADRIATIC COAST, CROATIA)

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The saltern in the town of Ston is the oldest in Europe, dating back to the 14th century. The saltern did not change its appearance and mode of production since the foundation. The territory of the saltern (the production area of ca. 43 ha) is structurally composed of areas having various configurations in relation to the different production phases of salt: the storage basins and the first evaporation ponds present irregular morphologies and reveal their membership in the biotope from which they originate, while the second and third evaporation ponds, the salting basins and the canal system correspond to man-made structures having a very regular morphology. Several phytosociological papers have already dealt with the vegetation of the salterns in the Adriatic Basin, however, the saltern in Ston remains site that has not yet been investigated. In 2018 and 2019, soil and water properties, water level, plant distribution and succession at salt pans were studied. Altogether, 52 phytosociological relevés were carried out following the Braun-Blanquet method (Whestoff and van der Maarel, 1978). The water salinity was affected by seawater input, rainfall and evaporation. From October to April, seawater was introduced for salt production. The pH of salt pan soils was mostly above 8. Soil salinity was particularly high (more than 400) at crystallizing ponds. In rainy season, the brine was somewhat diluted. The main ecological factors which determine the various distributions of the vegetational types are the level and salinity of the water. There are only 21 halophytic taxa at the salt pans under operation (9) where soil and water salinity are extremely high. Two type of vegetation were determined: halophytic and halotolerant. The associations of the *Phragmito-Magnocaricetea* Klika in Klika et Novák 1941, *Ruppietea maritimae* J. Tx. ex Den Hartog et Segal 1964, *Therosalicornietea* Tx. in Tx. et Oberd. 1958, *Juncetea maritimi* Br.-Bl. in Br.-Bl. et al. 1952, *Salicornietea fruticosae* Br.-Bl. et Tx. ex A. Bolòs y Vayreda et O. de Bolòs in A. Bolòs y Vayreda 1950 and *Cystoseiretea* Giaccone 1965 classes were identified. The result confirmed "azonal vegetation" character of the halophilic populations, i.e. their widespread geographic distribution, but strictly linked to very particular edaphic conditions which thus assume the role of ecologic factors, absolutely prevalent and determinant. Major efforts should be addressed to further research of the biodiversity of the area and for a design of the most efficient conservation strategy.

Keywords: ecology, gradient, halophilous vegetation, numerical analysis, phytosociology

MISCONCEPTIONS OF INVASIVE ALIEN SPECIES. ARE WE ALWAYS AWARE OF THEM?

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When trying to motivate different target groups for actions against IAS or raising public awareness about the issue, communication is hindered by some misconceptions. We have to be aware, to recognize and know how to deal with them. A list of such misconceptions (MC) has been scored (1=low to 5=high) regarding MC's overall presence in public (P), importance (I) and discutability (D). Specific subgroups (SG) of public prone to some of misconceptions were recognized and a short explanation or correction (E/C) of concept provided. Here are three out of about 30 MCs listed:

■We have to study IAS more thoroughly to understand the issue better and develop more efficient tools for control and eradication. P:5 I:4 D:2 SG: researchers, policy makers E/C: bearing in mind the speed of exponential spread of new IAS, we have no time to study their potentials in detail; at the early phase of naturalization an expert opinion should suffice for rapid response

■We know how to tackle weeds for centuries, we can use the same approach also with IAS. P:3 I:4 D:2 SG: farmers, gardeners E/C: no, weeds of agricultural landscape can be controlled by several tools (tillage, crop rotation, pesticides, changing soli conditions, seed cleaning) that are not applicable in natural ecosystems.

■ If we find some use of particular IAS, it will motivate people to eradicate the species. P:4 I:4 D:2 SG: »progressives« E/C: a dangerous idea, because if the benefit from one IAS is big enough, the greedy humans would only be motivated for further spreading of that IAS.

DIATOM GENUS *POULINEA* AS EPIBIONT ON ADRIATIC LOGGERHEAD SEA TURTLES

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Poulinea Majewska et al. is a marine diatom genus originally described from carapaces of olive ridley sea turtles (*Lepidochelys olivacea*) but has since been reported on other sea turtle species as well. Although phylogenetically distant from freshwater genus *Gomphonema*, *Poulinea* and genera such as *Tripterion* Holmes et al., *Chelonicola* Majewska et al., and *Medlinella* Frankovich et al. are often referred to as marine epizoic "gomphonemoids" due to the transapical heteropolarity of their valves. It has recently been noticed, that members of the above-mentioned taxa are characterized by remarkable morphological plasticity, which seems to be particularly high in *Poulinea*. The aim of the current study is to characterize the Adriatic *Poulinea* populations associated with local loggerhead sea turtles (*Caretta caretta*) using both morphological and molecular analyses. Diatom samples for morphological observations were obtained from the skin of several frozen loggerhead carcasses collected between 1995 and 2002. Abundant *Poulinea* populations were found on seven (out of 14) animals, each time showing a pronounced morphological variability. Moreover, several monocultures of *Poulinea* spp. were obtained from living sea turtles. Samples were analysed under light and scanning electron microscopy. In addition, three molecular markers (*rbc*L, *psb*C, and SSU) were sequenced from our cultures. This research offers new insights into the phylogeny and ecology of *Poulinea* and related taxa and sheds more light on the crypto and pseudo-crypto diversity in these small and poorly-known epibionts.

Keywords: diatoms, epizoic, marine "gomphonemoids", morphology, phylogeny

PRIMJENA SKYPE-A I DOKUMENTARNIH FILMOVA U NASTAVI PRIRODE

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U ovom radu prezentirana je uporaba dokumentarnih filmova i Skype-a u nastavi prirode kroz suradnju OŠ Ivane Brlić Mažuranić Ogulin i OŠ Bogumila Tonija Samobor. Cilj projekta bio je povezati dvije škole u obradi izbornih nastavnih sadržaja. Projekt je pokrenut u suradnji s udrugom *Ekološki socijalni forum* iz Rijeke koja je osnovnim i srednjim školama u Hrvatskoj 2018. g. za primjenu u nastavi ponudila kratke dokumentarne filmove "zelene" tematike. Učenici obje škole u okviru izbornih sadržaja prirode u 6. razredu obradili su temu *Invazivne vrste u šumskim staništima našeg kraja* uz uporabu filma *Šume za ljude*. Obrada je predstavljala pripremu za debatu. Odabrana grupa učenika je suprotstavljala svoja mišljenja debatom putem Skype-a, kroz pet unaprijed dogovorenih pitanja vezanih uz invazivne vrste. Ekipa iz Samobora predstavljala je afirmacijsku, a ekipa iz Ogulina negacijsku ekipu. Prije debate njihovo je znanje, vezano uz temu invazivnih vrsta, provjereno *online* kvizom *Testmoz.* Anketom je ispitano zadovoljstvo učenika projektom. Projektom je pokazana važnost uporabe suvremenih tehnologija u nastavi kroz tri odrednice učenici-ekologija-edukacija.

Ključne riječi: edukacija, ekologija, učenici

"UČILIŠTE, A NE PLANDOVALIŠTE": 130 GODINA BOTANIČKOG VRTA PRIRODOSLOVNO-MATEMATIČKOG FAKULTETA SVEUČILIŠTA U ZAGREBU

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Utemeljen 1889., Botanički vrt Prirodoslovno-matematičkog fakulteta Sveučilišta u Zagrebu slavi 130. rođendan te stotu obljetnicu smrti svog osnivača, profesora botanike i rektora zagrebačkog Sveučilišta, Antuna Heinza (1861. – 1919.). Nastao na površini od jedva četiri hektra u vrijeme kad Zagreb nije imao niti 40.000 stanovnika, Botanički je vrt ostao nepromijenjen i danas se nalazi u srcu milijunske metropole, s više od 150.000 posjetitelja tijekom sezone. Osmišljen kao spoj dva velika vrtna stila, Botanički vrt većim se dijelom sastoji od perivoja (arboretuma) podignutog u tzv. engleskom stilu, slijedom kojega su drvenaste biljke sađene prema tadašnjem Englerovom taksonomskom sustavu, zadržanom do danas. Manji je dio Vrta osmišljen u tzv. francuskom stilu, sa središnjim parterom iznad kojega je podignut izložbeni staklenik, javnosti nedostupan još od Prvog svjetskog rata. Prvi popis biljnog fonda Botaničkog vrta objavljen je već 1895. Autor, profesor Heinz, u njemu donosi impresivan broj raznovrsnih biljnih vrsta smještenih u stakleniku i na otvorenom. Već 1927. Botanički vrt dobiva i prvu zbirku samoniklih biljnih vrsta: današnju kršku biljno-geografsku vegetacijsku skupinu, za kojom slijedi još nekoliko manjih „kamenjara" namijenjenih uzgoju domaće flore. Upravo te zbirke danas su temelj stručnih i znanstvenih istraživanja koja se u Botaničkom vrtu provode i odvijaju, uključujući program uzgoja i ex-situ zaštite strogo zaštićenih vrsta hrvatske flore, jedinstven u zemlji. Od osnutka, Botanički vrt bori se sa sličnim problemima. Osim nemogućnosti širenja i kadrovsko-financijskih poteškoća, ostaju i one edukacijske prirode: kako posjetitelje naučiti da ulaze u muzejsku zbirku na otvorenom, zakonom zaštićenu znanstveno-obrazovnu ustanovu, a ne u gradski park?

Keywords: botaničke zbirke, Botanički vrt, edukacija, povijesni perivoj, zakonska zaštita

BOHEMIAN KNOTWEED *Reynoutria* × *bohemica* Chrtek et Chrtková SEEMS TO BE MORE A PHYSICAL BULLY THAN A CHEMICAL WEAPON SPECIALIST

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Bohemian knotweed displays a number of invasive characteristics. The key of its success could potentially lie in its allelopathic activity, which was confirmed in number of experiments conducted with the knotweed's leaf and roots extracts in Petri dishes, testing its effect on germination and growth of various test plants. Here, we tested impact of the Bohemian knotweed on soil with respect to its alteration of some chemical properties (pH, organic matter, humus) and allelopathic potential it might have on germination and growth of two test plants, *Triticum aestivum* L. and *Sinapis alba* L. We have collected triplicate soil samples from centre of the three knotweed stands, its edge and control samples in near proximity (overall 27 samples). After three weeks of germination (270 seeds per test species) and growth in the climate chamber (12:12 hours 2.6 klux light vs. dark, 24 ˚C), all seedlings were weighted, scanned for measuring of their length, dried (24 hours at 80 ˚C) and weighted again. Based on ANOVA and Tukey's post-hoc test we determined that the presence of *R.* × *bohemica* did not significantly affect chemical characteristics of the soil or the growth and sprouting of *Triticum* and *Sinapis* based on their length, fresh, dry and dry/fresh ratio weight. Competition through early growth in the season and success in obtaining resources (light, water and nutrients) seems to be the main mechanism of invasive success of this taxa. However, this should be further tested on plant species that are actually outcompeted and supressed in nature.

Keywords: allelopathy, Croatia, ImageJ, invasive species, Zagreb

IZRADA, KONCEPT I PRIMJENA PRIRUČNIKA ZA TERENSKU NASTAVU IZ EKOLOGIJE BILJA I GEOBOTANIKE

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Pristupačan, sadržajno temeljit i studentu razumljiv nastavni materijal preduvjet je kvalitetne provedbe nastavnih aktivnosti. Priručnik za terensku nastavu iz ekologije bilja i geobotanike proizašao je iz potrebe za praktičnim i kvalitetnim nastavnim materijalom koji će sistematskim pristupom studentu predočiti odabrane lokalitete s opisom ekoloških obilježja, karakterističnih biljnih zajednica i pripadajućeg flornog sastava. Program terenske nastave obuhvaća pregled horizontalne i vertikalne raščlanjenosti vegetacije, sukladno fitogeografskoj i biogeografskoj podjeli Hrvatske. Iz Mediteranske regije odabrane su terenske postaje: otok Košljun (eumediteran), otok Krk (submediteran), Oštrovica (epimediteran). Za Eurosibirsko-sjevernoameričku regiju odabrane su postaje: Gornje Jelenje (paramediteran), Skrad (brdski pojas), Golubinjak (gorski pojas) te Risnjak, Snježnik ili Bjelolasica (pretplaninski pojas). Svaka je terenska postaja u priručniku obrađena kao zasebno poglavlje. Uvodni dio sastoji se od karte s položajem terenskih postaja i pregledne tablice s osnovnim podacima (npr. dominantni ekološki faktori, krajobrazni elementi, glavni tipovi vegetacije, posebne zanimljivosti, itd.). Potom slijedi iscrpni opis svih ekoloških i vegetacijskih obilježja koje će student vidjeti pri obilasku pojedine postaje. Uz tekst se nalaze shematski prikazi te izdvojeni sadržajni okviri koji dopunski pojašnjavaju određene pojave. Kompletan priručnik obilno je ilustriran izvornom fotodokumentacijom radi boljeg razumijevanja sadržaja te njegove cjelokupne preglednosti i dinamike. Na kraju svakog poglavlja nalazi se kratki pregled opaženih biljnih zajednica. Trenutna verzija priručnika osmišljena je kao vodič kroz program terenske nastave kojeg student koristi za prepoznavanje pojedinih stanišnih tipova (vegetacije), svojstvenih vrsta u fitocenozama, ugroženih i zaštićenih predstavnika flore te za izradu terenskoga dnevnika.

Ključne riječi: nastavni materijal, terenski dnevnik, vodič, fitogeografija, vegetacija

DRY PIONEER GRASSLANDS OF SAND AND SHALLOW SKELETAL SOILS (*Koelerio–Corynephoretea canescentis*) ALONG THE DRAVA RIVER

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Dry grasslands of sand and shallow skeletal soils belonging to the *Koelerio–Corynephoretea canescentis* Klika in Klika et Novák 1941 class are habitats of European Community importance, included in Habitats Directive. Despite their natural value they have not been thoroughly studied in the whole distribution area either in Hungary or in Croatia. This study was carried out in the valley of the Drava River in the period 2014-2019. Phytosociological relevés were recorded on 2 × 2 m plots by using the standard Braun-Blanquet approach. The data were analysed using numerical methods and the relevant database. The main ecological features of these habitats are shallow soils, which often dry out, and they are very pour in nutrients. Depending on ecological conditions and successional stage, as well as floristic composition, two main grassland types could be recognised: 1. open grasslands in the initial stage on skeletal soils, mainly consisting of ephemeral and dwarf therophytes, low growing grasses, succulent chamaephytes (e.g. *Sedum sexangulare*), lichens (e.g. *Cladonia* spp.) and mosses; 2. grasslands formed on sandy substrate with the prevalence of *Festuca rupicola* and other grasses. In both types *Selaginella helvetica* occurred with a cover of up to 35% (often below tussocks of fescue). In the lowland near the Drava River also a semi-dry grassland dominated by *Bromus erectus* occurred. The frequent Bryophyte species were e.g. *Barbula convoluta, Scleropodium purum, Eurhynchium hians, Abietinella abietina*. In these grasslands orchids such as *Anacamptis morio, A. pyramidalis, Orchis militaris, O. coryophora* frequently occurred. The main treats for persistence of these habitats are encroachment of shrubs during vegetation succession and the impact of the overpopulation of wild boar in this area.

Keywords: Drava River, *Koelerio–Corynephoretea canescentis,* dry grassland, phytosociology, *Selaginella helvetica*

PHYLOGEOGRAPHY OF AMPHI-ADRIATIC PLANT GROUPS

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The Mediterranean peninsulas are recognized as major areas of biodiversity in Europe, where the interplay of geological, climatic and evolutionary processes shaped the distribution of species and the dynamics of speciation, dispersal, adaptation and extinction. Some of these factors have triggered common patterns on the phylogeographies of different species sharing similar habitats and areas. The Adriatic Sea presents a natural barrier between Balkan and Apennine peninsulas which are both recognized as important glacial refugia of temperate plant and animal species and a number of them exhibit amphi-Adriatic distributions. Such distribution patterns can be explained by land connections between the two peninsulas during the Messinian salinity crisis (Miocene/Pliocene) or Pleistocene climatic oscillations. However, a long-distance dispersal events, or migrations along the northern Adriatic coast in different periods cannot be excluded. The accumulation of molecular phylogenetic and phylogeographic data provides the baseline to infer shared spatio-temporal patterns and to define robust biogeographic hypotheses. Some examples of different amphi-Adriatic plant groups illustrating the most recent findings will be presented. *Campanula garganica* group includes 12 species whose diversification started in Miocene but some observed genetic variation within the group was also influenced by Pleistocene climatic fluctuations. Genus *Knautia* represents a prime example of Pliocene/Pleistocene rapid diversification and radiation and includes several transadriatic connections among closely related taxa. Genus *Aurinia* has the centre of origin and diversity in south-eastern Europe and three out of seven species exhibit species specific amphi-Adriatic distributions and different genetic patterns.

Keywords: Apennine peninsula, *Aurinia*, Balkan peninsula, *Campanula garganica*, *Knautia*

PRELIMINARY WORKS ON A "FLORA OF THE ISLAND OF KRK" IN THE KVARNER BAY

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The island of Krk is with an area of 405.78 km^2, exactly the same as the island of Cres, the largest Croatian island with a very rich flora including some very special rare and unique taxa. The island is covered by the typical vegetation of the submediterranean zone (mixed *Quercus pubescens* woods and Šibljak), just in the southernmost parts (around Baška and Stara Baška) with transistions to eumediterranian vegetation. Tommasini (1875) enumerates in his paper „Sulla vegetazione dell'Isola di Veglia e degli adiacenti scogli di S. Marco, Plavnik e Pervicchio" 883 species. Today we count the number of phanerogames (only including the islet St. Marko) of about 1400 to 1500 species. As a further part of the „Flora of Istria" project, which started in 1987, the work on a „Flora of the island of Krk" is already in progress and will be finished and published in spring 2021 by the „Verlag des Naturwissenschaftlichen Vereins für Kärnten, Klagenfurt". About 100 collaborators (authors of systematic groups and photographers) will contribute to this flora, which contains determination keys to all phanerogamic taxa of the island, accompanied by drawings and mainly photos, which support the determination of the plants. Additionally the determination keys will lead also to those genera, which are only known as cultivated on this island. Algae, mosses, lichens and fungi will just be presented by descriptions and photos.The intermediary results will be published as papers in the magazine „Joannea Botanik (Graz)".

Keywords: algae, excursion flora, lichens, mosses, phanerogames

NEXT-GENERATION CONSERVATION: A BRYOLOGICAL APPROACHES

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Bryophytes represent the second biggest group of land plants (after flowering plants) by the species number, present in all ecosystems except the seas. They are heterogenous group linking by specific life cycles. Though, they were used trough history by humans for various purposes and play significant roles in nature, bryophyte never reach huge economical importance as vascular plants. This may be one of the reasons they are less represented in conservation initiatives, eventhough they are not forgotten. However, even passive protection in some territories as far as legal protection or red lists make no significant break trough in conservation, of these very sensitive plants reacting to microchanges. These peculiarities make them good bioindicators of environment. Nowadays, with unpredictably changing environment rapidly increase of use and abuse of earth resources, they are threatened more than ever with climate changes. Absence of disemination propagules, or impossibility to shift the climate belt raise the need of active protection of bryophytes i.e. highlighting more than ever *ex situ* conservation tools (one of the CBD goals), prior to final loss of bryophyte species. Bryophyte Biology Group at Belgrade University have an *in vitro* collection of over 260 species from all over the World, 58% of which are regionally or globally threatened. In Europe, ca. 21% of species are (CR+EN+VU) while in EU28 ca. 23%, stressing the need of active protection and urgent actions. The sucessfull stories on reintroduction, population strengthening and propagation will be presented stressing recent achievments in bryophyte conservation biology, problems and needs.

Keywords: *ex situ*, liverworts, mosses, protection

ACTA BOTANICA CROATICA, CURRENT STATE AND FUTURE PERSPECTIVES

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The journal Acta Botanica Croatica is the scientific journal in the field of botanical sciences, of Biological Department of Faculty of Science, University of Zagreb, Croatia. It covers field (terrestrial and aquatic) and experimental research on plants and algae; including plant viruses and bacteria; from the subcellular level to ecosystems. Manuscripts focusing upon the lowland and karstic areas of southern Europe, karstic waters, other types of fresh water, and the Adriatic (Mediterranean) Sea are particularly welcome. The journal originally entitled Acta Botanica Instituti Botanici Regalis Universitatis Zagrebensis was founded in 1925. In 1957 its name was changed to Acta Botanica Croatica. In 1998, it became an entirely English-language journal. Acta Botanica Croatica is published two times yearly. It has Impact factor since 2010. Current IF_{2018} is 0.985, and five-year IF is 1.006. First editor of the Journal was Professor Vale Vouk (1925-1956), then Professor Stjepan Horvatić (1957-1968), Professor Ljudevit Ilijanić (1969-1992), Professor Ljerka Marković (1993-1997), Professor Damir Viličić (1998-2013), and Branka Salopek Sondi, PhD (2014-2019). Current Editor is Professor Nenad Jasprica.

Keywords: publication, botany, Croatia, impact factor, scientific journal

ARCHAEOBOTANICAL RESEARCH OF THE PREHISTORIC SITE DONJA DOLINA

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Plant remains from the archaeological site Donja Dolina near Bosanska Gradiška were analysed. Findings from pile-dwellings settlement dates back to the Early Iron Age (Hallstatt). In total, 707 plant macrofossils were determined, including seeds, fruits and other plant remains, and they were mostly found in the carbonized state. Only fruits of useful wild plants (*Cornus mas* and *Rubus fruticosus*) were non-carbonized. The most abundant were cereals that constituted 91.09% of the finds (*Triticum dicoccon, T. spelta, T. monococcum, T. aestivum, Hordeum vulgare, Setaria italica*). Legumes (*Vicia faba*), admixture crops and useful wild plants were found in small quantities. The cultivated cereals and legumes were probably grown in the immediate vicinity of the settlement. Pile-dwelling inhabitants from Donja Dolina were primarily cattle-breeders and agriculturist, however, gathering, hunting, and fishing were important supplementary activities. The comparison of the findings from pile-dwellings in Donja Dolina and other similar Iron Age sites in Bosnia and Herzegovina shows that cereals were the most common plant remains of all localities, so were the pulses, only in significantly smaller quantity. Gathering wild fruits was also very important for inhabitants of almost all sites.

Keywords: plant macrofossils, cereals, pile dwellings, Iron Age, Bosnia and Herzegovina

PHYTOPLANKTON DIVERSITY IN SHALLOW EUTROPHIC MAKIRINA COVE AND MORINJE BAY (EASTERN COAST OF MIDDLE ADRIATIC SEA)

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Coastal lagoons are shallow, complex habitats defined by fluctuations in salinity and temperature. Due to its complexity, these rare and endangered types of habitat are protected under directives of European Union, as a part of the Natura 2000 ecological network. Makirina bay and Morinje inlet represent shallow coastal lagoons of the eastern coast of the middle Adriatic, whose sediment floor rich in nutrients, is made of fine, peloid mud. In order to determine the ecological status of two coastal ecosystems investigation of basic physico-chemical parameters, chlorophyll-*a* and phytoplankton community was conducted during spring and summer season 2018. Detailed analysis of phytoplankton community was assessed in order to determine bioindicators of the ecosystem ecological status. In total, 110 phytoplankton taxa were recorded. The phytoplankton composition in both lagoons did not show significant difference and was dominated by diatoms (up to 6.8×10^4 cells L^{-1}) and small nano fraction dinoflagellates (up to 5.1×10^4 cells L^{-1}). The dominance of the dinoflagellate *Prorocentrum* species suggests eutrophic state of both ecosystems and possible anthropogenic influence. Recorded dinoflagellate *Alexandrium* implies to the toxicity of the phytoplankton and the need for further toxicological analysis of the ecosystems. Although chlorophyll-*a* is most commonly used as a bioindicator of coastal water quality, the results of this study indicate that the composition of phytoplankton is a very good indicator of trophic and ecological status of coastal ecosystems and indicates the need to include phytoplankton composition as a standard bioindicator when assessing coastal water status.

Keywords: bioindicators, coastal lagoons, toxic species, Natura 2000

THE USE OF METABOLOMICS IN PLANT CHEMOTAXONOMY: CURRENT CHALLENGES AND FUTURE OPPORTUNITIES

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Plants produce large numbers of metabolites of diversified structures and abundance that play important roles in plant growth, development, and response to environments. Generally, these metabolites are classified into primary and specialized metabolites. The former are indispensable for the growth and development of a plant, while the latter are not essential but are crucial for a plant to survive under stress conditions by maintaining a delicate balance with the environment. Primary metabolites are highly conserved in their structures and abundances while specialized metabolites differ widely across plant kingdoms. The ability to synthesize specialized compounds evolved in different plant lineages and it is rooted in their evolution-based specific biological purpose what make metabolomic profiling of specialized metabolites very useful in chemotaxonomy. The main focus of presentation is to provide an overview of basic operational principles of various modern metabolomic platform (GC-MS, HPLC-QToF, MALDI_Imaging and NMR) used in chemotaxonomic studies and to present examples of their applications in the recent study of *Brassicaceae* and *Psilotaceae* plants.

Acknowledgment: Research on *Psilotaceae* was supported by Marie Curie FP7-PEOPLE-2011-COFUND NEWFELPRO program for a project no. 64. Research on *Brassicaceae* is supported by Croatian Science Foundation project no. IP-2014-09-4359.

Keywords: specialized metabolites, plant metabolomic, chemotaxonomy, *Brassicaceae*, *Psilotaceae*

CHAINSAW AND AXE STILL HAS THE HIGHEST IMPACT ON TEMPERATE FOREST FLORA IN MEDVEDNICA MT. (CROATIA) OVER A 20-YEAR PERIOD

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Aim of this study was to determine whether there are floristic changes in temperate forest communities on Medvednica Mt. central transect over a 20-year period (1998-2017). The research was conducted on 20 forest vegetation plots 50 × 50 meters in size. Data on floristic composition of same plots were analyzed based on their flora, life forms, Ellenberg's ecological indicator values, CSR strategies and functional diversity calculated based on several plant life traits. Forest vegetation was still developed on all plots, except for one due to clear-cutting that took place 8-10 years ago. In the 1998 survey a total of 184 taxa were recorded, while 196 taxa were recorded in 2017. Similarity of two taxa records is 65.22%, while at plot level it ranged from maximum 67.86% of similarity to as low as 24.47%. Increase of number of taxa was mostly associated with management activities in certain plots, which has resulted in partly openness of the canopy. Latter was observed in increase of Ellenberg's indicator values for light in such plots. On majority of plots, decrease in share of hemicryptophytes was observed. In general, slight shift towards the C-R part of Grime triangle was observed, indicating that disturbance level has increased in the area. Based on paired t-test, there haven't been statistically significant differences of the functional diversity values. This research shows that forest management, whether it is by clearcutting or by single-tree selection, is still most important factor that will influence floristic changes, primarily by changing the amount of light reaching the understory.

Keywords: climazonal vegetation, disturbance, floristic changes, forest management, light

THE EFFECT OF ELEVATED TEMPERATURE ON OXIDATIVE STRESS IN *Arabidopsis thaliana* WITH MODIFIED *BPM* GENES EXPRESSION

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BPM1 protein from *Arabidopsis thaliana* is a part of a protein family that contains MATH (Meprin and TRAF Homology) and BTB/POZ (Bric-a-Brac, Tramtrack, Broad Complex) domains. Most proteins of the MATH-BTB family participate in the ubiquitin-dependent protein degradation in which, within the cullin3 dependent E3 ligase, selectively target specific proteins for ubiquitination and degradation on proteasomes. It is well known that BPM1, apart from regulation of developmental processes, plays an important role in phenotypic and physiological adaptability and the ability of plants to survive in a changing environment. Preliminary research has shown that BPM1 is accumulated at elevated temperature and some of the proteins involved in oxidative stress are BPM1 protein partners. Therefore, the aim of this study was to investigate the effect of elevated temperature on oxidative stress in Arabidopsis. Seedlings with overexpressed (*OEBPM1*) and suppressed (*amiR-bpm*) *BPM1* gene, along with the wild type were exposed to a temperature of 37 °C for six hours. Plant material was collected immediately after treatment and after 24-hour recovery at the temperature of cultivation (24 °C). Content of hydrogen peroxide (H_2O_2) and level of lipid peroxidation, as well as activity of catalase (CAT), superoxide dismutase (SOD), ascorbate (APX) and guaiacol (GPOX) peroxidases were measured. After treatment at 37 °C, a change in the content of H_2O_2 and the activity of the APX and SOD in the wild type were observed. Compared to the wild type, *OEBPM1* and *amiR-bpm* lines have a different dynamics in the above-mentioned parameters. The obtained results indicate dependence of certain biochemical parameters of oxidative stress upon BPM proteins.

Keywords: *amiR-bpm*, antioxidative enzymes, H_2O_2, *OEBPM1*, thermotolerance

FLORISTIC MAPPING OF THE ISLAND OF ZLARIN (NORTHERN DALMATIA)

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The island of Zlarin lies in the central part of the eastern-Adriatic coast, belonging to the eu-Mediterranean zone of Mediterranean littoral vegetation belt. The first check list of its flora was produced in 1998, with an addition made a year later, and the last study was in 2010, when five localities were floristically surveyed. Our study consisted of a detailed survey of the whole island and a systematic mapping of flora through eight MTB 1/64 fields over six days of fieldwork in May 2018. More than 480 plant taxa were found, the majority already listed by previous researches who altogether stated almost 600 taxa, while some taxa were newly recorded. Noteworthy, altogether 13 orchid taxa were recorded, out of which *Ophrys bertolonii* Moretti and *Orchis tridentata* Scop. were the most widespread. As the island is permanently inhabited by almost 300 inhabitants, numerous gardens and cultivated areas were found, occupied with 64 cultivated taxa, some of which were frequently found in the wild, such as *Pisum sativum* L. and *Vicia faba* L. In addition, eight invasive species were found. Some of the noteworthy recorded taxa are data deficient *Linaria chalepensis* (L.) Mill., critically endangered *Papaver hybridum* L., extremely rare *Vincetoxicum fuscatum* (Hornem.) Rchb. f. and *Frankenia pulverulenta* L., endemic *Centaurea spinosociliata* Seenus ssp. *cristata* (Bertol.) Dostál, *Vincetoxicum hirundinaria* Medik. ssp. *adriaticum* (Beck) Markgr., *Aurinia sinuata* (L.) Griseb. and other.

Keywords: Croatia, floristics, endemic taxa, the Mediterranean, vascular flora

ONGOING DISCOVERIES OF RARE PLANTS IN CROATIA

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According to the Flora Croatica Database, Croatian flora so far includes 5722 plant taxa, which is a rather high number considering the corresponding area. Although the distribution of the majority of taxa is well documented, rare taxa are often poorly known. Native rare taxa are most commonly documented in historical literature, while recent data are absent or very scarce. Alien taxa may be rarely recorded due to the short residence time, or low speed of spread. Within the course of different botanical studies, we have encountered some of the rarely documented plants such as *Frankenia pulverulenta* L., *Vincetoxicum fuscatum* (Hornem.) Rchb. f., *Quercus trojana* Webb, *Lemna minuta* Kunth, *Reynoutria sachalinensis* (F. Schmidt) Nakai, *Sporobolus pungens* (Schreb.) Kunth, *Veronica peregrina* L., *Crocus thomasii* Ten. and *Petasites kablikianus* Tausch ex Bercht., gaining new insight into their occurrence in Croatia. These findings are of great importance for the conservation of rare natives, and early detection and better understanding of spread of rare aliens. Given that loss of biodiversity starts with rare species, specific studies and continuous field searches and visits to historical localities of rare taxa are needed in order to keep the track of the status of Croatian plant diversity.

Keywords: conservation, distribution, new records, new aliens

SAŽETCI

ABSTRACTS

POSTERSKA IZLAGANJA

POSTER PRESENTATIONS

DISTRIBUTION AND CALCIFICATION INDEX OF COCCOLITHOPHORE *Emiliania huxleyi* WITH THE RESPECT TO SEASONAL VARIATIONS

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Vertical distribution and morphology of coccolithophore *Emiliania huxleyi* was investigated in open waters of Central Adriatic Sea throughout one year period, using Scanning Electron Microscopy. *Emiliania huxleyi* is generally the most spread coccolithophore in the world oceans and also in the Adriatic. Abundance of *E. huxleyi* was higher during the winter season reaching up to 2.5×10^4 cells L^{-1}. Regarding the contribution of this species to coccolithophore assemblage, it was dominant in period from November till March at all sampled depths. In warmer months it contributes more at depth of 50m and below. Degree of *E. huxleyi* coccoliths calcification was measured for two opposite seasons: winter and summer (January and July). The results showed higher calcification index in January which was supported with negative Spearman rank correlation with temperature. Also, the abundance and ratio of *E. huxleyi* was negatively correlated with temperature. In this study, beside the dominant morphotype *E. huxleyi* type A, several cells of *E. huxleyi* type O have been recorded. The morphotype O was observed for the first time in the Adriatic Sea.

Keywords: coccolithophores, *Emiliania huxleyi*, morphology, calcification index, Adriatic Sea

EARLY SPRING MICROPHYTE COMPOSITION IN LAKE JOŠAVA (EASTERN CROATIA)

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Microphyte diversity (planktonic, epiphytic and epilithic) was investigated in the shallow Lake Jošava in early spring of 2018 at four different sampling stations (P1, P2, P3, P4). Higher concentrations of ammonium (0.12 mg L^{-1}), nitrites (0.06 mg L^{-1}), organic nitrogen (3.92 mg L^{-1}), total phosphorus (4.02 mg L^{-1}) and chlorophyll (Chl-*a*: 152.73 µg L^{-1}; Chl-*b*: 47.74 µg L^{-1}; Chl-*c*: 123.72 µg L^{-1}) were found at the shallowest part of the lake (P4) while higher concentrations of nitrates (2.54 mg L^{-1}) and total nitrogen (3.99 mg L^{-1}) were measured at the deepest part (P1). The lowest concentration of total phosphorus (0.42 mg L^{-1}) and total nitrogen (2.35 mg L^{-1}) was found at P3. In total, 137 microphytes were recorded in Lake Jošava. At all sampling stations, 60 phytoplankton species were found, with the highest diversity at P2 (44). The research showed high microphyte diversity (109) on stones at P1 (68) and reed at P2 (61). Hierarchical clustering showed a grouping of data according to various types of substrate. The most common microphytes were diatoms such as *Cocconeis placentula*, *Navicula capitatoradiata* and *Cyclostephanos dubius*. Increased concentrations of nutrients, high chlorophyll concentrations and high microphyte diversity indicate strong anthropogenic impact (traffic, livestock breeding, farming), especially in the shallower lake parts.

Keywords: epilithon, epiphyton, eutrophication, phytoplankton

Helianthemum jonium Lacaita et Grosser ex Fiori et Bég. (CISTACEAE), A NEW SPECIES IN THE EASTERN ADRIATIC FLORA

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The species *Helianthemum jonium* Lacaita et Grosser ex Fiori et Bég. (Cistacaeae) was described by Lacaita and Grosser from Taranto (Puglia) in southern Italy, while the name was published by Fiori and Béguinot in 1910. Till now, *H. jonium* has been known from Morocco and Italy where it has very scattered distribution along the Apennine Peninsula. The aim of this study was to investigate the presence and occurrence of *H. jonium* in the amphi-Adriatic area based on recent field research, literature and revision of herbarium specimens. The occurrence of *H. jonium* is reported here for the first time in Croatian and Montenegrin flora. In April and May of 2018, the species was found growing on sandy soils within macchia and garrigue vegetation on the eastern Adriatic islands of Biševo, Vis and Lopud. Therefore, a revision of herbarium specimens that are stored in CNHM, ZA, ZAGR and ZAHO revealed and confirmed the presence of *H. jonium* on the islands of Vis and Hvar and from Ulcinj in Montenegro. According to literature data from 1934 and 1940, *H. jonium* was cited also for sand dunes of Durres in Albania and completely neglected in recent botanical literature or floras. The examination of type materials of *H. jonium* revel the existence of syntypes deposited in different European herbaria, and in accordance to the ICN a lectotype is designated among Lacaita's specimens from FI herbarium. Distribution map of *H. jonium* in the amphi-Adriatic area was also provided and now the species occurrence is extended easternmost.

Keywords: amphi-Adriatic, Croatia, Italy, Montenegro, neglected species

Campanula cremnophila (CAMPANULACEAE), A NEW ISOPHYLLOUS SPECIES FROM CROATIA

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Within the isophyllous group of *Campanula* ser. *Garganicae* Trinajstić, represented by species of prevalent amphi-Adriatic and Ionian distribution, a rare new endemic species named *Campanula cremnophila* is described new to science and illustrated from Pelješac Peninsula and the nearby Elaphite islands of Olipa and Jakljan in southern Croatia. *Campanula cremnophila* is a chasmophyte growing on calcareous rocky crevices near the sea, showing close relationship with *C. garganica* from Mt Gargano in southern Italy. Phylogenetic analyses based on nuclear ITS and chloroplast *trn*L–*trn*F data emphasized that *C. cremnophila* is distinct from other species of *Campanula* ser. *Garganicae*, forming a subclade with *C. garganica* and *C. poscharskyana*. The morphology, SEM microstructure of seeds and pollen grains, taxonomical relationships, ecology, conservation status of *C. cremnophila*, as well as an identification key including all the species of the *Campanula* ser. *Garganicae* are provided.

Keywords: Dalmatia, endemic, phylogeny, series *Garganicae*, taxonomy

ANALYSIS AND DIGITALISATION OF THE HERBARIUM OF COUNT FRANJO VOJKOVIĆ-VOJKFFY KLOKOČKI

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Count Franjo Vojković-Vojkffy Klokočki, Croatian florist, lived in the first half of the 19th century. During his lifetime he collected herbarium specimens which are today kept in Herbarium Croaticum (ZA) at the Division of Botany of the Department of Biology, Faculty of Science, University of Zagreb. These herbarium specimens are one of the oldest specimens in Herbarium Croaticum. The herbarium sheets are in the original protective cases and are in good condition. A number of 183 specimens were systematized according to Linne in Genera Plantarum vol. I and II, while the rest of the material was not systematized. The renowned Croatian naturalist Dragutin Hirc brought Count Vojković's herbarium to the Department of Botany and Phisiology (now Division of Botany) in 1910. Hirc wrote an article about it for the Periodicum Biologorum in 1911, providing the list of species found in the herbarium. During February and March of 2019 Vojković's herbarium was digitalized. The list of the species found was compared to that of Hirc's from 1911. The percentage of invasive and allochthone species was analysed, as well as the percentage of plants belonging to various plant families. In total, 355 specimens belong to 70 different families. Most common are *Asteraceae* (12.4%), *Lamiaceae* (11.6%) and *Fabaceae* (11.6%). Five taxa are today considered invasive in Croatia. Allochthonous flora of the herbarium counts 82 specimens, which raises the question whether they were sampled within Croatia or elsewhere.

Keywords: count Vojković-Vojkffy Klokočki, digitalisation, flora, Herbarium Croaticum, Hirc

CONTRIBUTION TO THE KNOWLEDGE OF THE VASCULAR FLORA OF ZAGREB: FOREST-PARK JELENOVAC

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Forest-park Jelenovac is located on the southern slopes of the Medvednica Mt. The surface area of the park is 54.5 hectares, 48.9 of which is covered with forests dominated by hornbeam and sessile oak (the association *Epimedio-Carpinetum betuli* (Horvat 1938) Borhidi 1963). Numerous pathways are present mostly within the forest habitats, whereas on higher elevations near Vrhovac several grasslands and meadows occur. Since this area has not yet been botanically explored, a survey of vascular plant species was conducted during March and June 2019. Approximately 250 taxa were found within the park, with the largest families being *Compositae* and *Rosaceae*. According to current legal acts, three strictly protected species were found, including two orchids (*Cephalanthera damasonium* (Mill.) and *Neottia nidus-avis* (L.) Rich.). Seven species are included in the IUCN Red List of Threatened Species; three as Least Concern, three as Near Threatened and one as Vulnerable. In total 12 invasive and 33 cultivated taxa were recorded, as a result of rather considerable human influence. The results of this research represent a valuable addition to the urban flora of Zagreb and Croatian flora in general.

Keywords: floristic survey, urban flora, diversity

HERBARIUM GRAMINA HUNGARICA – A TREASURE CHEST OF EUROPEAN BOTANY

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Herbarium "Gramina Hungarica" (1900-1938) prepared by Hungarian botanist Árpád von Degen is a collection of nine tomes; each separately bound as a book. Árpád von Degen was born in 1866 in Pozsony (today Bratislava). As all naturalists of that time, he graduated in medicine, but afterwards devoted himself exclusively to botany. He was, among many functions, head of the Royal Seed Testing Station in Budapest, professor of botany at the University of Budapest, a member of Hungarian Academy of Science and Arts. While working in the Royal Seed Testing Station in Budapest, he created the collection "Gramina Hungarica". This Herbarium comprises grass taxa (Poaceae=Graminae) collected in the area covered by Austro-Hungarian monarchy, including plants from Croatia. This important collection was essential for analysis and improvement of meadows and pastures. Due to species richness, this collection had outdone similar works in other countries. Tomes of this Herbarium are hardback, covered in red canvas, 29 × 44.5 cm in size, with 50 numbers inside each. "Gramina Hungarica" contains 450 numbers altogether, however, herbarium sheets were added subsequently and marked with letter "b" (129b, 137b, 144b, 174b, 186b, 273b and 334b) enlarging the collection to a total of 457 herbarium sheets, including 64 from Croatia. Croatian Natural History Museum possesses four tomes (II, III, V, and VI) inside which there are 42 sheets with taxa from Croatia.

Keywords: Árpád von Degen, Austro-Hungarian monarchy, Croatia, Croatian Natural History Museum, Poaceae.

KVANTITATIVNA ANALIZA FENOLNIH SPOJEVA U VRSTAMA *Impatiens glandulifera* Royle I *Impatiens balfourii* Hook. f.

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Žljezdasti nedirak, *Impatiens glandulifera* Royle, Balsaminaceae, i balfurov nedirak, *Impatiens balfourii* Hook. f., potječu iz područja Himalaja, odakle su uneseni u Europu, gdje danas predstavljaju invazivne strane vrste. Vrste roda *Impatiens* L. koriste se u narodnoj medicini izvornog područja te u zemljama gdje imaju status neofita. Prethodna istraživanja roda *Impatiens* ukazala su na prisutnost više skupina farmakološki zanimljivih sekundarnih metabolita. Cilj ovog istraživanja je proučiti kemijski sastav vrsta *I. glandulifera* i *I. balfourii* prikupljenih u periodu cvatnje na području Čučerja (Grad Zagreb). Spektrofotometrijskim postupcima određeni su ukupni polifenoli, trjeslovine i flavonoidi u etanolnim ekstraktima suhih cvjetova i listova. Sadržaj ukupnih polifenola iznosio je od 4.58 do 15.22 mg ekvivalenta galne kiseline (EGK) po gramu suhog biljnog materijala (SBM), od čega su trjeslovine iznosile od 1.12 do 2.66 mg EGK po gramu SBM, a sadržaj flavonoida je iznosio od 1.39 do 14.90 mg ekvivalenta kvercetina (EK) po gramu SBM. Listovi vrste *I. glandulifera* sadrže najviše fenolnih spojeva (15.22 mg EGK/g SBM) dok je sadržaj flavonoida najviši u cvjetovima vrste *I. balfourii* (14.90 mg EK/g SBM). Rezultati ovog istraživanja ukazuju na moguću korisnost ovih invazivnih stranih vrsta kao izvora fenolnih spojeva s antioksidativnim učinkom.

Ključne riječi: fitokemija, flavonoidi, polifenoli, rod *Impatiens*, trjeslovine

SPATIOTEMPORAL DIVERSIFICATION OF *Cerastium decalvans* subsp. *decalvans*, *C. dinaricum* AND *C. grandiflorum* (CARYOPHYLLACEAE) IN THE DINARIC ALPS

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Although the Dinaric Alps were not covered by a continuous ice sheet during the Pleistocene glaciations, the snowline was about 1000 m lower than today. Fluctuations in the position of the snowline likely triggered altitudinal range shifts of biota and periodic expansions or reductions of their distribution ranges, accompanied by genetic bottlenecks and differentiation among isolated populations. Using ecological niche modelling (ENM), we investigated whether ecologically different but closely related taxa endemic to the Dinaric Alps, *Cerastium decalvans* subsp. *decalvans*, *C. dinaricum* and *C. grandiflorum*, responded differently to the Pleistocene and Holocene climatic changes and modelled future distribution dynamics in face of the climate change. Phylogeographic patterns were explored using amplified fragment length fingerprinting (AFLP) and sequences of the nuclear ribosomal internal transcribed spacer (ITS) and the plastid *trnT–ndhJ* region. Correlation between relative genome size (RGS) and genetic differentiation was also investigated. Our results support significant niche differences among the three taxa. Nonhierarchical K-means clustering revealed an optimal split in all three datasets into two or three groups, indicating genetic differentiation between northwestern and southeastern populations, possibly connected with different northern and southern refugia, as suggested by the ENM. Even though not completely congruent with the AFLP data, NeighborNets of ITS sequences and statistical parsimony networks of the plastid sequences revealed similar pattern of genetic differentiation. Despite ecological differences among the studied taxa, their overall genetic structure is similar, suggesting comparable underlying processes.

Keywords: AFLP, ENM, ITS, phylogeography, trnT–ndhJ

TRADITIONAL KNOWLEDGE ON NATURAL DYES USE: MUSEUM EDUCATIONAL PROGRAMME

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Educational programme titled „Nature – the Laboratory of Dyes" on the traditional knowledge of the dye plants use with special attention on habitat conservation and biodiversity was developed. This educational programme as a part of the Technical Museum Nikola Tesla exhibition „Nature – the Laboratory of Dyes: traditional technological knowledge" is aimed at different groups. The exhibition represents the traditional knowledge of the household use of natural dyes of plant origins and bases itself on research work carried out in the far south of Croatia from Pelješac, Primorje to Konavle during 2015 and 2016. Field data has been collected through open interviews, mainly involving farmers and elderly people who were born or have been living in the region for a long time. The research includes data about plant species: the scientific name, family, vernacular name, life form, status (wild or cultivated), parts used in the production of household dyes, the process of making a dye, and the way the dye is used. Educational programme consists of the interdisciplinary educational workshops on the following themes: traditional ecological knowledge on household dye use in the Dubrovnik region, karst landscape valorisation and conservation status of plants used for dyeing. The main methods of the workshops include short lectures, field work (photography, identification of various plant species, collection of plant material were appropriate etc.), laboratory work – making a dye with the collected material and finally testing the application of the laboratory results on different materials, referring onto the heritage of the area.

Keywords: conservation, dye plants, ethnobotany, folk tradition, South Croatia

SURVEY OF *Ophrys* TAXA AND THEIR DISTRIBUTION ON THE ISLAND OF KORČULA, SOUTH CROATIA

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In this study we present list of *Ophrys* taxa (Orchidaceae) and their distribution on the island of Korčula, South Croatia. Although mainly Mediterranean, the genus is also present throughout Europe and Asia Minor. Floristic investigations have been made in the period from 2012 to 2018, mainly during the vegetation period. Altogether, 17 taxa were recorded on the island. Among them, three taxa were noted for the first time in the area. This high number of *Ophrys* species could be related to local conditions and to the ecological requirements of the inhabiting species and habitat diversity. The nomenclature of taxa was derived from Delforge (2006). Genus *Ophrys* attracts the attention of many experts for its intricate caracteristics and cofused taxonomy, therefore we consider this study to be contribution to the knowledge of chorology of *Ophrys* taxa on the island of Korčula.

Keywords: chorology, identification, Orchidaceae, species richness, taxonomy

MONITORING ŠIROKOLISNE VEPRINE (*Ruscus hypoglossum* L.) U PARK ŠUMI TEPEC - PALAČNIK - STRAŽNIK

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U radu su prezentirani rezultati istraživanja rasprostranjenosti širokolisne veprine (*Ruscus hypoglossum* L.) na 15 lokaliteta u park šumi Tepec-Palačnik-Stražnik smještenoj na širem području grada Samobora. Istraživanje je provođeno tijekom jeseni 2015., proljeća 2016. i proljeća 2019. Određivana je učestalost (U2), gustoća (G2) i pokrovnost (P) na po pet lokaliteta u svakom od tri predjela izabranog područja istraživanja. Korištena je petostupanjska ljestvica za procjenu učestalosti, gustoće i pokrovnosti. Rezultati istraživanja su pokazali kako je širokolisna veprina na istraživanom području rasprostranjena na čak 14 od 15 lokaliteta. Učestalija je na sjevernim ekspozicijama i većim nadmorskim visinama, dok je manje prisutna na kiselim tlima i nižim nadmorskim visinama. Njezina najveća učestalost je na području predjela Palačnik u šumi bukve na sjevernoj ekspoziciji, a najmanja na području predjela Stražnik u šumi hrasta kitnjaka i crnog graba na jugozapadnoj ekspoziciji. Nije nazočna u miješanoj šumi hrasta kitnjaka i običnog graba na predjelu Stražnik. Veća je učestalost uglavnom povezana s većom gustoćom i pokrovnošću. U istraživanom razdoblju mjere zaštite njezinih staništa nisu poduzimane.

Ključne riječi: širokolisna veprina, park šuma, učestalost, gustoća, pokrovnost

NEW BRYOPHYTE RECORDS FOR KOSOVO FROM SHARRI NATIONAL PARK

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Bryoflora of Kosovo is poorly investigated. The aim of this study is to increase this knowledge by investigating Sharri National Park for its moss flora. Several field trips were carried out in 2014, 2015 by the first author and in 2018 by both authors. About 1900 specimens were collected in various locations of the Park (e.g. Brezovicë, Prevallë, Prroi i Duhlës, Ostrovicë, Restelicë, Mushtishtë, Pashallarë, Burimi i Lumbardhit, Kalaja e Prizrenit, Gryka e Lumbardhit, Stanet e Mushtishtit, etc.). Thus far, most of the specimens are identified and represent about 180 moss taxa. Seventy-two taxa are new records for Sharri National Park, which now reaches a total of 254 moss taxa. Furthermore, 19 species are new records for Kosovo, which now reaches a total of 346 moss taxa: *Amphidium lapponicum, Brachythecium geheebii*, *Bryum elegans, Dicranella schreberiana, Didymodon rigidulus, Grimmia dissimulata, G. muehlenbeckii, G. trichophylla, Kiaeria starkei, Paraleucobryum longifolium, Pohlia melanodon, Racomitrium affine, R. lanuginosum, R. macounii* subsp. *alpinum, Rhynchostegium murale, Schistidium dupretii, Seligeria recurvata, Thamnobryum alopecurum* and *Weissia brachycarpa.* The following recorded species *Brachythecium geheebii, Grimmia caespiticia, G. reflexidens*, *Meesia uliginosa* and *Schistidium papillosum* are candidate species for the red list of European bryophytes; and many more have conservation value in the context of the Balkans. All this shows for the enormous biodiversity values of Sharri National Park and the need for its nature conservation.

Keywords: mosses, biodiversity, floristic survey, red list, conservation, the Balkans

EFFECTS OF GRASSLAND MANAGEMENT ELEMENTS ON DIVERSITY AND FUNCTIONAL STATE OF SPECIES RICH MEADOW STEPPES IN THE SOUTHERN GREAT PLAIN REGION, HUNGARY

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There is a quick decline in area of species rich, high nature value (HNV) grasslands in Central-East and South-East Europe strongly by big changes in their management. There is a great need to develop better techniques for the conservational practice to provide conservation of HNV grasslands. We studied differently managed HNV grasslands in the Southern Great Plain Region, in Kiskunság, Hungary. The climate is submediterranian-continental and the potential vegetation is mostly sandy forest-steppe. Valuable, special grassland type in this region is the meadow steppe which is an ecotone between fens or wetlands and sandy steppe meadows. Meadow steppes are so valuable and diverse with several strictly protected taxons, like *Ophrys* spp. These grasslands are permanently utilized by three main conservation management elements: 1) management type: grazing, mowing or combined management, 2) management intensity with different levels: low (<0.5 AU/ha/year), medium (0.5-0.8 AU/ha/year) and high (>0.8 AU/ha/year), and 3) spatiotemporal complexity: low (permanent grazing in a single grazing unit), medium (mowing with aftermath grazing OR mowing with 10% uncut), high (mowing and grazing are combined between years OR varying sequence of four grazing units between years). By our analyses of different effects of these management elements, we experienced that levels of intensity probably the most effectively forming factor on vegetation in these conservational systems. Spatiotemporal complexity of management was second and management type was the third most important element by our experiences. Combined use of management elements is also important to sustain a satisfactory state of these valuable grasslands.

Keywords: high nature value, ecotone, species frequency, plant composition, conservational practice

DIVERSITY OF MACROPHYTES IN AQUATIC HABITATS OF NERETVA RIVER BASIN

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Present study deals with the investigation of species diversity and the distribution of macrophytes for making an assessment of water quality of aquatic habitats in Neretva River Basin (Bosnia and Herzegovina). Macrophytes were studied during the May and June 2018 on 20 localities. One hundred and five (105) species of macrophytes were identified in the diferent habitat, of wich 66 are vascular plants, 29 species are algae and 10 species are mosses. Species characteristic of nutrientrich habitats (*Ceratophyllum submersum*, *Potamogeton perfoliatus*, *Potamogeton lucens* and *Myriophyllum spicatum*) occurred mainly in the lakes and lower parts of the rivers.

Keywords: aquatic habitats, macrophytes, Bosnia and Herzegovina

NEW ACHIEVEMENTS IN CROATIAN LICHEN FLORA INVENTORISATION

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The history of the lichenological exploration in the present-day territory of Republic of Croatia dates back to the beginning of 19th century. The earliest records were given by Pál Kitaibel in 1802., while in the last thirty years great contributions were achieved for better knowledge on lichen flora. Based on data from publications, current database and field observations, a unique database was made for all records from 1802 until 2018. Georeferencing of lichen records and spatial data processing were done in GIS software QGIS 3.4.1., and the scientific names were revised according to valid nomenclature. The spatial and temporal dynamics of the lichenological exploration in Croatia had been analysed. The resulting list of the Croatian lichen flora comprises 1,275 species in total, classified into 309 genera and 92 families of the lichenized, non-lichenized and lichenicolous fungi. The most numerous families are: Verrucariaceae (166 species), Teloschistaceae (114) and Parmeliaceae (98); the most numerous genera are: Caloplaca (78), Cladonia (63) and Verrucaria (60 species). A total of 18,307 records of lichen taxa had been put into database and georeferenced. Distribution analyses according to MTB grid and number of species shows the highest diversity in MTB quadrants Dubrovnik (289 species) and Zagreb (180 species), while for 251 quadrants (45% of total territory of Croatia) there was no lichen records. The number of records was 7,492 in the 1862-1990 period, and 7,831 in the period after 1990. Recent lichenological surveys are being carried out in the protected areas (national parks, nature parks) and some urban areas.

Keywords: biodiversity, check-list, database, distribution

PHOTOSYNTHETIC RESPONSES OF AQUATIC PLANT *Lemna minor* AFTER MULTIPLIED PULSED PESTICIDE EXPOSURES

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The maximum concentrations of pesticides in aquatic ecosystems are frequently present for short periods. Hence, aquatic non-target species are exposed to fluctuating pesticide concentrations. These sequential pulses, which are usually associated with spray drift, precipitation and surface runoff events, can reach concentrations that would affect non-target organisms. Standard ecotoxicity tests employ set durations with continuous exposure conditions. Thus, these approaches not provide a truly estimate of the impacts of a certain toxicant on organisms in the real ecosystem. The overall aim of this study was to assess the effects of isoproturon pulses on the changes in content of photosynthetic pigments, in particular chlorophyll *a*, chlorophyll *b*, total chlorophyll and carotenoids in *Lemna minor*. Isoproturon is a phenylurea systemic herbicide for the control of monocot and dicot weeds, and it is extensively used in conventional agricultural production. Duckweeds were treated with 50, 100, 150 and 200 µg L^{-1} of isoproturon (48 h of pulse treatment followed by 5 day recovery period) during 21 days. Herbicide treatment caused a significant decrease in photosynthetic pigments content, which is in the mode of action of this herbicide. Due to the toxic effects of isoproturon on *L. minor*, there is a potential negative impact of this toxicant on non-target plant communities in aquatic ecosystems. Results gained in the present study should support the effect assessment of multiplied exposures and fluctuating pesticide concentrations. Moreover, such experiments parallel with standard ecotoxicity tests, can contribute to a more accurate environmental risk assessment.

Keywords: common duckweed, herbicide, isoproturon, photosynthetic pigments, sequential pulses

ECOLOGICAL VALORIZATION OF BIODIVERSITY OF WOODEN FRUIT TREES IN THE PROTECTED LANDSCAPE "KONJUH" (BOSNIA AND HERZEGOVINA)

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The area of the protected landscape "Konjuh" of 8,139.77 ha is located in the northeastern Bosnia and Herzegovina, abounds with different flora and fauna. This work is based on reserach the ecological valorization of wooden fruit trees in the protected landscape "Konjuh". The main goal of this work is to determine and highlight the most important fruit tree taxons which contribute preservation of biodiversity ecosystems of protected landscape area of Konjuh. One more goal of this work is to determine diversity and number of observed fruit trees on the researched areas and determine phytocoenological communities in which researched plant taxa are present. Reserach was done from 2015 to 2017, it included field work and laboratory work. Field work included areas such as: Mačkovac, Zlača, Zobik, Bebrava and Tiskovac. At these sites, environmental conditions were analyzed and phytocenological records were performed according. Phytosociological records were done using Braun Blanquet method. Laboratory work included the use of microscope, loupe, determination keys, qualitative and quantitative analysis of taxons which were found. In 2015 and 2016, 20 taxa were identified, and in 2017 21 taxa were noted. Determined wooden fruit trees taxed in phytocenoses *Querco-Carpinetum*, *Fagetum sylvaticae montanum* and *Piceetum abietis*. The most common taxa in this herbal communities are *Prunus avium* L. and *Vaccinium myrtillus* L., with 90 units, and the least common taxa of Sorbus, seven units. The wooden fruit trees have multifunctional significance in the Protected landscape „Konjuh“ for biodiversity of environment ring blooming, when they „decorate“ wood and its edges, provide honey bee, bring fruits which are food for many members of fauna as well as for humans, which should contribute to protection and preservation of rare and endagered taxa. It was all done in order to preserve ecological development.

Key words: ecological valorization, Protected landscape "Konjuh", phytocoenosis, wooden fruit trees

RAZNOLIKOST MAKROFITA RIJEKE DUNAV – OD IZVORA DO UŠĆA

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Nakladnička kuća Academia iz Praga, objavila je koncem svibnja 2018. knjigu naslova: Makrofita Dunavskog bazena. U pisanju 21 poglavlja ove znanstvene knjige sudjelovala su 34 autora iz deset zemalja. Knjiga je postignuće međunarodnog istraživačkog projekta koji je obuhvatio gotovo ukupni toka Dunava, od izvorišnih tokova Breg i Brigach u Njemačkoj sve do delte i ušća u Crno more u Rumunjskoj. Primjenom identične metodologije terenskog rada i obrade podataka, svaki od nacionalnih timova istraživao je obilježja staništa te zastupljenost vodenih makrofita u koritu Dunava, uz riječne obale, te u odabranim pritocima i drugim vodnim tijelima Dunavskog bazena. Zabilježene su ukupno 504 vrste koje pripadaju taksonomskim skupinama: alge (24 vrste), jetrenjarke (10), prave mahovine (83), papratnjače (12), dvosupnice (216) i jednosupnice (159 vrsta). Potvrđene su razlike u sastavu i rasprostranjenosti makrofita između izvorišnog, gornjeg, srednjeg i donjeg toka Dunava. Također su zabilježene neke strane invazivne vrste. Istraživanja u Hrvatskoj provedena su na 137 km desne obale Dunava i u Parku prirode „Kopački rit“. Utvrđena je raznolikost od 37 vrsta makrofita u Dunavu i 158 u Parku prirode „Kopački rit“. Spoznaje o raznolikosti, rasprostranjenosti i ekologiji makrofita, te obilježjima staništa važne su u procjeni ekološkog statusa vodnih tijela u Dunavskom bazenu.

Ključne riječi: flora, površinske kopnene vode, stanište

FLORA I VEGETACIJA OTOKA RIVNJA I SESTRICE MALE

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Otok Rivanj (4,4 km^2; 15 stanovnika) i Sestrica mala (0,03 km^2) nalaze se u zadarskom arhipelagu između Sestrunja i Ugljana. Prve florističke podatke za Rivanj navodi Horvatić istražujući vegetaciju bušika. U tri fitocenološke snimke navodi 24 svojte. Tijekom 2019. obavljena su floristička i vegetacijska istraživanja Rivnja i Sestrice male. Za Rivanj je zabilježeno oko 400, a za Sestricu malu 66 biljnih svojti. Morske cvjetnice naseljavaju muljevito-pjeskovita dna. U uvali Lokvina je asocijacija *Cymodoceetum nodosae* Feldman 1937, a između otoka asocijacija *Posidonietum oceanicae* Funk 1927. U halofitskoj zoni na položenim stijenama fragmentarno je razvijena asocijacija *Plantagini-Limonietum cancellati* Horvatić (1934) 1939, a na muljevitoj podlozi asocijacija *Puccinellio festucaeformis-Sarcocornietum fruticosae* (Br.-Bl. 1928) Géhu 1967. Na otoku Rivnju po naselju ruderalna vegetacija pripada asocijaciji *Hoordeetum leporini* Braun-Blanquet 1936, a korovna asocijaciji *Tribulo terrestri-Amaranthetum graecizans* Hodak 1962 ex Pandža, Franjić et Škvorc 2005. U šumskoj vegetaciji su različiti razvojni stupnjevi od asocijacije *Myrto communis-Pistacietum lentisci* (Molinier 1954) Rivas-Martínez 1975 na Sestrici maloj do asocijacija: *Erico arboreae-Arbutetum unedonis* Allier et Lacoste ex Foggi et Grigioni 1999, *Pistacio lentisci-Juniperetum phoeniceae* Trinajstić 1987, *Pistacio lentisci-Pinetum halepensis* De Marco, Veri et Caneva 1984. Floristička i vegetacijska istraživanja se nastavljaju.

Ključne riječi: fitocenologija, istočni Jadran, *Quercetea ilicis*, otoci

CHLOROPHYLL-*A* FLUORESCENCE OJIP TRANSIENT AS A TOOL TO ASSESS COLD TOLERANCE IN WHEAT SEEDLINGS

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Low temperature affects a broad spectrum of physiological processes, and photosynthesis is one of the essential processes, which is more inclined to cold stress. This study aimed to test the influence of cold stress on the photosynthetic machinery of wheat seedlings (*Triticum aestivum*). In two experiments, cold stress was investigated in the form of a sudden drop in temperature (from ~22°C/18 °C day/night down to -2 °C in the first hour of the night), and in the form of slow gradual decrease (also down to -2°C during the night). Chlorophyll-*a* fluorescence induction was used as *in vivo* assessment of cold tolerance, and measurements were performed on two genotypes of winter wheat (L459-2012 and Osk 114/08), both non-acclimated (~22°C/18 °C) and acclimated to low temperatures (~4°C, day/night). OJIP curves and JIP parameters revealed differences between the type of stress duration, acclimated and non-acclimated plants and between genotypes. Acclimated plants of L459-2012 genotype performed better (PI_{ABS}, PI_{TOT}) under both types of cold stress, whereas as performance indexes of Osk 114/08 genotype were increased only after the slow drop in temperature, while sudden drop caused a significant decrease of photosynthetic efficiency. On a subsequent day after the cold stress, acclimated plants of both genotypes increased their photosynthetic performance up to 21%. Detailed analysis of fluorescence data showed that OJIP transient contains useful information for the evaluation of cold stress tolerance of seedlings, that data is stress type and genotype-specific, and can complement the knowledge needed to address some fundamental issues, like the degree of plasticity.

Keywords: performance index, photosynthesis, slow temperature decrease, sudden temperature drop, tolerance to stress

POPULATION VARIABILITY OF SWEET CHESTNUT (*Castanea sativa* Mill.) IN CROATIA ACCORDING TO THE FRUIT MORPHOLOGY

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Morphological variation of the fruit was studied in a multipurpose tree species, *Castanea sativa* Mill., across the Croatian continental and Mediterranean bio-geographical regions. A total of 12 sweet chestnut populations from environmentally divergent habitats were included in the study. Descriptive and multivariate statistical methods were combined using seven morphological fruit traits to examine the diversity and structure of sweet chestnut populations. The results clearly demonstrated a high phenotypic diversity of sweet chestnut populations in Croatia. In addition, the existence of two morphologically distinct and well-defined groups of sweet chestnut populations was observed. Nevertheless, the results were not entirely consistent with the bio-geographical distribution of the researched species. Rather, they indicated that the morphological variability of sweet chestnut populations in Croatia is the result of both environmental heterogeneity and significant and lengthy human impact.

Keywords: bio-geographical regions, environmental heterogeneity, intra- and inter-population variability, morphometric analysis, phenotypic diversity

SSR GENOTYPING OF ENDEMIC CROATIAN DWARF SPECIES *Iris adriatica* Trinajstić ex Mitić (IRIDACEAE)

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Iris adriatica Trinajstić ex Mitić is a strictly endemic rhizomatous dwarf plant from the *I. pumila* complex first described in 2002. As an endemic species it is confined to a few Croatian localities in the wider area of Dalmatia (recorded 1980) and the island of Cres (recorded 2014) in the Northern Adriatic. *Iris adriatica* is classified as a NT (near threatened) species in the IUCN Croatian Red Book of Vascular plants. Recent metabolic profiling of the species revealed a great pharmacological and chemotaxonomic potential with notable diversity between the ecotypes. Despite potential medical applications, the *Iris* genus has garnered little to no attention from the scientific community as it has mainly been exploited for horticultural purposes. Many of the species, including *I. adriatica*, have only been taxonomically classified using traditional taxonomical methods of observation and comparison. In the present study we aim to describe the EST-SSR microsatellite profile of the collected *I. adriatica* samples utilizing eight *Iris* specific markers. The collected samples cover the known distribution areas and help explore the genetic relationship between the Dalmatia and Cres ecotype localities. Additionally, we aim to expand the available *Iris* SSR profiles by also characterizing *Iris lutescens* and *Iris pumila.* The objective of the study was to provide an insight into the genetic diversity of endemic *Iris adriatica* along the Eastern coast of the Adriatic.

Keywords: ecotypes, EST-SSR, genetic diversity, microsatellites, UPGMA dendrogram

PRIMJENA GLOBE PROTOKOLA PRIDONOSI BOLJEM RAZUMIJEVANJU BOTANIČKIH SADRŽAJA U NASTAVI

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Najveći dio aktivnosti u GLOBE programu U OŠ Ivane Brlić-Mažuranić Virovitica provodi se u nastavi prirode i biologije. GLOBE protokoli pomažu učenicima u redovnoj nastavi od petog do sedmog razreda da razviju potrebna znanja o listu kao važnom biljnom organu. Vezu između lista i ostalih dijelova biljke te povezanost biljke s okolišem učenici spoznaju kroz terenski rad na GLOBE postajama u gradu i okolišu škole. Pri tome prikupljaju podatke o pupanju, ozelenjavanju, žućenju listova, opsegu i visini stabla, temperaturi zraka i tla te količini oborina. Učenici izrađuju praktične radove kao što su kalendar fenološkog promatranja, zbirka listova, herbarij, mikroskopiranje puči i presjeka listova te prikupljanje podataka o temperaturi zraka, vode i tla i prikaz promjena temperature tijekom godine. Škola već dugi niz godina priređuje projekte gdje su učenici analizirali različite načine mjerenja promjera lipa, pratili populacije proljetnica u gradu, pupanje i listanje breze, analizirali krajobraznu raznolikost i pratili promjene vezane uz alergene i invazivne biljke u gradu Virovitici. Uključivanjem u GLOBE program učenici razvijaju trajnija znanja i sposobnosti. Iskustvenim učenjem stječu nove spoznaje o cjelovitosti okoliša, a pritom razvijaju pozitivne stavove i samosvijest temeljenu na svom aktivnom sudjelovanju.

Ključne riječi: botanika, GLOBE program, osnovna škola

HORNWORT FLORA OF CROATIA

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Hornworts are quite inconspicuous ephemeral bryophytes mostly inhabiting transient but regularly recurrent habitats subjected to yearly disturbances, such as arable and stubble fields with loamy and clayey soils. Globally, they are the least diverse group among bryophytes regarding the species number. Similarly, only four genera with eight species are known from Europe, five of which were reported from Southeast Europe. Only *Phaeceros laevis* (L.) Prosk and *Phymatoceros bulbiculosus* (Brot.) Stotler, W. T. Doyle et Crand.-Stotl. are listed in the available literature for Croatia; however, with no new records for over 85 years in the case of *P. laevis*, and 100 years in the case of *P. bulbiculosus.* Our study, carried out in April 2013 and August 2018 in Central Croatia and focusing on the habitats suitable for hornworts, identified three new species for Croatia, including two new genera – *Notothylas* and *Anthoceros.* Record of very rare Natura 2000 species *Notothylas orbicularis* (Schwein.) A. Gray is the first in Southeast Europe and the southernmost in Europe, with previously known localities from only four Central European countries. Furthermore, we recorded *Anthoceros agrestis* Paton and *Phaeoceros carolinianus* (Michx.) Prosk., which are either very rare or, more likely, overlooked and understudied in Southeast Europe. Additionally, available data on hornworts from the literature and herbaria were examined and countrywide overview of the whole group is provided. Finally, these findings increase the richness of Croatian bryophyte flora to 711 taxa - 544 mosses, 162 liverworts and five hornworts.

Keywords: Anthocerotophyta, *Anthoceros agrestis*, *Notothylas orbicularis*, *Phaeoceros carolinianus*, Natura 2000

MORPHOGENESIS OF SELECTED MOSS SPECIES IN *IN VITRO* CONDITIONS: EFFECTS OF NUTRIENTS AND SUCROSE

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Bryophyte development remains somewhat obscure in comparison to vascular plants. They are rather small in size, phylogenetically very diverse and rather morphologically heterogenous. Bryophyte morphogenesis was the aim of very few studies. Their very slow growth and unexpectedly powerful totipotency are huge disadvantage for studying morphogenesis in changing environmental (i.e. wild) conditions. We established *in vitro* culture of four selected moss species, namely *Pohlia nutans* (Hedw.) Lindb., *Pohlia drummondii* (Müll. Hal.) A. L. Andrews, *Tortella tortuosa* (Hedw.) Limpr. and *Syntrichia ruraliformis* (Besch.) Düll. to study development with very few variables. Thus, the temperature (18±2 °C), light regime (16h light/8h dark) and pH (5.8) were constant and nutritional content in medium (i.e. media types) as well as sucrose concentrations (as one of carbon and energy sources) varied. The results obtained clearly showed different developmental pattern in mosses tested. Both *Pohlia* species fully developed gametophores (similar to those present in mature phase in nature) on sucrose free BCD medium. In contrast to bryoid mosses tested, pottioid mosses (*T. tortuosa* and *S. ruraliformis*) best developed on KNOP medium (free of sugar). The sucrose addition in any media type significantly increased the secondary protonemal growth as inferred by parameters. *P. drummondii* multiplicated the best in all media types, while in BCD medium supplemented with sucrose multiplication index was the highest (20× better compared to other tested species). We can prove the positive correlation of sucrose to multiplication in all tested species.

Keywords: axenic, bryophytes, culture, development, sugar

SEED DORMANCY AND GERMINATION OF *Ligularia sibirica* (L.) Cass. POPULATION FROM NATIONAL PARK PLITVICE LAKES, CROATIA

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Ligularia sibirica (L.) Cass. is a boreal Euro-Asian species which colonizes a wide range of habitats from East Asia, along the southern Siberia, Belarus, Ukraine and European parts of Russia. In the southwestern-most parts of its areal it is very rare, found mostly in small, scattered and isolated mountainous populations with decreasing population trends. In Croatia, *Ligularia sibirica* is considered a postglacial relict. This species is spread over only a single, isolated locality within the territory of National park Plitvice Lakes and it is assessed as critically endangered (CR) in Croatian Red Book. In the Botanical garden of the Faculty of Science, University of Zagreb, we conducted a germination study to shed light on the topic of *Ligularia sibirica* seed ecology and consequently advance its conservation effort. The freshly matured seeds were exposed to cold or warm stratification in duration of four to sixteen weeks and their germination was investigated through different regimes of incubation parameters, i.e. illumination (light/dark) and temperature (5, 15/6, 23 °C). *Ligularia sibirica* had higher germination values after cold stratification and presumably *L. sibirica* seeds had non-deep physiological dormancy. The overall germination rate was 45% which indicates that the only Croatian natural population of *L. sibirica* is genetically impoverished from inbreeding, therefore careful management including appropriate *ex situ* and *in situ* conservation programs are necessary for this small population to survive.

Keywords: seed ecology, *ex situ* conservation, endemic species

THE GENUS *Festuca* L. (POACEAE) IN ZAGR HERBARIUM

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The genus *Festuca* L. (Poaceae) is not a well-researched genus in the Croatian flora, probably because of the high morphological similarity and variability within the taxon level which makes determination demanding. The aim of this study was a revision of fescues specimens in ZAGR herbarium. A revision was based on 14 different morphological and anatomical characters that are important for determination: plant height, leaf height, panicle length, number of spikelets, average length of spikelet, number of flowers per spikelet, average length of awn, number of vascular bundles, ribs and sclerenchyma strands, leaf length, leaf thickness and central rib height and width. For microscopic investigation hand made sections of five tiller leaves per plant were taken. ZAGR herbarium has 104 fescues specimens mainly from Croatia, Italy, North Macedonia, Montenegro and Bosnia and Herzegovina. At the beginning of research 55% specimens were identified at generic level and after this revision the number is reduced to 25%. ZAGR holds 15 different species and the most represented ones are *F. hercegovinica* Markgr.-Dann. and *F. valesiaca* Schleich. ex Gaudi both having the same number of specimens. Both taxa were found in Croatia and Bosnia and Herzegovina, while *F. hercegovinica* was also recorded in Northern Macedonia and Montenegro. There are five specimens of Croatian endemic *F. lapidosa* (Degen) Markgr.-Dann. from Istria Peninsula and Dalmatia. The rarest fescue in ZAGR is *F. nitida* Kit. found on Mt Velebit. A revision revealed new data on occurrence of some rarest Croatian fescues e.g. *F. circummediterranea* Patzke and *F. panciciana* (Hack.) K. Richt.

Keywords: anatomy, Balkans, fescue, herbarium revision, taxonomy

FITOCENOLOŠKO ISTRAŽIVANJE PARK-ŠUME MARJAN

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U sklopu izrade Programa gospodarenja za Gospodarsku jedinicu Park šuma Marjan (2019. – 2029.) sakupljeno je 16 fitocenoloških snimki na području sedam gospodarskih odsjeka Gospodarske jedinice Park šuma Marjan. Fitocenološke snimke sakupljene su sukladno Braun-Blanquet metodi. Površine snimki bile su 400 m^2. U većini snimaka u sloju drveća prevladavale su vrste karakteristične za šume alepskoga bora i crnike, dok su u sloju grmlja i u prizemnom sloju prevladavale vrste karakteristične za zajednice crnike i crnoga jasena. Također je zabilježena prisutnost invazivne vrste svinuti šćir (*Amaranthus deflexus* L.) na većini lokaliteta na kojima su napravljene snimke. Zabilježeno je i da se u prizemnom sloju nalazi jako malo pomladka alepskoga bora. Na nekoliko lokacija su zabilježene i druge alohtone ili sađene vrste poput čempresa, agave i opuncije. Ovo istraživanje daje uvid u florni status Parka šume Marjan i može poslužiti kao dobar temelj budućeg upravljanja šumskim staništem.

Keywords: fitocenologija, Park šuma Marjan, Mediteran, alepski bor, invazivne vrste

INVENTORY OF THE HISTORICAL *Dianthus sylvestris* HERBARIUM MATERIAL FROM ZA AND ZAHO

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Dianthus sylvestris group is considered to be one of the most complex groups within the genus *Dianthus* (Caryophyllaceae). It includes several taxa of doubtful taxonomic value, and synonymy confusion is common. In order to initiate a taxonomical review, an inventory of historical *D. sylvestris* herbarium material from ZA and ZAHO collections was conducted. Herbarium specimens of *D. sylvestris* group from these two Croatian herbaria were digitized and the data from the original text on labels were stored within the Flora Croatica Database. A total of 319 herbarium sheets were digitized; the ZA collection holds 182 sheets and ZAHO collection holds 137 sheets. Altogether, four taxa (*D. sylvestris* Wulfen in Jacq., *D. sylvestris* Wulfen in Jacq. ssp. *sylvestris*, *D. sylvestris* Wulfen in Jacq. ssp. *tergestinus* (Rchb.) Hayek and *D. sylvestris* Wulfen in Jacq. ssp. *nodosus* (Tausch) Hayek) were registered within studied collections. The exsiccata originate from eight European countries; however, 61% are from Croatia. The majority of specimens were collected between 1910s and 1940s, originating mostly from Ivo Horvat's fieldwork. The average age of the collected specimens was 98 years. Inventory of herbarium sheets from ZA and ZAHO historical collections provided a significant insight into historical distributional data of *D. sylvestris* taxa related to the area of Balkan Peninsula, which is a prerequisite for accurate taxonomic/geographic sampling for further morphological and molecular analyses. Apart from historical herbarium specimens, *D. sylvestris* collection from ZA herbarium has recently been growing due to extensive sampling of *D. sylvestris* taxa throughout the Balkans.

Keywords: digitization, distribution, Flora Croatica Database, the Balkans

TOWARDS THE EDUCATIONAL BOTANICAL TRAIL OKIĆNICA (ŽUMBERAK-SAMOBORSKO GORJE NATURE PARK)

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Circular Educational Trail "Okićnica" beneath the Old medieval Town of Okić, has been opened in 2017 as a new visiting spot of the Žumberak-Samoborsko gorje Nature Park, presenting mostly historical and ethnological heritage of that region. With an idea to expand the visitors' experience and introduce the story of natural values, the vascular flora along the trail was explored during 2018. The trail is approximately 2.5 km long, surrounded mostly by forest and, to a smaller extent, grassland habitats. In total 287 taxa were recorded. This research showed that flora composition of Okićnica Trail is rich with diverse and very interesting taxa, many of which are strictly protected by law. In order to present the flora along the future botanical trail we suggest emphasising several interesting floristic highlights: (1) the story of endangered plants by presenting sixteen taxa which are included in the IUCN Red List of Threatened Species, (2) the tale about endemic flora, (3) the narrative about the invasive species and their pathways and (4) the outdoor nature based learning about colourful spring flora. Orchid diversity should be presented separately through the story of each of the six species recorded. Ultimately, presentation of the usage of indigenous plants through local folk medicine and traditional cuisine along with the idea of preserving the grasslands in a traditional, extensive way of maintenance, as local biodiversity hotspots, could be easily implemented within already existing promotion of the ethnological heritage of this particular region.

Keywords: indigenous plants**,** IUCN, Okić, strictly protected taxa, vascular flora

INVASION HOTSPOTS FOR NON-NATIVE PLANTS IN THE AREA OF THE NATURE PARK ŽUMBERAK – SAMOBORSKO GORJE

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One of the biggest challenges for the biodiversity of the Nature Park Žumberak – Samoborsko gorje, beside the vegetation succession of habitats, is the invasion of non-native plants. Unlike the non-invasive flora, invasive non-native plant species have not been systematically studied in the entire area of the Park. Therefore, the aim of this study was to determine the presence and invasion hotspots of the non-native plant species within the boundaries of the Park. The research was carried out in August of 2016, 2017 and 2018 using MTB 1/64 grid units. Over 90% of the Park area was explored and a total of 32 invasive non-native plant species were recorded. The most common were *Erigeron annuus* (L.) Pers., *Ambrosia artemisiifolia* L., *Conyza canadensis* (L.) Cronquist, *Robinia pseudoacacia* L., *Galinsoga ciliata* (Raf.) S.F.Blake, *Galinsoga parviflora* Cav., *Solidago gigantea* Aiton and *Solidago canadensis* L. Explored grid units were categorized with respect to the number of determined invasive plants. As a result, an invasion hotspots map was obtained and the comparison was made with the topographic map of Croatia to analyze the correlation between the inhabited areas and the invasion hotspots. These results represent the basis for further monitoring of the population size and impact of invasive plants on the biodiversity of the Nature Park Žumberak – Samoborsko gorje, as well as possible control mechanisms of their spread.

Keywords: invasive species, biodiversity, MTB grid, protected areas

FLORA ZNAČAJNOG KRAJOBRAZA SUTINA (DALMACIJA, HRVATSKA)

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Tijekom 2016. i 2017. sustavno je istraživana flora značajnog krajobraza Sutina, u blizini grada Sinja, što je rezultiralo s 411 novoutvrđenih svojti. Prema dostupnoj literaturi i našim terenskim istraživanjima, ukupno je za istraživano područje zabilježena 581 svojta vaskularne flore. Međutim, 53 literaturna navoda nisu potkrijepljena terenskim uvidima. Smatramo da je to rezultat potencijalno mogućih pogrešnih determinacija u prošlosti. U radu je napravljena analiza flornih elemenata, životnih oblika te ugroženih, strogo zaštićenih i endemičnih svojti.

Ključne riječi: flora, Hrvatska, Sutina

PRELIMINARY MAPPING OF THE INVASIVE ALIEN SPECIES *Erigeron annuus* (L.) Pers. IN THE TOWNS OF ZAGREB COUNTY

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Preliminary mapping of the invasive alien species *Erigeron annuus* (L.) Pers., annual fleabane, in all nine towns of the Zagreb County was conducted during the year 2012. Research was performed on plots of 250 × 250 m^2. In total, among 541 researched plots, the species *E. annuus* was found on 362 plots (66.9%). In Ivanić Grad, the species was established on 44 of 73 surveyed plots (60.3%), in Jastrebarsko on 32 of 48 plots (66.7%), in Sveti Ivan Zelina on 28 of 44 plots (63.6%), in Sveta Nedjelja on 18 of 31 plots (58.1%), in Velika Gorica on 48 of 76 plots (63.2%), in Vrbovec on 29 of 48 plots (60.4%), in Zaprešić on 31 of 58 plots (53.4%), in Dugo Selo on 28 of 54 plots (51.9%), and in Samobor on 85 of 109 surveyed plots (78%). The comparative analysis of spatial distribution of *E. annuus* between Dugo Selo and Samobor, based on the repeated research in 2016, showed that the number of new plots with *E. annuus* has increased by 7 plots (12.96%) in Dugo Selo, and by 11 plots (10.1%) in Samobor. In all towns, particular appearance on the edge of urban areas can be noticed, though it is also present in all urban centers. This preliminary research has pointed to the need for more intensive monitoring and control of distribution and spread of this aggressive weed and invasive plant, in order to reduce its negative impact on biodiversity of the Zagreb County.

Keywords: annual fleabane, invasive alien weed, spatial distribution, urban areas, Croatia

FLORISTIC-VEGETATION FEATURES OF PEDUNCULATE OAK (*Quercus robur* L.) FORESTS IN THE DINARIC REGION OF CROATIA

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The remains of floodplain and wet pedunculate oak forests in the Dinaric region of Croatia are very rare. The river valleys in which they once grew in the past were meliorated and turned into agricultural land. What is left are only smaller localities, out of which we researched Hrastov Lug near Drežnica, Premužno Jezero and Crno Jezero near Otočac and a few fragments in Ličko Polje in the vicinity of Gospić. The research was carried out by the classical method of Central European Phytosociological School (Braun Blanquet 1964), 28 relevés were recorded. Studies have shown heterogeneity within the pedunculate oak forests and deviations in the floristic composition in relation to already known syntaxa. They are conditioned by the specific water regime and biogeographic position of the Dinaric area. Some research sites are completely isolated from similar hygrophilous forests and show a refugial character. Stands from Ličko Polje show great resemblance to the well known forests of pedunculate oak and common hornbeam in northern Croatia, while stands from Hrastov Lug are significantly different. They include species *Spiraea salicifolia*, *Prunus padus*, *Carex cespitosa*, *Pseudolysimachion longifolium*, *Euphorbia villosa* and some others, which are absent or are exceptionally rare in the planar pedunculate oak forests of Southeast and Central Europe. Another special feature is the presence of mesophilic flora from surraunding zonal beech and beech-fir forests. An important result of this research is the protection proposal of locality Hrastov Lug, in area of 52 ha, as a special reserve of forest vegetation.

Keywords: floodplain forest, phytosociology, refugial, the Dinarides

BIOLOGICAL ACTIVITIES OF ESSENTIAL OIL AND HYDROLATE OF *Hypericum perforatum* L. ssp. *veronense* (Schrank) H. Lindb.

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Chemical composition, antiphytoviral activity and cytotoxicity of *Hypericum perforatum* ssp. *veronense* (Schrank) H. Lindb. (Clusiaceae) essential oil and hydrolate derived from the aerial parts of the plant is presented. Forty-six compounds, representing 82.5% of the oil, were identified. GC-MS analyses of the oil revealed presence of α-pinene (16.5%), n-nonane (13.5%), (E)-caryophyllene (9.5%) and caryophyllene oxide (7.6%) as the main oil components. HPLC analysis identified 3,4-dihydroxybenzoic acid (22.66 μg/mL) as the main component of the hydrolate. Both essential oil and hydrolate of *H. p.* ssp. *veronense* increased the plant resistance to viral infection with *tobacco mosaic virus*. Local host plants treated with essential oil prior to virus inoculation showed delay in the development and almost complete reduction of lesions in the early stage of infection. Pretreatment by hydrolate reduced the number of lesions on the leaves of local host plants as well as the virus concentration in systemically infected plants. In order to assess the antiproliferative potential of *H. p.* ssp. *veronense*, cytotoxicity for hydrolate was determined on healthy (RPE1) and tumor (HeLa) cell lines. The obtained results reveal similar susceptibility toward both cell lines, ensuring further investigation of both, essential oil and hydrolate, on more cell lines to enable further elucidation of *H. p.* ssp. *veronense* biological activity. This study opens up a new area of research concerning plant protection against viruses by demonstrating not only antiphytoviral activity of essential oils, but also aromatic plant hydrolates, with potential application in development of new naturally derived antiphytoviral preparations.

Keywords: antiphytoviral activity, cytotoxicity, tobacco mosaic virus, 3,4-dihydroxybenzoic acid

PROLJETNA FLORA NA LIVADAMA U PODRUČJU ŠTIROVAČE (NACIONALNI PARK SJEVERNI VELEBIT)

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Štirovača je prostrana dolina smještena u južnom dijelu Nacionalnog parka Sjeverni Velebit na nadmorskoj visini od oko 1100 m. Među rijetkim je lokalitetima Nacionalnog parka s izvorom pitke vode i nekoliko potočića koji mjestimice znatno vlaže okolne livade. Budući da flora Štirovače nije sustavno istražena, 2018. godine započeli smo s terenskim istraživanjima flore vlažnih livada. U ovom radu prikazani su rezultati florističkih istraživanja vaskularne flore livada na području Štirovače u proljetnom aspektu. Do sada smo na području Štirovače inventarizirali 54 proljetnice, od kojih osobito ističemo europsku planinčicu (*Trollius europaeus* L.) te vrste iz roda sirištara (*Gentiana* sp.) i kaćuna (*Dactylorhiza* sp.). Obavljena je taksonomska analiza te analizirana zastupljenost ugroženih i zaštićenih svojti. Smatramo da će ovo preliminarno istraživanje dati uvid u brojnost i raznolikost proljetne flore vlažnih livada na području Štirovače, a time i doprinijeti boljem poznavanju biljne raznolikosti livada kao iznimno značajnih staništa za prirodnu i kulturnu baštinu Hrvatske.

Ključne riječi: biljna raznolikost, livada, Štirovača, vaskularna flora, Velebit

POPULATION VARIABILITY OF EUROPEAN WHITE POPLAR (*Populus alba* L.) IN CROATIA ACCORDING TO THE LEAF MORPHOLOGY

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Morphological variation was studied in a pioneer tree species, *Populus alba* L., across the Croatian continental and Mediterranean bio-geographical regions. The material for morphometric analysis was collected in 12 natural populations of European white poplar. Population variability was estimated according to 9 morphological traits of the leaves and 3 derived ratios. Descriptive and multivariate statistical methods were used to evaluate the differences among and within populations. High phenotypic variation and two distinct morphotypes were found: small-leaf in the Mediterranean region, and large-leaf in the continental region. A bio-geographical structuring of populations with a high level of among-tree variation within the populations was identified. Multivariate phenotypic analysis confirmed the existence of small- and large-leaf ecotypes. Furthermore, it was found that phenotypic divergence of the studied European white poplar populations can be explained as a result of a significant level of isolation both by distance and by environment.

Keywords: bio-geographical regions, intra- and inter-population variability, isolation by distance and by environment, morphometric analysis, small- and large-leaf ecotypes

RAZNOLIKOST I OBILJEŽJA FLORE LIŠAJEVA LAPJAKA – PARK PRIRODE PAPUK

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Izražene geološke specifičnosti, reljefne i klimatske prilike, očuvanost šumskih staništa i udaljenost od urbanih i industrijskih područja, pogoduju razvoju velikog broja lišajskih vrsta na području Parka prirode Papuk. Cilj istraživanja, provedenog u srpnju 2018., bio je utvrditi sastav i ekološka obilježja flore lišajeva na području poučne staze Lapjak u blizini mjesta Velika. Ukupno su zabilježene 42 vrste iz 16 porodica i devet redova liheniziranih gljiva. Najbrojniji vrstama su rod Cladonia (sedam vrsta) i porodica Parmeliaceae (11 vrsta). Za floru lišajeva Parka prirode Papuk po prvi puta je zabilježeno šest novih vrsta: *Candelariella aurella, Cladonia foliacea, Cladonia parasitica, Cladonia portentosa, Melanelixia glabra* i *Parmelina quercina*. Ovisno o podlozi na kojoj rastu, 23 vrste su epifitske na drveću i grmlju, 16 epilitske, a tri su terikolne. Najveća raznolikost epifitskih lišajeva utvrđena je na stablima crnog jasena i medunca oko Veličkog starog grada, a epilitskih i terikolnih lišajeva na silikatnoj podlozi Tauberovih stijena. Prema životnom obliku, 45% vrsta su listasti, 31% korasti, a 24% grmasti lišajevi. Prema analizi indikatorskih vrijednosti za lišajsku floru, kvaliteta zraka je ocijenjena kao umjereno onečišćena. Istraživanja lišajske flore iznimno su važna zbog praćenja promjena strukture i raznolikosti lišajeva, a koje mogu ukazati na stanje očuvanosti šumskih ekosustava i stupanj onečišćenja zraka, posebno u zaštićenim područjima prirode u Hrvatskoj.

Ključne riječi: bioindikator, kvaliteta zraka, šumsko stanište, zaštićeno područje

LICHENIZED FUNGI ALONG THE LANË RIVER IN TIRANA

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The study provides data on lichens collected along the Lanë River part of the city park. A remarkably rich vegetation, considered that the locality is situated in the middle of the city. There were found 44 species in all. Conspicuous are yellow species characterized by *Candelaria concolor* and *Xanthoria parietina* as well as a great number of grey species belonging to the *Physcia* group. There is, however, a number of *Parmelia* species. *Parmelia perlata*, *P. subrudecta* and *P. caperata* should be noted as they prefer acid bark and shun nitrates. The following species are attached to the geographical position (mediterranean-submediterranean): *Caloplaca pollinii*, *Physcia biziana*, *Physciella chloantha* and *Ramboldia lusitanica*. The vegetations on this locality are mixed up with montane species on acid bark. *Hypogymnia physodes*, *H. tubulosa*, *Pseudevernia furfuracea* and *Platismatia glauca* were found, although in small quantities.

Keywords: city park, diversity, lichens, taxonomy

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