4. Hrvatski Botanički Simpozij s međunarodnim sudjelovanjem, Split 2013.

4th Croatian Botanical Symposium with international participation, Split 2013

Knjiga sažetaka

Book of Abstracts

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In cooperation with University of Split,
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Predgovor

Zadovoljstvo nam je pozdraviti sve vas, sudionike 4. Hrvatskog Botaničkog Simpozija s međunarodnim sudjelovanjem. Svima želimo srdačnu dobrodošlicu, ugodan boravak u Splitu, uspješna izlaganja i inspirativnu razmjenu ideja s kolegama.

Hrvatsko botaničko društvo nedavno je, u studenom 2012, proslavilo desetu obljetnicu svog postojanja, tako da ovaj simpozij organiziramo u svečanom ozračju, ponosni što smo u tom kratkom vremenu stigli do četvrtog simpozija i što svaki naredni okuplja sve više sudionika.
Stoga nam je osobito drago što se odazvali da sudjelujete u njegovu radu i predstavite rezultate svojih istraživanja. Zahvaljujući svima vama ovo je dosad najveći HBS po broju sudionika i izlaganja. Simpozij je također po sastavu sudionika prerastao u međunarodni skup koji okuplja sudionike iz jugoistočne i srednje Europe. Uz kolege iz Hrvatske tu su kolege iz Austrije, Bosne i Hercegovine, Bugarske, Crne Gore, Češke, Francuske, Grčke, Italije, Kosova, Mađarske, Njemačke, Poljske, Portugala, Slovenije, Srbije, i Turske.
Osobita nam je čast i zadovoljstvo što je ovaj simpozij domaćin Godišnjeg zbora Federacije europskih fikoloških društava (Annual Council Meeting of the Federation of European Phycological Societies – FEPS).
Sve navedeno govori u prilog tome da je ostvarena temeljna ideja simpozija, a to je razmjena znanstvenih i stručnih spoznaja iz botanike u najširem smislu te promicanje suradnje, ali i prijateljstva kao i temeljnih humanističkih vrijednosti među istraživačima.
Nadamo se da će simpozij pridonijeti široj prepoznatljivosti botanike u društvu kao jedne od temeljnih znanstvenih disciplina koja je ujedno kroz mnoge aspekte neraskidivo povezana sa životom ljudi.
Ugodna nam je dužnost zahvaliti svim kolegama koji su svojim radom bilo na koji način doprinijeli organizaciji ovog simpozija i ujedno istaći da bez njih ovaj simpozij ne bi bio moguć.
Najljepše zahvaljujemo svim pokroviteljima i donatorima koji su svojim prilozima, u ovim nimalo lakim i izdašnim vremenima, uvelike olakšali održavanje ovog simpozija i skinuli nam teško breme neprekidnog propitivanja hoćemo li uspjeti završiti simpozij bez dugova.

I dodajmo za kraj da je u ime Splita, grada domaćina, ugrađeno jedno biljno ime. Naime, priča kaže da su stari Grci ovom kraju dali ime prema brnistri (*Spartium junceum*), koju su zvali aspálathos, a isticala se u proljetnom krajoliku zbog bujne žute cvatnje. Druga pak priča kaže da je car Dioklecijan, nakon što se povukao s rimskog prijestolja u svoju splitsku palaču vrijeme kratio uzgajajući kupus. Neka ta splitska biljna nit koja povezuje tisućljeća nadahne i rad ovog simpozija.

U ime Znanstvenog i Organizacijskog odbora 4. Hrvatskog Botaničkog Simpozija,

Antun Alegro i **Mirko Ruščić**

Preface

It is a great pleasure for us to welcome you, the participants of 4th Croatian Botanical Symposium with international participation. We wish you a pleasant stay in Split, successful presentations and inspiring exchange of ideas.

Due to the recent celebration of the tenth anniversary of Croatian Botanical Society, in November 2012, this symposium is organised in festive spirit. We are proud of our four symposia organised in a short period of time, with more participants every time.
Therefore, we are very pleased with your participation and willingness to present the results of your researches. Thanks to you this symposium is the largest so far, both in number of participants as well as presentations. Regarding the countries where participants are from, the symposium become international, South- and Central-European assembly. Besides Croatian colleagues, with us are colleagues from Austria, Bosnia and Herzegovina, Bulgaria, Montenegro, Czech Republic, France, Greece, Italy, Kosovo, Hungary, Germany, Poland, Portugal, Slovenia, Serbia and Turkey.
We are specially honoured to host the Annual Council Meeting of the Federation of European Phycological Societies – FEPS.
All of the above supports the main ideas of symposium – exchange of scientific botanical knowledge in the broadest sense and promoting cooperation, but also promoting friendship and basic humanistic values.
We hope that this symposium will promote botany in public as one of the basic scientific disciplines closely connected with many aspects of human life.
We thank all of our colleagues who enabled this symposium through their help and devoted work.
A great thanks goes also to all sponsors and donors who greatly facilitated and supported this symposium and alleviated the burden of standing questions about the financing and debts.

And at the very end, let it be said that the name of the host town Split is derived from an ancient Greek name for Spanish broom (*Spartium junceum*), which overgrew the slopes in surroundings, and with its luxuriant blossom dominated the spring landscape. In another tale, it is said that emperor Diocletianus was growing cabbage in his Split palace after he left the throne of the Roman Empire. Let this plant spirit, which connects the millennia, inspire this symposium.

On behalf of the Scientific and Organizing Committees of the 4th Croatian Botanical Symposium

Antun Alegro and **Mirko Ruščić**

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Vladimir Vladimirov, Svetlana Bancheva, Valentina Goranova, Rayna Natcheva, Stoyan Stoyanov, Malina Delcheva, Daniella Ivanova, Nikolay Velev, Natalia Valyovska, Dimitar Peev
Conservation of rare plants in the Bulgarian flora using the plant micro-reserve model

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Occurrence and conservation of *Tragopogon floccosus* (Asteraceae) in Bulgaria

Plenarna predavanja
Plenary lectures

The vegetation science from an amphi-Adriatic point of view. Interesting connections and open syntaxonomical issues

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The vegetation science in Italy became established with a certain delay compared with the other central and southern European countries where the first drafts of the national Prodromes were already outlined during the 40's and the 50's. As a consequence the first phytosociological papers which outlined the vegetation features of the Peninsular Italy used references borrowed from the syntaxonomical frameworks in vogue in the neighboring countries and in particular those adopted in central European and Spain. It was only with the first studies on the vegetation of the Apennines which was evident that the Italian Peninsula had a clear floristic and vegetational identity, mainly related to its high number of endemic species but also to a relatively high occurrence of amphi-Adriatic and trans-Adriatic species (especially in the central and southern Apennines). The central location of Italy in the Mediterranean basin and its past paleogeographical and paleoclimatical vicissitudes have brought the Italian Peninsula to work as a floristic crossroad for various chorological components. Typical is its intermediate position between the sub-Atlantic/W-Mediterranean chorotypes and the SE-European/E-Mediterramnean ones, but it cannot be underestimated Boreal/Arctic-Alpine component which took advantage of the N-S orientation of the Apennines during the Ice Ages and used it as a "fast track" to South. One of the questions which have still not been completely solved and which is strictly linked to the proposal of a general syntaxonomical scheme of the Italian vegetation is that concerning the choice between the W-European high-rank syntaxa or the Eastern-European ones for many critical and biogeographically diagnostic Italian plant communities. This uncertainity reveals within the whole altitudinal pattern of the Apennines and in several vegatational types such as Thermo-Mediterranean dry grasslands (*Hyparrhenion hirtae/Cymbopogono-Brachypodion*), Sub-Mediterranean dry grasslands (*Brometalia erecti/Scorzonero-Chrysopogonetalia*), Mediterranean garrigue (*Rosmarinetea/Cisto-Micromerietea*); evergreen sclerophyllous forests (*Quercion ilicis/Orno-Qurcion ilicis*), mesophilous forests (*Carpinion betuli/Erythronio-Carpinion*), beech forests (*Fagion/Aremonio-Fagion*), subalpine dwarf-shrubs (*Junipero-Pinetea/Erico-Pinetea*), chasmophytic vegetation (*Asplenietalia glandulosi/Centaureo-Campanuletalia/Onosmetalia frutescentis*) etc. The distribution of the amphi-adriatic (trans-adriatic) species and vegetation communities in the Italian Peninsula does not simply follow a E-W decreasing gradient; in fact it depends on several environmental variables (altiutude, lithology, geomorphology, vegetation physiognomy etc). The highest percentages of amphi-Adriatic species occurs in the limestone dry grasslands of the upper montane and subalpine belt of the central and southern Apennines (*Seslerietalia tenuifoliae*) and in the Mediterranean limestone cliffs of the Apulia region (*Centaureo-Campanuletalia* and *Onosmetalia frutescentis*). As regards woodlands it is likely the Tyrrhenian side of the central Italy the area in which it is possible to find the highest degree of similarity with the western Balkan vegetation (*Orno-Ostryon*).

Phytoiconography: a way to communicate through images of plants. Some examples from Roman archaeology

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The representation of plants in every kind of human artefacts dates back to remote epochs. In the history of art and archaeology it is possible to notice elements in which the theme of nature, realistically represented or simply stylized, assumes great importance. Good examples can be the well known plants with strong symbolic meaning of rebirth, renewal, renovation and purity: such as palms (*Phoenix dactylifera*), loti (*Nymphaea caerulea*, *N. lotus*) and papyrus (*Cyperus papyrus*) occurring in the capitals of ancient Egypt, or bear's breeches (*Acanthus mollis*) and lilies (*Lilium candidum*) in the capitals of Greek-roman world. Widespread presence of poppy *(Papaver somniferum)* on the artefacts from a funeral context is yet another example of using a plant as a strongly defined symbol of a wish of a pleasant and peaceful sleep, rather than the final death. In the past, symbols were omnipresent, and have represented some kind of language and communication. The origins of plant symbols were in the biology of the plants (in their morphology, physiology, phenology, etc.), evidently well known to the ancient men, because of the very close relationship and connection with nature which represented a divinity in its broad way of onsets and expressions. Phytoiconographic studies can provide the information of great naturalistic value like the ones about plant biodiversity, history and diffusion of plant species, evolution of cultivated plants, plant diseases, landscape architecture, garden art, history of natural science and naturalistic/botanical knowledge in certain historical periods. Further, the obtained information can be very useful in completing the interpretative outline of a monument and sometimes can be crucial for discovering important details about a monument; which was the case of the phytoiconografical studies of Livia's Villa at Prima Porta (Rome) and *Ara Pacis Augustae* (Rome). The recent iconographic studies have shown (testified, in fact) the impressive naturalistic knowledge of the ancient Romans. It is, on one hand, confirmed by the high diversity of the represented species (more than 200 taxa) and on the other, by the finesse and delicacy with which some details were represented. One of the fascinating examples is the representation of orchid gynostemium with pollinia used like some kind of an indirect symbol, which alludes to a natural phenomenon (plant pollination and fecundation) which they obviously knew very well and used as a symbol of new life, fertility and prosperity.

Snow ball earth and the split of Streptophyta and Chlorophyta

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About 700 million years ago (Mya), the ancestor of all green plants evolved into two major groups: the Chlorophyta (many green algae) and the Streptophyta (some green algae and land plants = embryophytes). Both groups are separated by several morphological, physiological, and molecular characteristics, including different photorespiration pathways. The Chloropyhta/Streptophyta split was probably very important for the colonization of the terrestrial habitat because embryophytes, the descendants of streptophyte algae, today completely dominate the macrophyte flora of the terrestrial habitats. By contrast, in aquatic ecosystems macrophytes from brown, red, and green algae compete with embryophytes. In this paper, I will argue that the Chlorophyta/Streptophyta split is related to glaciation events (snow ball earth states) in the Neoproterozoic and provide an explanation for the different photorespiration pathways.

Algologija– usmena priopćenja
Phycology– oral presentations

Charophytes of the Baćina lakes and surrounding freshwater localities (Dalmatia, Croatia)

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The Baćina lakes, which have karstic origin, Mediterranean position, freshwater (except Crniševo where periodically intrude salt water in depth) with diluted carbonate, neutral or slightly alkaline reaction and high transparency, are very interesting and unique ecosystems. Situated in semiarid Mediterranean climatic zone, on Jurassic limestone bedrock, they have no tributaries and are fed by precipitations, neighbouring and sublacustric springs. The Baćina lakes and surrounding freshwater localities are characterised by well developed belts of emerse and submerse macrophyte vegetation. The belt of floating macrophytes is developed in the channels and the Desanka rivulet, since on other localities it occurs only fragmentary on sheltered places in still waters. Beside general favourable conditions for macrophyte development, transparency of water is of special importance, enabling them to reach up to 10 m in depth, where monodominant stands of *Nitellopsis obtusa* (Desv.) J. Grov. and polyspecific stands of *N. obtusa* and *Lychnothamnus barbatus* (Meyen) v. Leonh. are spread. In eight Baćina lakes and surrounding freshwater habitats (the Desanka rivulet, Lake Desne, the Modro oko spring and channels in the Neretva river delta) 40 macrophyte species were found: emerse (9), floating (6), submerse (25). Charophytes (*Charophyta*) are of special importance among submerse macrophytes, due to its species richness, abundance and cover. They are represented with 11 species: *Chara* (6), *Nitellopsis* (1), *Lychnothamnus* (1) and *Nitella* (3). Beside commonly widespread species (*Chara aspera* Willd., *Ch. globularis* Thuill., *Nitellopsis obtusa* (Desv. In Loisel.) J. Grov.), here can be also found some rare and threatened species, e.g. *Lychnothamnus barbatus* (Meyen) Leonh. and *Chara corfuensi* J.Gr. ex Fil.

Charophytes of standing waters in Vojvodina (Serbia)

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Investigations of distribution and ecology of charophytes in standing waters of Vojvodina were carried out during vegetation seasons of 2012 and 2013. Vojvodina is a plain in northern part of Serbia with Sava and Danube rivers representing its southern border. This area is quite rich in various types of water bodies, such as ponds, fishponds, rivers with their floodplains, oxbows and backwaters, channels, lakes (mostly artificial), etc. More than one hundred localities were visited and the charophytes were found at just several of them. The presence of only seven species was recorded, five of them belonging to the family Characeae: *Chara globularis* Thuill. 1799, *Ch. contraria* A.Braun ex Kütz. 1845 s.str., *Ch. hispida* (L.) Hartm. 1820, *Ch. intermedia* A.Braun in A.Braun, Rabenh. & Stizenb. 1859 and *Nitellopsis obtusa* (Desv. in Loisel.) J.Groves 1919 and two of them belonging to the family Nitellaceae: *Nitella mucronata* (A. Braun) Miq. in H. C. Hall 1840 emend. Wallman 1853 and *Tolypella glomerata* (Desv.) Leonh. Charophytes inhabit different water types : fresh, brackish, salt, mineral but have a preference to transparent, clear standing waters with neutral to slightly alkaline reaction. Unfortunately, most of the visited localities did not meet their demands. During the study, ecological parameters were also measured and observed: temperature, Secchi disc depth, pH reaction, dissolved oxygen concetration, conductivity, substrate type and macrophytes growing with stoneworts. Nutrient concentrations (ammonia, nitrites, nitrates, orthophosphates and total phosphates) were aslo determined. Results showed that charophytes in Vojvodina inhabit pure and oligotrophic water, with high transparency, neutral or slightly alkaline pH and low content of N

and P compounds. This confirms the role of charophytes as indicator species and also their influence to a water clarity. Our general conclusion is that biological survival of charophytes in this part of Serbia is largely threatened due to various kind of threat factors such as agriculture, industrial waste waters discharge and urbanization, having disapperance of suitable habitats as their result, as well as, spreading of invasive species. There are some areas that are still mostly unimpaced and unpolluted, and represent a refuge for such delicate species. They are generally found in the protected areas of Vojvodina. Moreover, significant habitats for charophytes in Vojvodina are new habitats created as a result of send digging. These are different kind of ponds, permanent or ephemeral, were stonworts appear as a pioneer species colonizing them.

Investigations of cell wall composition and remodeling during infection of brown algae by the oomycete *Eurychasma dicksonii*

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E. dicksonii is a marine oomycete that infects more than 45 brown algal species showing a significant range of compatibility. In this study, we investigate three strains of *E. dicksonii* infecting representatives of four brown algal orders (Ectocarpales, Laminariales, Discosporangiales, Tilopteridiales). After testing seven lectins with high specificity in different sugar moieties in both infected and uninfected cultures, it was found that the attachment of the parasite's spore in some cases is accompanied by cell wall modifications in host cells. The application of fluorescent lectins provides new information on the potential mechanism of host-parasite recognition. In addition, the experiments clarify the difference in the chemical composition of the cell wall among the different brown algal strains and demonstrate for the first time useful elements on the oomycete's cell wall composition.

Climate change and marine invasions: will new environmental scenarios increase the performance of introduced species?

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The risk and consequences of biological invasions on marine coastal habitats are rapidly increasing in concomitanceto the current changes in global climate. Average atmospheric and sea surface temperatures are increasing and excessive CO^2 continues to dissolve in the oceans, causing acidification. We examined the effects of these two climate-driven stressors, both in natives and invasive macroalgae, aiming to examine if invasive species will perform better in the predicted future environmental conditions. Here I present results from differentexperiments using mesocosms where we increased temperature and CO^2 partial pressure in a fully orthogonal experimental setups. As species performance proxies we used fitness related responses like growth and photosynthetic performance (PAM). In general our results show that future high concentrations of CO^2 generated a highly productive response, and this was similar with future high temperatures. However, a synergistic interaction between the two environmental factors was the most frequent response when both stressors where combined. Also invasive seaweeds performed better than natives in overall. Thus, species responses to future global changes are unpredictable from single stressors experiments. Invasive species seem to show better chances under the future environmental scenarios.

Morfologija i taksonomija planktonskih dijatomeja roda Chaetoceros Ehrenberg (Bacillariophyta) u Jadranskom moru

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Rod *Chaetoceros* Ehrenberg obuhvaća više od 170 opisanih vrsta i time predstavlja jedan od najvećih rodova morskih planktonskih dijatomeja. Identifikacija pojedinih taksona je iznimno teška zbog iznimne intraspecijske morfološke varijabilnosti, česte pojave prijelaznih oblika, a i zbog toga što je neke bitne identifikacijske karakteristike moguće vidjeti isključivo pomoću elektronskog mikroskopa. Iako je dosad u Jadranu zabilježeno oko 50 vrsta od kojih su neke od velike ekološke važnosti i često dominiraju u fitoplanktonu, do sada ne postoje taksonomska istraživanja koja se bave isključivo s vrstama ovog roda. Cilj ovog rada bio je istražiti raznolikost vrsta unutar roda *Chaetoceros* analizom laboratorijskih kultura fitoplanktona i terenskih mrežnih uzoraka prikupljenih duž istočne obale Jadranskog mora pomoću svjetlosnog, transmisionog i skenirajućeg elektronskog mikroskopa. Dobiveni podaci su upotrijebljeni za reviziju postojećih taksonomskih opisa, s posebnim naglaskom na ultrastrukturne karakteristike kao što su sete vegetativnih stanica te mirujuće spore. Ukupan broj identificiranih vrsta u prikupljenim terenskim uzorcima iznosi 38 uključujući 28 vrsta identificiranih iz 43 kultivirana soja. Većina zabilježenih vrsta je karakteristična za umjerena područja, međutim, zabilježene su po prvi put u Jadranskom moru i detaljno istražene neke malo poznate vrste inače karakteristične za tropska mora poput *Chaetoceros bacteriastroides* i *C. pseudodichaeta*. Morfološka analiza dominantnih vrsta rezultirala je novim informacijama o karakterističnim ultrastrukturnim detaljima poput nedostatka trnova na setama kod vrste *C. vixvisibilis* i tanke silicijeve opne koja pokriva otvor između susjednih stanica kod vrste *C. affinis*. Također, analizirajući morfološki slične vrste *C.contortus/C. compressus, C.lorenzianus/C. decipiens* te *C.lauderi/C.teres* rezultati su pokazali da se radi o vrsti *C. contortus, C. decipiens* i *C. lauderi* u svom dostupnom materijalu te postoji opravdana sumnja u prisutnost vrsta s kojom ih je lako zamijeniti. Točni i potpuni opisi vrsta dijatomeja prikupljeni u ovom istraživanju će olakšati buduću ispravnu identifikaciju u planktonskim uzorcima i poboljšati taksonomijsku rezoluciju ovog važnog roda na lokalnoj, tako i globalnoj razini. To će u budućnosti pridonijeti podacima o globalnoj biogeografskoj rasprostranjenosti, kao i doprinijeti poboljšanju kvalitete podataka o ekologiji fitoplanktona.

Morphology and taxonomy of the planktonic diatom genus *Chaetoceros* Ehrenberg *(*Bacillariophyta*)* from the Adriatic Sea

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The genus *Chaetoceros* Ehrenberg is one of the largest genera among marine planktonic diatoms comprising more than 170 described species. The species identification is notoriously difficult due to the large morphological variability within species, frequent occurrence of intermediate forms, and owing to the fact that some of the characters used for delineation can only be observed using electron microscopy. Although ca. 50 species has been recorded in the Adriatic Sea of which few taxa are of great ecological importance often dominating in the phytoplankton, there have not been any previous taxonomic investigations dealing specifically with the members of this genus. Therefore, the aim of present study is to look into the *Chaetoceros* diversity by analysing the laboratory clonal cultures and the field samples collected along the eastern Adriatic coast using light, transmission and scanning electron microscope. The acquired data were used for revision of the existent species descriptions and taxonomic interrelationships, with particular emphasis on comparison of the ultrastructural characters e.g. setae and of the vegetative cells as well as resting spores. A total number of 38 distinct taxa were recognized in the field material including 28 taxa identified from 43 cultured strains. Most of the taxa studied are characteristic for the temperate regions, however we recorded and studied in details some little-known species otherwise recorded only in the tropical seas such as *Chaetoceros bacteriastroides* and *C. pseudodichaeta* which were for the first time identified in the Adriatic Sea samples. The morphological analysis of the dominant species, except providing distinct novel ultrastructural details such as the absence of the spines on setae for *C. vixvisibilis* and thin silica wall structure covering the aperture between sibling cells in *C. affinis*, helped to clear previously common misidentifications as in the case *C. contortus/C. compressus, C. decipiens/C. lorenzianus* and *C. lauderi/C. teres.* The analysis showed that in all analysed material only first species from the giver pair could be identified. The accurate and complete diatom taxa descriptions obtained in this study will facilitate future correct species identification and improve the taxonomic resolution of this important genus on the local as well as global level which will in long term add information to the global biogeographical species distribution as well as contribute to the improvement of quality of the data on phytoplankton ecology in the future studies.

Sezonska dinamika epifitskih dijatomeja na "algi ubojici" *Caulerpa taxifolia* (Vahl) C. Agardh u Starigradskom zaljevu (otok Hvar)

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Istraživanja su usmjerena na taksonomski sastav epifitskih dijatomeja na makroalgi *Caulerpa taxifolia* (Vahl) C. Agardh. Materijal je sakupljan mjesečno tijekom dvije godine (jesen 2008 – jesen 2010) u području s *Caulerpa taxifolia* u Starigradskom zaljevu na otoku Hvaru. Pomoću svjetlosnog i elektronskog mikroskopa, po prvi put će se odrediti taksonomski sastav dijatomeja, opisati morfologija i ultrastruktura vrsta te utvrditi sezonska dinamika na finoj vremenskoj skali. Najčešće i najabundantnije svojte na talusu *Caulerpa taxifolia* pripadaju rodu *Cocconeis* Ehrenberg. Nova vrsta roda *Cocconeis*, sićušni epifit *Cocconeis caulerpacola* Witkowski, Car *et* Dobosz, neravnomjerno prekriva različite dijelove talusa *Caulerpa taxifolia*. Poznavanje taksonomskog sastava dijatomeja u područjima s *Caulerpa* spp. važna su u istraživanjima toksičnog učinka domaćina.

The seasonal dynamics of epiphytic diatoms of 'killer' seaweed *Caulerpa taxifolia* (Vahl) C. Agardh from the Bay of Stari Grad (the Island of Hvar)

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The framework of the author's research project includes a description of the epiphytic diatom flora on *Caulerpa taxifolia* (Vahl) C. Agardh. Material was collected monthly over two years (autumn 2008 – autumn 2010) from an area influenced by *Caulerpa taxifolia* in the Bay of Stari Grad (Island of Hvar). Light and electron microscopy is expected to provide for the first time information on the general morphology and ultrastructure of species, and enable a determination of the taxonomy of diatoms. Taxa of genus *Cocconeis* Ehrenberg were the most frequent and abundant epiphytes of the *Caulerpa* thallus. A new species of *Cocconeis*, tiny *Cocconeis caulerpacola* Witkowski, Car *et* Dobosz was observed as epiphyte with patchy distribution covering the surface of *Caulerpa taxifolia*. The seasonal dynamics will be described on a fine time scale. Knowledge of the diatom community structure in the areas of *Caulerpa* spp. is important for studies of the toxic effects of the host.

Procjena udjela alkalne fosfataze u biomasi pikoplanktona južnog Jadrana

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Koncentracija ortofosfata učestalo predstavlja limitirajući faktor rasta fitoplanktona u južnom Jadranu, što se indirektno odražava i na biomasu heterotrofnog bakterioplanktona. Alkalna fosfataza AF je višestruko važan i rasprostranjen enzim biljnog i životinjskog svijeta. U stanicama fitoplanktona odgovoran je prije svega za odgradnju ortofosfata iz fosfomonoestera i unos ortofosfata u stanicu, dok je u heterotrofnim bakterijama uglavnom konstitutivno eksprimiran te igra važnu ulogu i pri unosu ostataka organskih molekula s izvorima ugljika i dušika nakon odgradnje ortofosfata iz fosfomonoestera. Biomasom pikoplanktona u južnom Jadranu dominiraju cijanobakterije. Aktivnost alkalne fosfataze AAF kao relativna mjera količine enzima (pri 37 °C) izmjerena je spektrofotometrijski (absorbancija *p*-nitrofenola očitana pri λ = 400 nm, kivete 1 cm, Perkin Elmer λ15) u 283 uzorka pikoplanktona nakon koncentriranja enzima iz 200 mL mora frakcije 0.2 do 2 µm u eufotskom sloju i dublje na 6 postaja (Malo jezero, Veliko jezero i Uvala Gonoturska u Mljetskom akvatoriju, estuarij Omble, obalno more kod Lokruma i otvoreno more Južnojadranske kotline) u razdoblju listopad 2009. - siječanj 2012. Procijenjene su biomase svih sastavnica pikoplanktona nakon određivanja abundancija i dimenzija stanica epifluorescentnim mikroskopom Zeiss – Jenalumar uz povećanje 1500 te korištenjem konverzijskih faktora za pretvorbu abundancije i volumena stanica u sadržaj ugljika. Specifična AAF pikoplanktona sAAFp izračunata je kao AAF pikoplanktona/biomasa pikoplanktona. U jednakim reakcijskim uvjetima, kao i pri određivanju AAF (TRIS-HCl 0.1 M, pH 8.35 – 8.25, S_0 1.812 mM), ispitana je aktivnost modelnog enzima „alkaline phosphatase from calf intestine" (Roche) deklarirane aktivnosti 2 IJ/µg pri drugačijem sastavu pufera, većem pH, većoj S_0 *p*-nitrofenil fosfata i većoj koncentraciji aktivatora (0.5 mM Mg^{2+}). Nakon korekcija i masenih normalizacija rezultata sAAFp prema aktivnosti modelnog enzima, izračunat je srednjak udjela AF u biomasi pikoplanktona. Nije poznato u kojoj mjeri modelni enzim odgovara specifičnoj aktivnosti AF (aktivnost prema biomasi enzima) prirodne populacije pikoplanktona te u kojoj mjeri se razlikuju AF pikoplanktona (cijanobakterije, heterotrofne bakterije, pigmentirani i heterotrofni flagelati). Relativna veličina greške u konačnom rezultatu ostala je neodređena, a procijenjeni udio AF u biomasi pikoplanktona južnog Jadrana iznosio je 1 µg AF/20000 µg C (0.05 ‰).

Assessment of the alkaline phosphatase share in biomass of picoplankton in South Adriatic

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Orthophosphate concentration is usual limiting factor of the phytoplankton growth in South Adriatic, which indirectly impacts the growth of heterotrophic bacteria. Alkaline phosphatases AP are widely synthesized in plants and animals and play numerous roles in cell life. In phytoplankton the most important role of AP is degradation of phosphomonoesters and uptake of orthophosphate, while in heterotrophic bacteria AP is mostly constitutive enzyme being also active in uptake of organic moiety (carbon and nitrogen source) after dephosphorilation. Cyanobacteria dominate the biomass of picoplankton in South Adriatic. Alkaline phosphatase activities APA were detected as relative measure of enzyme abundance (at 37 °C) by spectrophotometer Perkin Elmer λ15 (absorbances of *p*-nitrophenol read at λ = 400 nm, cuvettes 1 cm) in 283 samples of picoplankton after concentrating enzymes from 200 mL of filtered sea in fraction 0.2 – 2 μm throughout photic zone and deeper at 6 locations (Small Lake, Big Lake and Gonoturska in Mljet aquatory, Ombla Estuary, coastal sea near Lokrum and open waters of South Adriatic Pit) in period October 2009. - January 2012. Biomass of picoplankton constituents were assessed after counting abundances and measuring dimensions of cells by epifluorescent microscope Zeiss – Jenalumar (magnification 1500) and using factors for conversion of volume and abundance into carbon content. Specific APA of picoplankton sAPAp were calculated as APA of picoplankton/biomass of picoplankton. Model enzyme „alkaline phosphatase from calf intestine" (Roche) with specified activity of 2 IU/μg at different buffer, higher pH, higher S_0 of *p*-nitrophenyl phosphate and higher concentration of activator (0.5 mM Mg^{2+}) was tested in the same reaction conditions as for picoplankton APA (Tris-HCl 0.1 M, S_0 1.812 mM, pH 8.35 – 8.25). After correction and mass normalization of sAPAp according to activity of model enzyme, assessment of the average AP share in picoplankton biomass was given. It remained unknown to which degree model enzyme suited the specific activity of picoplankton AP (activity per mass of enzyme) and what was the similarity among AP of picoplankton constitutents (cyanobacteria, heterotrophic bacteria, pigmented and heterotrophic flagellates). Relative dimension of error introduced to the final result remained unevaluated, while average AP share in picoplankton biomass of South Adriatic was estimated at 1 μg AP/20000 μg C (0.05 ‰).

Molekularna i morfološka istraživanja potencijalno toksičnog roda Pseudo-nitzschia u Parku prirode „Telašćica"

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Planktonske dijatomeje roda *Pseudo-nitzschia* su učestale u oceanskom i neritčkom plankton diljem svijeta. Do sada je utvrđeno 14 vrsta sa sposobnošću sinteze domoične kiseline, neurotoksina koji uzrokuje amnezičko trovanje školjkašima (ASP). U Parku prirode Telašćica provedeno je šest terenskih istraživanja, u svibnju i listopadu 2011., te veljači, ožujku, svibnju i kolovozu 2012 s ciljem taksonomske, morfološke i filogenetske determinacije fitoplanktonske zajednice s posebnim naglaskom na rod *Pseudo-nitzschia*. *Pseudo-nitzschia pseudodelicatissima* "sensu lato" je dominirala u svibnju 2011. (maksimalna abundancija 1.5 x 10^4 stanica L^{-1}, s udjelom od 11% u ukupnoj abundanciji dijatomeja) i u kolovozu 2012. (maksimalna abundancija 1.1 x 10^4 stanica L^{-1},

s udjelom od 95% u ukupnoj abundanciji dijatomeja). *Pseudo-nitzschia seriata* pojavljuje se u listopadu 2011. (maksimalna abundancija 0.4 x 10^4 stanica L^{-1}, s udjelom od 0.3% u ukupnoj abundanciji dijatomeja). Uspostavljene su monoklonalne kulture stanica vrste *Pseudo-nitzschia* (izoliranih iz uzoraka uzetih u svibnju i listopadu 2012.) te su provedene molekularne analize na različitim markerima (18S, ITS1-5,8S-ITS2, 28S). Filogenetske analize su dokazale prisustvo *P. mannii* i potencijalno toksičnu *P. fraudulenta.* Statistička filogenetska mreža pokazuje genetički jednake populacije za obje vrste u srednjem Jadranu. Stalno praćenje fitoplanktonske zajednice je neophodno uslijed čestog razvijanja vrsta roda *Pseudo-nitzschia* u ljeto te ranu jesen. Taksonomija je izrazito složena jer su razlike među vrstama ultrastukturne te je za njihovo određivanje neophodna elektronska mikroskopija ili molekularna analiza. Istraživanja fizikalno-kemijskih parametara u moru, interspecijskih i intraspecijskih interakcija, kao i sastava vrsta roda *Pseudo-nitzschia* su od izrazite važnosti na lokalnoj i globalnoj skali u svrhu predviđanja i prevencije njihovog masovnog razvoja i potencijalne toksičnosti.

Molecular and morphological characterisation of potentially toxic diatom genus *Pseudo-nitzschia* in Nature Park „Telašćica"

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Planktonic diatom species of the genus *Pseudo-nitzschia* are common in oceanic and neritic plankton worldwide. Fourteen *Pseudo-nitzschia* species have been known as producers of domoic acid, a neurotoxic amino acid responsible for Amnesic Shellfish Poisoning (ASP), therefore considerable scientific interest on its ecology and taxonomy has been generated.
During the last two years several field investigations have been conducted in the Telašćica lake, two in 2011 (May and October) and four in 2012 (February, March, May, and August) with the aim of taxonomic, morphologic and phylogenetic determination of the phytoplankton community, with special emphasis on the genus *Pseudo-nitzschia*. *Pseudo-nitzschia pseudodelicatissima* "sensu lato" was one of the dominant diatom species in May of 2011 (maximal abundance of 1.5 x 10^4 cells L^{-1}, contributed up to 11% of the total diatom abundance) and August of 2012 (maximal abundance of 1.1 x 10^4 cells L^{-1}, contributed up to 95% of the total diatom abundance). *Pseudo-nitzschia seriata* appears in October of 2011 (maximal abundance of 0.4 x 10^4 cells L^{-1}, contributed up to 0.3% of the total diatom). Monoclonal cultures of *Pseudo-nitzschia* cells (isolated from May and October samples) were established and molecular analysis on different molecular markers (18S, ITS1-5,8S-ITS2, 28S) has been performed. Phylogenetic analysis resulted in the identification of *P. mannii* and potentially toxic *P. fraudulenta.* Statistical phylogenetic networks demonstrate genetically unique populations for both species in the middle Adriatic. The taxa of the genus were present throughout the year and dominated the community in summer and early autumn, urging continuous monitoring of the system. The difficulty in monitoring these diatoms is in classification to the species level. This relies on ultra-structural features seen only on cleaned frustules observed with an electron microscope or by molecular methods. Furthermore, studies elucidating the nutrient and physical requirements, as well as the biotic interactions of *Pseudo-nitzschia* species and species composition on regional and global scales are essential for the prediction and prevention of its mass occurrence and resulting toxicity.

Algologija – posterska priopćenja
Phycology – poster presentations

Algologija u Hrvatskoj: jučer, danas i sutra

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Kao i u svim granama prirodoslovlja 21. stoljeće, uz intenziviranu međunarodnu suradnju, donosi nove znanstvene spoznaje i naprednije pristupe što se odražava i na istraživanja alga u Hrvatskoj. Prodorom novih ideja u smislu biocenološkog pristupa proučavanju akvatičkih biotopa objavljuju se radovi o sezonskoj dinamici, prostornom rasporedu, kvalitativno-kvantitativnim odnosima, ulozi u procesima pročišćavanja kopnenih voda kao i o primarnoj organskoj produkciji. Provode se intenzivnija i sveobuhvatnija, višegodišnja planska istraživanja koja su objavljena u brojnim prilozima, radovima i studijama. Izraziti značaj algi za ljudsku zajednicu (ekološki, ekonomski, estetski i moralni i dr.) posljednjih se godina intenzivno konkretizira u globalnom pristupu skrbi o vodi (Okvirna direktiva o vodama EU) u kojem i RH provodi postupnu transformaciju i prilagodbu svog zakonodavnog i institucijskog okvira. Bit će predstavljena kratka povijest istraživanja alga u Jadranskom moru, kao i današnji stupanj poznavanja alga.

Algology in Croatia: yesterday, today and tomorrow

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As in all fields of natural sciences, the 21st century, with intensified international cooperation, has brought new scientific knowledge and advanced approaches, which is reflected to the algal research in Croatia. Influx of new ideas in terms of biocenological approach to the research of aquatic biotopes leads to publications about the seasonal dynamics, spatial distribution, qualitative and quantitative relationships, role in the process of ground water purification as well as the primary organic production. An intensive and comprehensive, multi-year targeted studies that have been published in a number of annexes, works and studies have been conducted. Expressive significance of algae in human community (ecological, economic, aesthetic, moral, etc.) during recent years, has lately being realized in a global approach to care about water (EU Water Framework Directive), according to which Croatia has been implementing and gradually transforming and adapting its legal and institutional framework. Short an overview of history of algae research in the Adriatic Sea and recent activities will be presented.

Changes in composition of phytoplankton assemblages due to organic contaminants depending on the sensitivity of dominant species

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The problem of chlorinated hydrocarbons accumulation in soil and in groundwater as a consequence of earlier industrial activity is again in the focus of attention nowadays, since the latest results of monitoring showed that the risk of appearance of these compounds in surface waters increased. Effects of chlorinated hydrocarbon contaminants on natural phytoplankton assemblages in shallow lake ecosystems are relatively rarely studied. Although the impact of biodiversity on ecosystem functioning has become one of the most studied area of ecology, the importance of diversity in a changing environment is still poorly understood. Changes in composition of phytoplankton assemblages due to short-chained chlorinated hydrocarbons (tetrachloroethane, tetrachloroethylene and trichloroethylene) were studied in microcosm experiments in summer of 2011 and 2012. Diversity further decreased during treatments in the less diverse 2011 summer community, dominated by the euglenid *Trachelomonas volvocinopsis* Svirenko (its relative abundance was nearly 70%). Diversity did not change significantly during treatments in the more diverse 2012 summer community, dominated by cryptomonads (their relative abundance were 40%). Cryptomonads were extremely sensitive to treatments, they almost completely disappeared from the treated communities. In contrast, the dominant *Trachelomonas volvocinopsis* in 2011, presumably also due to its high competition skills, filled "space" occurring after disappearance of sensitive species. Chlorinated hydrocarbons affect negatively the composition of phytoplankton communities, but there were more resistant species in the more diverse system (2012 summer assemblages in our case), which enabled it to offset the functional impairment resulting from the disappearance of other species.

Possible anticyanobacterial effects of *Cryptomonas ovata* (Cryptophyta) on *Microcystis aeruginosa* (Cyanobacteria)

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Algal taxa could influence the survival and/or growth of other populations in phytoplankton communities by their presence, metabolism, nutrient uptake, and allelochemicals. According to earlier theories, cyanotoxins play an important allelopathic role in planktonic communities. However, there are only few studies in which direct algal-cyanobacterial allelopathy, effects of extracellular toxin content to other algae, or influences of other algal population on active toxin release was discussed. In our study we focused on the effects of non-toxic *Cryptomonas ovata* Ehrenberg to growth, nutrient uptake and extracellular toxin content of toxic *Microcystis aeruginosa* Kützing in mixed cultures (containing both *C. ovata* and *M. aeruginosa* cells) and in *C. ovata* crude extract treated *M. aeruginosa* cultures. The survival and growth of the eukaryotic alga or the cyanobacterium in mixed cultures were closely related on the initial cell numbers of populations. Extracellular toxin contents were

not detected throughout the experiments. The crude extracts of *C. ovata* seemed to have weak inhibitory effects to *M. aeruginosa* cells. To prove these anticyanobacterial activities, *M. aeruginosa* cultures were treated by its own crude extracts as well. Its own crude extract stimulated the growth of *Microcystis* cultures. To summarize our results, the interaction between *C. ovata* and *M. aeruginosa* was not primarily influenced by cyanotoxins, but by nutrient competition and weak anticyanobacterial effects of *Cryptomonas* cells.

On the possible use of phytoplankton diversity metrics for shallow lake and potamal river quality assessment

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Since most of water quality problems are frequently connected to overdominance of some phytoplankton species (which inevitably implies the decrease of diversity), the use of diversity metrics as state indicators seems plausible. Diversity is frequently investigated as a function of productivity, since increment of phytoplankton biomass and decrease in diversity are those phenomena that can be expected during undesirable human alterations of the aquatic systems. Productivity–diversity relationships were studied for lakes and large potamal rivers. It has been demonstrated that the relationship is scale dependent. At wide biomass range both species and functional diversity values showed unimodal distribution. Increasing and decreasing tendencies were also observed, but these were characteristic for the two ends of the biomass ranges. The results suggest that phytoplankton diversity metrics as ecological state indicators have several shortcomings; therefore, their use in the ecological state assessment is restricted to special cases when the biomass diversity relationship shows strong decreasing or increasing tendencies.

Alge na makrofitima u oligotrofnoj močvari Hutovo blato, Bosna i Hercegovina

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U lipnju, kolovozu i rujnu 2003. i listopadu 2004. istraživana je flora epifitskih alga na listovima lopoča (*Nymphaea alba* L.) i lokvanja (*Nuphar luteum* (L.) Sm.) u močvari Hutovo blato. Oligotrofna močvara ukupne površine 7441 ha nalazi se na jugu Bosne i Hercegovine. Uzorci alga su prikupljani s 13 postaja metodom struganja materijala s donje površine listova i dijela drške lokvanja (*Nuphar luteum* (L.) Sm.) i lopoča (*Nymphaea alba* L.). Ukupno je određeno 247 svojti, od toga 141 pripada odjelu Ochrophyta, 73 Chlorophyta, 29 Cyanobacteria, tri Dinophyta i jedna Rhodophyta. Najveću raznolikost bila je unutar skupine dijatomeja (135 svojti). Rodovi s najvećim brojem svojti bili su *Eunotia* (14), *Gomphonema* (13) *Cymbella* i *Navicula* (9), *Cyclotella* (6), *Diatoma* i *Nitzschia* (5). Najzastupljenije svojte bile su *Brebissonia lanceolata* (C. Agardh) Mahoney & Reimer, *Eunotia arcus* Ehrenberg, *Navicula radiosa* Kützing, *Desmodesmus quadricaudatus* (Turpin) Hegewald, *Scened-*

esmus ecornis (Ehrenberg) Chodat i *Gleocapsa turgida* (Kützing) Hollerbach. Najveća raznolikost zabilježena je u lipnju 2003.

Algae on macrophytes in the oligotrophic wetland Hutovo blato, Bosnia and Herzegovina

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The epiphytic algae on the floating leaves of *Nymphaea alba* L. and *Nuphar luteum* (L.) Sm. were subject to the research in the oligotrophic wetland Hutovo blato in June, August and September 2003, and October 2004. The wetland is situated in the south Bosnia and Herzegovina, and occupies area of 7441 ha. Samples were taken from 13 sites using methods of scraping sludgy material from the lower surface of leaves and stems. In total, 247 taxa were identified, 141 of them belong to phylum Ochrophyta, 73 Chlorophyta, 29 Cyanobacteria, three Dinophyta and one Rhodophyta. Diatoms had the greatest number and diversity of taxa (135 taxa). Genera with the greatest number of taxa were *Eunotia* (14), *Gomphonema* (13) *Cymbella* and *Navicula* (9), *Cyclotella* (6), *Diatoma* and *Nitzschia* (5). The most represented taxa were *Brebissonia lanceolata* (C. Agardh) Mahoney & Reimer, *Eunotia arcus* Ehrenberg, *Navicula radiosa* Kützing, *Desmodesmus quadricaudatus* (Turpin) Hegewald, *Scenedesmus ecornis* (Ehrenberg) Chodat and *Gleocapsa turgida* (Kützing) Hollerbach. The greatest diversity of taxa was recorded in June 2003.

Species area relationship (SAR) for phytoplankton

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Species-area relationship (SAR), i.e. how species number varies along spatial scales is one of the most intensively studied questions in ecology, but most of our current knowledge in this field is based on the study of macroscopic terrestrial systems. Species area relationship was studied for phytoplankton covering a habitat range of 10^{-2} to 10^{8} m^2. The relationship was studied at the level of samples taken from a single point from the water bodies. The results revealed that phytoplankton species-area relationship shows hump-shaped distribution. It increased up to 10^{5}-10^{6} m^2 and then showed decreasingtendency towards the larger lakes. We introduced a term "large lake effect" for this unusual phenomenon. This type of the distribution was attributable to the fact that the habitat diversity peaks at 10^{5} – 10^{6} m^2 range, while in the larger lakes the pelagial is more exposed to the homogenising effects of wind induced disturbances.

Unusual Dinophyta bloom in drinking water reservoir

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Reservoirs can provide suitable conditions for development of various algal blooms, which have adverse impact on water quality. Although most of the drinking water reservoirs were established in regions where the human impact is low, these systems may also be threatened by algal blooms. Spatial and temporal patterns of algal abundance and composition with respect to a series of physical and chemical properties were studied in a mountainous reservoir (Lázbérci-tározó, North-East Hungary) between May 2007 and September 2008. Our results suggest that nutrients (in particular TN, NO_3–N concentrations), turbidity, and hydrologic regime all played important roles in regulating algal biomass. The low level of nitrogen coupled with the internal release of phosphorus from the lake sediment under brief periods of anoxia helped the development of a unique dinoflagellates bloom. Strong significant relationship between algal biomass and organic carbon concentration was also demonstrated.

Primjena bentoskih dijatomeja u procjeni kakvoće vode prema Okvirnoj direktivi o vodama Europske unije (ODV EU) u krškim vodotocima Hrvatske i Mađarske

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Kao konstitutivni element obraštajne zajednice i sedimenta, bentoske se dijatomeje kao značajni pokazatelji ekoloških uvjeta u Europi i svijetu koriste za procjenu ekološkog stanja površinskih voda. Jedan od glavnih ciljeva Okvirne direktive o vodama Europske unije (ODV EU) je uspostava klasifikacijskih sustava u ocjeni ekološkog stanja tekućica koristeći biološke elemente kakvoće vode i tip-specifične referentne uvijete. Cilj rada je na osnovi bentoskih dijatomeja procijeniti primjenjivost hrvatskog i mađarskog sustava ocjene kakvoće vode u krškom području. U Hrvatskoj su uzorci sakupljani (tijekom vegetacijskog razdoblja od svibnja do rujna) u slatkovodnim dijelovima tokova rijeka Zrmanje (na pet postaja) i Krke (na tri postaje) te njihovih pritoka Krupe i Otuče (Zrmanja) te Butišnice, Radljevca, Bribišnice, Kosovčice i Orašnice (Krka). U Mađarskoj je uzorkovan Tárkány- Eger kompleks potoka na planini Bükk, kraj grada Eger (sjeveroistočna Mađarska), od izvora do ušća u razdoblju od proljeća do jeseni. Dijatomeje su uzorkovane na prirodnim supstratima (pretežno na kamenju), konzervirane formalinom i očišćene kiselinama u svrhu pripreme trajnih preparata. Učestalost pojedine vrste određena je identifikacijom i brojanjem 400 frustula na svakom trajnom preparatu. Uzorci za kemijsku analizu vode uzimani su istodobno s uzorkovanjem zajednice bentoskih dijatomeja. Kakvoća ispitivanih vodotoka određena je multimetrijskim indeksima hrvatskog (Hrvatski trofički indeks dijatomeja - TID_{HR}, Hrvatski saprobni indeks dijatomeja-SID_{HRIS} i IPS - indeks osjetljivosti na onečišćenje) i mađarskog sustava (TID, SID i IPS). Statistička obrada dobivenih rezultata predmet su daljnje rasprave i interkalibracijskog procesa.

Application of benthic diatoms in water quality assessment according to the EU *Water Framework Directive* (WFD) in Croatian and Hungarian karstic watercourses

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As constitutive part of benthic community, diatoms are, as good environmental indicators, widely used in Europe and worldwide to access ecological status of running waters. Also, one of key goals of Water Framework Directive is to classify rivers and streams using biological quality parameters and type specific reference conditions. The goal of this paper is to access the applicability of Croatian and Hungarian system for water quality assessment to karstic waters. The samples in Croatia were collected (during vegetation season, from May to September) in freshwater courses of the Zrmanja (five sampling points) and Krka rivers (three sampling points) and tributaries Krupa and Otuča as well as Butišnica, Radljevac, Bribišnica, Kosovčica and Orašnica of Zrmanja and Krka, respectively. In Hungary samples were collected in karstic Tárkány- Eger creek complex, in the Bükk Mountain, near Eger city, from source to the inflow during a year (in spring, summer and autumn). Diatoms were sampled from natural substrate (predominantly rocks), fixed in formaldehyde and acid cleaned prior to preparation of permanent slides. Abundance was determined by identification and counting of 400 frustules on each permanent slide. Along with samples of natural benthic diatom communities, samples of water for chemical analyses ware also taken. Water quality of investigated sites was determined using multimetric indices of Croatian (Croatian trophic diatom index - TID_{HR}, Croatian saprobic index - SID_{HRIS} and index of diatom sensitivity to pollution – IPS) and Hungarian system (TID, SID and IPS). Differences in observed results are statistically evaluated and further discussed.

Fitoplankton u vodama Kopačkog rita - promjene i trendovi

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Kopački rit je najveće očuvano poplavno područje srednjeg toka Dunava, kojeg karakteriziraju različiti tipovi vodenih i vlažnih staništa, čija dinamika plavljenja u najvećoj mjeri ovisi o vodostaju Dunava i dotoku poplavnih voda. Prvi sustavni popis fitoplanktonskih svojti u vodama Kopačkog rita koji obuhvaća 303 vrste, 45 varijeteta i 14 formi objavila je Dragica Gucunski (1975) čime su potaknuta daljnja sustavna istraživanja fitoplanktona voda Kopačkog rita, a također i razvoj algologije u Hrvatskoj. Tako se istraživanja strukture i ekologije fitoplanktona obavljaju kontinuirano već više desetljeća u svrhu utvrđivanjaekološkog stanja i promjena u složenom ekološkom sustavu rijeka-poplavno područje. Do sada je u taksonomskom sastavu fitoplanktona utvrđeno više od 600 svojti. Općenito, u sukcesijama fitoplanktonskih zajednica karakteristične su sljedeće faze: dijatomeje u rano proljeće, kasnu jesen i zimu, Chrysophyceae kasno u proljeće i jesen, „faza čiste vode" i dominacija vrsta iz razreda Cryptophyceae u svibnju te zajednica klorokokalnih zelenih alga i cijanobakterija u ljeto. Zanimljiva je pojava „red-tide" uzrokovana masovnim razvojem *Peridinium* spp. u jesen 1999. Invazivna vrsta *Cylindrospermopsis raciborskii* (Wol.) Subba Raju, tropski element u vodama umjerenog područja, utvrđena je u vodama Kopačkog rita u ljeto 2003., od kada se povremeno masovno razvija. Na promjene fitoplanktonskih zajednica najviše utječe dinamika plavljenja te su novija istraživanja pokazala kako poplave mogu imati dvojaki učinak na razvoj fitoplanktona. U proljeće pogoduju razvoju fitoplanktona obogaćivanjem voda nutrijentima, dok kasnije u ljeto predstavljaju disturbanciju za razvoj fitoplanktona zbog miješanja vodenog stupca,

razrijeđivanja nutrijenata i „ispiranja“ razvijene fitoplanktonske zajednice iz trajnih vodenih lokaliteta. Suvremena istraživanja fitoplanktona orijentirana su na klasifikaciju fitoplanktona na temelju morfoloških i funkcionalnih karakteristika te se primjenjuju različiti klasifikacijski sustavi. Rezultati tih istraživanja pokazuju da je poplavna faza karakterizirana s dijatomejama i klorokokalnim zelenim algama iz različitih funkcionalnih i morfo-funkcionalnih skupina koje su karakteristične za mutne i dobro izmiješane vode, dok velika količina nutrijenata i hidrološka stabilnost sustava omogućava dominaciju cijanobakterija. Pojave ekstremnih uvjeta, kao što su dugotrajna sušna razdoblja ili dugotrajna ekstremno poplavna razdoblja,rezultiraju u promjenama količine i strukture fitoplanktonskih zajednica od stanja „mutne vode“ u stanje „čiste vode“te ukazujuna moguće značajne posljedice globalnih klimatskih promjena.

Long-term changes of phytoplankton in the floodplain waters of Kopački Rit Nature Park

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Kopački Rit Nature Parkis one of the largest preserved natural floodplains of the Middle Danube stretch. This internationally important wetland provides a diversity of water and wet biotopes continuously changing depending on the inflow of river water. The first complete checklist ofits phytoplankton flora listing 303 species, 45 varieties and 14 forms was compiled by DragicaGucunski (1975) whose results encouraged future research on the KopačkiRit phytoplankton and gave large contribution to the development of algology in Croatia. The investigations of phytoplankton community structure and ecology have been conducted continuously for several decades in order to define the ecological state and changes in this complex river-floodplain system. So far, more than 600 phytoplankton taxa have been listed. In general, the seasonal phytoplankton succession pattern is characterised by diatoms in early spring, late autumn and winter, Chrysophyceae later in the spring and autumn, “clear-water phase”and dominance of Cryptophyceae in May, as well as the development of chlorococcal green algae and Cyanobacteria in summer. It is interesting to note the appearance of a “red tide”caused by massive development of *Peridinium* species in the autumn of 1999. Invasive species *Cylindrospermopsis raciborskii* (Wol.) Subba Raju, a tropical element in temperate waters, was detected in the summer of 2003. Since then, massive blooms have occurred periodically. Changes in phytoplankton communities depend mostly on flooding dynamics and recent investigations showed dual impact of flooding on phytoplankton development. The stimulative effect in spring is seen through nutrient enrichment, while later in the summer flooding acts as a disturbance causing water column mixing, nutrient dilution and washout effect. Current research is focused on phytoplankton classifications based on speciesmorphological and functional traits using different classification systems. Results show that the flood phase in the river-floodplain system is characterised by diatoms and chlorococcal green algae from different functional and morpho-functional groups characteristic for turbid and well-mixed waters, while large amount of nutrients and hydrological stability enabled the domination of Cyanobacteria. Extreme hydrological events such as long-term dry periods or extreme floods which are more frequent in this part of the Danube, result in the changes of phytoplankton abundance and community structure from “turbid state” to a “clear state” showing the possible consequences of global climatic changes.

Prostorna raspodjela fitoplanktona u poplavnom području Dunava (Park prirode Kopački rit)

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Riječna su poplavna područja karakterizirana velikom raznolikošću vodenih staništa u kojima je hidrološka povezanost sa matičnom rijekom jedan od najvažnijih ekoloških čimbenika. Ovim su istraživanjem analizirane prostorne raspodjele fitoplanktona u različitim tipovima vodenih staništa (eupotamal, parapotamal i paleopotamal) Kopačkog rita u odnosu na stupanj povezanosti s matičnom rijekom (Dunav). Istraživanjem je obuhvaćeno pet lokaliteta u lateralnom smjeru: Dunav - Hulovski kanal - Kopačko jezero - kanal Čonakut - Sakadaško jezero. Biomasa fitoplanktona izračunata je iz broja i volumena fitoplanktonskih jedinki i izražena kao mg/L svježe tvari. Za vrijeme hidrološke povezanosti dijatomeje su činile najveći udio ukupne fitoplanktonske biomase u svim lokalitetima. Na temelju redundancijske analize, razvoj dijatomeja je vezan uz veću dubinu i prozirnost vode te veću koncentraciju nutrijenata. Udio dijatomeja u ukupnoj biomasi smanjivao se s udaljenošću lokaliteta od matične rijeke. Tako je njihov najveći udio utvrđen u Dunavu (do 96.6%) i Hulovskom kanalu (do 82.9%), dok je u ostalim lokalitetima (Kopačko jezero, kanal Čonakut i Sakadaško jezero) njihov udio iznosio do 51.8%. Osim različitih vrsta dijatomeja, kriptofita i kolonijalne fitomonadine bile su dobro zastupljene tijekom poplavnih razdoblja. U vrijeme hidrološke izoliranosti istraživanih lokaliteta dominantnu su zajednicu činile različite vrste cijanobakterija, a subdominantne su bile klorokokalne zelene alge. Zbog masovnog razvoja cijanobakterija vrijednosti ukupne biomase fitoplanktona dostizale su do 185.5 mg/L, a udio cijanobakterija iznosio je do 92.9%. U Dunavu su dijatomeje ostale dominantne, ali je došlo do sukcesije vrsta. Na temelju redundancijske analize, razvoju fitoplanktona u uvjetima hidrološke izoliranosti u svim lokalitetima pogodovala je viša temperatura vode, manja dubina i prozirnost vode. Sveukupno, udaljenost lokaliteta i hidrološka povezanost s matičnom rijekom značajno su utjecali na strukturu fitoplanktonske zajednice pa tako i na ukupno ekološko stanje mikrolokaliteta poplavnog područja.

Spatial distribution of phytoplankton along a Danube floodplain system (Kopački Rit Nature Park)

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River-floodplain systems are characterized by a high level of habitat heterogeneity where the hydrological connection with the river has been recognized as the most important environmental parameter. The aim of the present research is to analyze phytoplankton spatial distribution in the different types of aquatic habitats (eupotamal, parapotamal and paleopotamal) in Kopački Rit Nature Park in relation to the hydrological connection with the river (Danube). The study included five floodplain habitats with their different location in the lateral direction: Danube - Channel Hulovo - Lake Kopačko - Channel Čonakut - Lake Sakadaš. Phytoplankton biomass was calculated from the number and volume of phytoplankton individuals and expressed as mg/L fresh mass. During the hydrological connectivity diatoms comprised the largest contribution to the total phytoplankton biomass in all sites. According to the redundancy analysis, the development of diatoms was associated with higher water depth, transparency and concentration of nutrients. Relative biomass of diatoms decreased with the distance of the floodplain sites from the river. The highest contribution of diatoms to the total biomass was

found in the Danube (up to 96.6%) and Channel Hulovo (up to 82.9%), while in the other sites (Lake Kopačko, Channel Čonakut and Lake Sakadaš) their contribution was up to 51.8%. Besides different diatom species, other groups such as cryptophytes and colonial phytomonads which were well represented during the flood period appeared to indicate altered conditions in the floodplain driven by flooding. During the isolation period, different species of Cyanobacteria were dominant followed by chlorococcal green algae. In that time, high values of total phytoplankton biomass in the floodplain sites were found (up to 185.5 mg/L), with high contribution of Cyanobacterial species (up to 92.9%). In the Danube, diatoms remained dominant species exhibiting a different pattern of species succession. According to the redundancy analysis, the development of phytoplankton during the hydrological isolation was associated with a higher water temperature, lower water depth and transparency. Altogether, the location of the floodplain sites in relation to the river and hydrological connectivity between the river and its floodplain significantly influenced the phytoplankton community structure and the overall ecological condition of floodplain microlocalities.

Variability of *microcystins* and its synthetase gene cluster in Microcystis Lemmermann 1907 and *Planktothrix* Anagnostidis et Komárek water-blooms in shallow lakes of Hungary

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Water-bloom samples of *Microcystis aeruginosa* and *Planktothrix agardhii* were collected from a variety of ponds, lakes and reservoirs in Hungary. Samples were tested with matrix-assisted laser desorption/ionization–time-of-flight mass spectrometry (MALDI-TOF MS) to identify the microcystin forms. The concentration of the microcystins was measured with capillary electrophoresis and the toxicity was tested by sinapis test. DNA was extracted from the samples and tested using a range of primers linked to the biosynthesis of microcystin. The results showed that a wide range of microcystin (MC) forms were detected in the *Microcystis* containing samples, among which MC-LR, -RR, - and -YR were the most common. The highest MC concentration was 15,701 mg g^{-1}, which was detected in an angling pond. The samples containing *Planktothrix agardhii* were less toxic, and the most common form was the Asp3-MC-LR.

Biocenotička struktura fitoplanktonskih zajednica u dubokim krškim jezerima (NP Plitvička jezera)

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Plitvička jezera su specifični geološki i hidrogeološki krški fenomen, sastavljen od 16 kaskadnih jezera smještenih u centralnom dijelu Hrvatske. Istraživanje je provedeno na jezeru Prošće (636 m nm, površine 0,68 km^2 i dubine 37 m) i Kozjak (534 m nm, dubine 46 m i površine 0,83 km^2). Uzorci za fizikalno-kemijsku analizu vode te za određivanje fitoplanktona uzimani su na najdubljem dijelu jezera jednom mjesečno tijekom 2009. i 2010. godine. Biomasa fitoplanktona određena je iz brojnosti i volumena stanice svake pojedine vrste. U jezeru Kozjak određeno je 80 vrsta svrstanih u 7 kategorija: Bacillariophyta (27), Chlorophyta (26), Chrysophyta (8), Cyanobacteria (8), Dinophyta (7), Cryptophyta (2) i Euglenophyta (2). U ukupnoj biomasi fitoplanktona dominantna je skupina Bacillariophyta (prosječno 0,53 mg l^{-1}), a subdominantna Chrysophyta (prosječno 0,17 mg l^{-1}). Prema brojnosti i biomasi dominantno je nekoliko vrsta centričkih (*Cyclotella* spp. (Kützing) Brébisson, *Discostella stelligera* (Cleve & Grunow) Houk & Klee) i penatnih dijatomeja (*Synedra* sp. Ehrenberg, *Ulnaria ulna* var. *acus* (Kützing) Lange-Bertalot) te *Dinobryon divergens* O.E.Imhof. Dinoflagelati (*Peridinium* spp. Ehrenberg) su zastupljeni tijekom čitave godine, dok kolonijalne vrste Chrysophyta (*Dinobryon sociale* (Ehrenberg) Ehrenberg, *D. cylindricum* O.E.Imhof) pokazuju veću brojnost u proljeće i zimu. Planktonske (*Asterionella formosa* Hassall) i bentičke dijatomeje (*Achnanthidium* sp. Kützing) te jednostanični (*Closteriopsis acicularis* (Chodat) J.H.Belcher & Swale) i kolonijalni oblici Chlorophyta (*Elakatothrix gelatinosa* Wille) prisutni su u svim sezonama s relativno malim udjelom u ukupnoj biomasi fitoplanktona. Zajednicu karakteriziraju vrste roda *Cyclotella*, *Synedra* i *Dinobryon*. Taksonomski sastav jezera Prošće obuhvaća 52 vrste u 7 skupina: Bacillariophyta (18), Chlorophyta (16), Chrysophyta (7), Cyanobacteria (5), Dinophyta (4), Cryptophyta (1) i Euglenophyta (1). Najveću biomasu u fitoplanktonskoj zajednici ima skupina Chrysophyta (prosječno 1,66 mg l^{-1}), dok su subdominantne skupine Dinophyta (prosječno 0,21 mg l^{-1}) i Bacillariophyta (prosječno 0,20 mg l^{-1}). Cvjetanje vrste *Dinobryon sociale* uzrokuje njenu potpunu dominaciju u proljeće. Neke vrste Chrysophyta (*Dinobryon divergens*), flagelatnih Cryptophyta (*Cryptomonas* sp. Ehrenberg) i planktonskih dijatomeja (*Stephanodiscus* sp. Ehrenberg, *Fragilaria crotonensis* Kitton) ističu se brojnošću i biomasom u svim uzorcima. Brojnost i biomasa dinoflagelata (*Peridinium inconspicuum* Lemmermann, *P. volzii* Huitfeldt-Kaas) veće su tijekom proljeća i zime. Visoku učestalost pojavljivanja s relativno malim udjelom u ukupnoj biomasi imaju neke dijatomeje (*Asterionella formosa*, *Cyclotella* sp., *Achnanthidium* sp., *Navicula* sp. Bory de Saint-Vincent), Chlorophyta (*Oocystis pusilla* Hansgirg, *Ankyra judayi* (G.M.Smith) Fott, *Elakatothrix gelatinosa*) te *Bitrichia chodatii* (Reverdin), dok nisku učestalost pojavljivanja sa značajnom biomasom imaju *Coenococcus planctonicus* Korshikov, *Cymbella* sp. C.Agardh, *Ulnaria ulna* var. *acus*, *Dinobryon sertularia* Ehrenberg i *D. cylindricum*. Zajednicu karakteriziraju vrste roda *Dinobryon*, *Stephanodiscus*, *Fragilaria* i *Peridinium*.

Biocenotical structure of phytoplankton communities in deep karstic lakes (Plitvice Lakes NP)

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Plitvice Lakes are a specific hydrogeological phenomenon, made of 16 cascading lakes in the central part of Croatia. The study was conducted at Lakes Prošće (636 m asl, area 0.68 km^2, depth 37 m) and Kozjak (534 m asl, depth 46 m, area 0.83 km^2). Samples for water analysis and phytoplankton determination were taken monthly during 2009 and 2010 at the deepest point. Biomass was estimated from the product of the population and the mean cell volumes. In Lake Kozjak a total of 80 taxa were identified, distributed in seven taxonomic divisions: Bacillariophyta (27), Chlorophyta (26), Chrysophyta (8), Cyanobacteria (8), Dinophyta (7), Cryptophyta (2), Euglenophyta (2). In terms of total phytoplankton biomass, the most representative group was Bacillariophyta (avg 0.53 mg l^{-1}), with Chrysophyta as a subdominant group (avg 0.17 mg l^{-1}). Several centric (*Cyclotella* spp. (Kützing) Brébisson, *Discostella stelligera (*Cleve & Grunow) Houk & Klee) and pennate diatoms (*Synedra* sp. Ehrenberg, *Ulnaria ulna* var. *acus* (Kützing) Lange-Bertalot), together with *Dinobryon divergens* O.E.Imhof were dominant, thus characterizing the community. Dinophyceans (*Peridinium* spp. Ehrenberg) were less numerous but contributed considerably to the biomass, while colonial chrysophytes (*Dinobryon sociale* (Ehrenberg) Ehrenberg, *D. cylindricum* O.E.Imhof) were well represented in spring and winter. Planktonic (*Asterionella formosa* Hassall) and benthic diatoms (*Achnanthidium* sp. Kützing) along with unicellular (*Closteriopsis acicularis* (Chodat) J.H.Belcher & Swale) and colonial chlorophyceans (*Elakatothrix gelatinosa* Wille) were frequently present throughout the seasons, but with small biomass contribution. Species composition of Lake Prošće revealed 52 taxa distributed in seven taxonomic divisions: Bacillariophyta (18), Chlorophyta (16), Chrysophyta (7), Cyanobacteria (5), Dinophyta (4), Cryptophyta (1), Euglenophyta (1). Total phytoplankton biomass was dominated by Chrysophyceans (avg 1.66 mg l^{-1}), while Dinophyta (avg 0.21 mg l^{-1}) and Bacillariophyta (avg 0.20 mg l^{-1}) were subdominant. During the spring the phytoplankton community was almost completely dominated by the bloom of *Dinobryon sociale*. Some chrysophyceans (*D. divergens*), flagellate cryptophyceans (*Cryptomonas* sp. Ehrenberg), and planktonic diatoms (*Stephanodiscus* sp. Ehrenberg, *Fragilaria crotonensis* Kitton) were abundant and contributed considerably to the biomass in all samples, therefore characterizing the community. Dinophyceans (*Peridinium inconspicuum* Lemmermann, *P. volzii* Huitfeldt-Kaas) were numerically abundant in spring and winter, showing high contribution to the overall biomass. Several diatom (*Asterionella formosa*, *Cyclotella* sp., *Achnanthidium* sp., *Navicula* sp. Bory de Saint-Vincent) and chlorophycean species (*Oocystis pusilla* Hansgirg, *Ankyra judayi* (G.M.Smith) Fott, *Elakatothrix gelatinosa*) along with *Bitrichia chodatii* (Reverdin) Chodat, showed a relatively high frequency of occurrence, but with low biomass contribution. Several species occurred with low frequency, but with a notable biomass: *Coenococcus planctonicus* Korshikov, *Cymbella* sp. C.Agardh, *Ulnaria ulna* var. *acus*, *Dinobryon sertularia* Ehrenberg and *D. cylindricum*.

Razvoj perifitonskih alga u uvjetima disturbancija u poplavnom području Dunava

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Razvoj alga u obraštajnim zajednicama u poplavnom području Dunava (Sakadaško jezero, Park Prirode Kopački rit) istraživan je na umjetnim (staklenim) podlogama u dvije eksperimentalne serije. Kako bi se utvrdio utjecaj sezonskih promjena na razvoj obraštaja, prva eksperimentalna serija je postavljena u proljeće, a druga u ljeto 2010. Ekstremne i dugotrajne poplave u proljeće i ljeto utjecale su na promjene fizikalno-kemijskih svojstava vode jezera te pridonijele širenju metafitona i makrofitske vegetacije. Metodom nemetrijskog višedimenzijskog grupiranja utvrđene su tri faze u razvoju obraštajnih zajednica. Početnu fazu rasta u obje istraživane serije karakteriziralo je kontinuirano povećanje ukupne biomase obraštaja (suhe tvari, organske i anorganske tvari), koncentracije klorofila i ukupnog broja jedinki alga. Razvoj zajednica od dijatomeja priljubljenih uz podlogu (*Stephanodiscus*) te postupnog izdizanja obraštaja kolonizacijom dijatomeja na stapkama (*Gomphonema*, *Encyonema*) i formiranje trodimenzionalne strukture, obilježilo je početnu fazu rasta u proljeće. Rano naseljavanje nitastih zelenih alga (*Oedogonium* sp.) obilježilo je razvoj zajednica u ljeto. Širenjem metafitona i makrofitske vegetacije nastali su nepovoljni uvjeti za daljnji razvoj perifitona. Zasjenjenje, mehaničko oštećenje obraštaja te jaki hranidbeni pritisak doveli su do faze gubitka obraštaja koju je karakterizirala mala biomasa. Kao odgovor na disturbancije zajednice su vraćene u ranu fazu razvoja s dominacijom dijatomeja čvrsto priljubljenih uz podlogu (*Epithemia*, *Cocconeis*). Prestankom plavljenja i odumiranjem metafitona i makrofitske vegetacije u jesen, nastali su povoljni uvjeti za oporavak zajednica i brzi razvoj alga u obraštaju. Sveukupno, složene promjene okolišnih uvjeta uzrokovane ekstremnim poplavama mogu značajno utjecati na razvoj alga u obraštaju. Daljnja istraživanja su neophodna kako bi se rasvijetlile vrlo složene interakcije između obraštaja i drugih biocenoza u vodenim ekosustavima poplavnih područja.

The response of periphytic algal assemblages to disturbances - field study in a temperate floodplain lake

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Temporal variations in periphytic algal communities were studied in Lake Sakadaš, a part of a Danubian floodplain known as Kopački Rit Nature Park. An *in situ* investigation was performed using artificial substrata (glass slides) exposed in the lake in two study series, spring and summer, and incubated until the winter 2010. Due to the extremely high and long-lasting spring-summer flooding, the physical and chemical environment significantly varied, and metaphyton and macrophytes were spread along the lake. Based on the non-metric multidimensional scaling, three phases were identified in the periphytic algal development. The initial accrual phase, in both spring and summer series, was characterized by the continuous increase in periphyton biomass (dry weight, organic weight, and ash-weigh), chlorophyll concentrations, and algal abundance. Diatom successions from low-profile species (*Stephanodiscus*) to the stalk-forming species (*Gomphonema*, *Encyonema*) with a tendency towards vertical overgrowth characterized periphyton communities in spring. Rapid development of filamentous green algae (*Oedogonium* sp.) characterized periphyton accrual in summer. Huge stands of metaphyton and macrophytes acted as a disturbance to periphytic algal accrual. Shading and mechanical injuries together with high grazing pressure led to a periphyton loss phases. Resetting of the algal community to an earlier stage of development, with diatoms firmly attached to the substrata (e.g. *Epithemia*, *Cocconeis*)

shows periphyton response to disturbance. The cessation of hydrological perturbations created an opportunity for periphyton development and the rapid accrual of algal communities occurred in autumn. In conclusion, the complexity of environmental changes caused by extreme flooding can significantly influence development of periphytic algal communities in a temperate floodplain. Further investigations are necessary to elucidate very complex interactions between periphyton and other aquatic biocenoses in river-floodplain systems.

Ima li akvakultura utjecaj na raspodjelu fitoplanktona u Malostonskom zaljevu?

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Malostonski zaljev je vrlo važno područje za uzgoj školjkaša koji vrše jak predacijski pritisak na fitoplanktonsku populaciju. U cilju praćenja dinamike populacija fitoplanktona, usporedili smo podatke abundancije iz razdoblja 1979-1989, 2002 i 2011-2012 godine. Uočene su razlike u sukcesiji i strukturi fitoplanktonskih zajednica tijekom istraživanih razdoblja. Promjene u taksonomskom sastavu i smanjenje abundancije fitoplanktona, kao i promjena trofičkog statusa u Malostonskom zaljevu mogli bi biti posljedica prekapacitiranosti ekosustava akvakulturom. Također, nekada ekološki stabilan ekosustav postao je osiromašeno područje za uzgoj školjkaša s potencijalnim rizikom od štetnih fitoplanktonskih cvatnji.

Does aquaculture have an impact on the distribution of phytoplankton in Mali Ston Bay?

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Mali Ston Bay is a very important area for shellfish cultivation, which exerts a strong predation pressure on phytoplankton populations.In order to monitorthe dynamics ofphytoplanktonpopulations we compared the dataon theabundancesfrom the periods of 1979-1989, 2002 and 2011-2012. No general pattern of phytplankton succesion and differences of community structure were observed during the study. Changes in phytoplankton composition and reduction of abundance, as well as the altered trophic status of the Mali Ston Bay could be a consequence of an aquaculture overcapacity in the ecosystem. Furthermore, a once ecologically stable ecosystem now becomes a potentially impoverished area for shellfish aquaculture with attendant risks of harmful algal blooms.

Taksonomski sastav, dubinska rasprostranjenost i fitogeografske značajke morske bentoske makroflore na užem području Splita (srednji Jadran, Hrvatska)

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Ovaj popis bentoskih morskih makroalgi i morskih cvjetnica temelji se na podacima istraživanja provedenih od 1950. do 2013. godine. U uže područje Splita uključeni su južna obala grada Splita od Instituta za oceanografiju i ribarstvo do Stobreča, zapadni dio poluotoka Marjan od Instituta do uvale Vranjic te sjeverna obala grada od uvale Vranjic do Kaštel Gomilice. Popis sadrži ukupno 358 svojti bentoskih alga i četiri vrste morskih cvjetnica. Od ukupnog broja svojti, njih 318 pripada vrsti, a 44 nižim taksonomskim kategorijama (2 podvrste, 31 odlika i 11 oblika). Najviše su zastupljene svojte iz odjeljka *Rhodophyta* (215 svojti ili 59,4%), a slijede ih svojte iz odjeljaka *Ochrophyta* (74 svojti ili 20,4%) i *Chlorophyta* (69 svojti ili 19,1%). Određene su sve četiri morske cvjetnice koje obitavaju uz istočnu obalu Jadranskog mora (*Posidonia oceanica, Cymodocea nodosa, Zostera marina* i Z. noltii) koje čine oko 1% ukupnog broja svojti zabilježenih u bentoskoj flori na užem području Splita. Prema vrijednostima kvocijenata R/P (Feldmann, 1937; 2.91) i R+C/P (Cheney, 1977; 3.84) bentoska flora užeg splitskog područja ima suptropski karakter. U fitogeografskom sastavu brojem i postotkom prevladavaju atlantski (80 svojti ili 22,1%), subkozmopolitski (73 svojte ili 20,2), mediteranski (69 svojti ili 19,1%) i indo-atlantski (49 svojte ili 13,5%) florni elementi, koji ukupno obuhvaćaju 271 svojte ili 74,9% svih dosad određenih svojti bentoskih alga i morskih cvjetnica (362) u podmorju užeg područja Splita.
U odnosu na zastupljenost bentoske flore na pojedinoj bionomskoj stepenici, najveći je broj svojti zabilježen u gornjem infralitoralu (312), dosta manje u srednjem (212) i donjem infralitoralu (117), a najmanji u eulitoralu (63). U stepenici supralitorala nađena je samo jedna vrsta.

Taxonomic composition, depth distribution and phytogeographic characteristics of marine benthic macroflora in Split area (middle Adriatic, Croatia)

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This list of benthic marine macroalgae and seagrasses is based on data from surveys conducted from 1950 to 2013. Split area includes the southern coast of the city of Split from the Institute of Oceanography and Fisheries to Stobreč, the western part of the peninsula Marjan from the Institute to the Vranjic bay and the northern coast of the Vranjic bay to Kaštel Gomilica. The list contains 358 taxa belonging to the *Rhodophyta* (215 taxa or 59.4%), the *Ochrophyta* (74 taxa or 20.4%), the *Chlorophyta* (69 taxa or 19.1%) and the *Magnoliophyta* (4 species or 1.0%), of which 318 are at specific level and 44 are infraspecific (2 subspecies, 31 varieties, 11 forms). The established ratio between the number of *Rhodophyta* and *Phaeophyceae* (R/P Index; Feldmann, 1937) was 2.91, and relation between the number of *Rhodophyta* + *Chlorophyta* and *Phaeophyceae* (R+C/P Index; Cheney, 1977) was 3.84. Both of these values show a subtropical character of benthic macroalgal flora in the surveyed area. With regard to its origin, benthic flora in the area of Split is not homogenous. It comprises floral elements from several phytogeographic regions. Predominant by number and percentage are Atlantic (80 taxa – 22.1%), subcosmopolitan (73 taxa – 20.2%), Mediterranean (69 taxa – 19.1%), and Indo-Atlantic (49 taxa – 13.5%) floral elements. Other phytogeographic regions contribute to marine algal flora by only 91 taxa - 25.1% of the total 362 taxa recorded. The analysis of benthic flora in relation to littoral bionomical zones reveals that the highest number of algal taxa is recorded in the upper infralittoral zone (312) and the lowest (the supralittoral excluded) in the eulittoral zone (63).

Koncentracija hranjivih soli i klorofila a u Neumskom zaljevu (Bosna i Hercegovina)

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Uzorci za analizu fizikalno-kemijskih parametara mjesečno su prikupljani u razdoblju od prosinca 2010. do prosinca 2011. na jednoj postaji u Neumskom zaljevu (Bosna i Hercegovina). Cilj rada je bio odrediti koncentracije hranjivih soli i klorofila *a* te procijeniti stupanj eutrofikacije. U tu svrhu uzorci su sakupljeni Niskinovim crpcem volumena 5 L na dubinama 1, 5, 10 i 20 m. Utvrđeni su slijedeći rasponi koncentracija hranjivih soli: ukupni anorganski dušik (TIN) 0,35-6,13 μM, ortofosfat (PO_4) 0,02-0,48 μM i ortosilikat (SiO_4) 0,48-17,89 μM. Prvi potencijalno limitirajući čimbenik rasta fitoplanktona je PO_4 čija je koncentracija u većini uzoraka ispod konstante poluzasićenja tipične za obalni fitoplankton. Koncentracije SiO_4 (za obalne populacije dijatomeja) i TIN-a većim dijelom godine bile su iznad konstante poluzasićenja. Vrijednosti trofičkog indeksa (TRIX-a), uglavnom manje od 4, karakteriziraju područje Neumskog zaljeva kao oligotrofno.

Nutrient and chlorophyll a concentrations in the Bay of Neum (Bosnia and Herzegovina)

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Samples for the analysis of physical-chemical parameters were collected monthly in the period from December 2010 to December 2011 at one station in the Bay of Neum (Bosnia and Herzegovina). The aim of this study was to determine nutrient and Chl *a* concentrations, and to estimate the level of eutrophication. For this purpose, water samples were taken with 5-L Niskin bottles at the depths of 1, 5, 10 and 20 m. Total inorganic nitrogen (TIN) ranged from 0.35 μM to 6.13 μM, orthophosphate from 0.02 μM to 0.48 μM and ortosilicate from 0.48 μM to17.89 μM. The main potentially limiting factor for phytoplankton growth is PO_4 whose concentration is under half-saturation constants for coastal phytoplankton in the most of samples. Concentrations of SiO_4 (for coastal diatom populations) and TIN were above half-saturation constants for the most of the year. Trophic index (TRIX) values mostly lower than 4 characterized the Bay of Neum as oligotrophic.

Taksonomski sastav bentoskih dijatomeja (Bacillariophyta) u Neumskom zaljevu (Bosna i Hercegovina)

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U razdoblju od ožujka 2010. do prosinca 2011. u Neumskom zaljevu su u mjesečnim intervalima na jednoj postaji (N 42° 54' 58.7" E 17° 36' 17.6") uzimani uzorci bentoskih dijatomeja s dubina 1 i 8 metara. Uzorci su konzervirani 4% formalinom, dok su trajni preparati pripremljeni metodom prema Hustedtu (1930). Uzorci su pregledavani mikroskopom Microstar (AO Scientific Instruments) koristeći imerzijski objektiv 100x. Na temelju 30 sakupljenih uzoraka, utvrđeno je 414 svojta koje su svrstane unutar 92 roda. Od toga 72 roda pripada redu Pennales, a 20 Centrales. Najveći broj svojta imali su rodovi *Mastogloia* Thwaites (36 svojta), *Nitzschia* Hassall (34), *Amphora* C.G.Ehrenberg (32), *Diploneis* C.G.Ehrenberg i *Navicula* Bory (25) te *Cocconeis* C.G.Ehrenberg (18) i *Surirella* Turpin (15). Ovim istraživanjem dobiveni su prvi podaci o taksonomskom sastavu morskih dijatomeja u Bosni i Hercegovini.

Taxonomic composition of benthic diatoms (Bacillariophyta) in the Bay of Neum (Bosnia and Herzegovina)

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Samples for analysis of benthic diatoms were collected at one station (N 42° 54' 58.7" E 17° 36' 17.6") in the Bay of Neum (Bosnia and Herzegovina) in the period from March 2010 to December 2011. The station was visited monthly and samples were taken at 1 and 8 m depths. Samples were fixed in a 4% formalin solution and prepared for investigation by cleaning frustules using the method described by Hustedt (1930). Examination and identification of benthic diatoms were carried out using the oil immersion lens (100x) of the *Microstar binocular microscope*, AO Scientific Instruments. A total of 414 diatom taxa belonging to 92 genera were identified. Seventy-two of the genera belong to the Pennales and 20 to the Centrales. The highest number of taxa occurred within genera *Mastogloia* Thwaites (36), *Nitzschia* Hassall (34), *Amphora* C.G.Ehrenberg (32), Diploneis C.G.Ehrenberg and *Navicula* Bory (25), *Cocconeis* C.G.Ehrenberg (18), and *Surirella* Turpin (15). This study presents the first data on composition of marine benthic diatoms in Bosnia and Herzegovina.

Fitoplankton u Neumskom zaljevu (Bosna i Hercegovina)

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U razdoblju od siječnja do prosinca 2011. na jednoj postaji u Neumskom zaljevu (Bosna i Hercegovina), mjesečno su uzorkovani fizikalno-kemijski parametri te fitoplankton. Cilj rada je bio analizirati sastav mrežnog fitoplanktona. U tu svrhu uzorci su sakupljeni fitoplanktonskom mrežom promjera pora 20 µm potezom od dna do površine. Uzroci su konzervirani 2 % formalinom te obrađeni pod svjetlosnim i pretražnim elektronskim mikroskopom. Utvrđena je 131 svojta fitoplanktona, od toga najviše dinoflagelata. Sastav fitoplanktona je sličan s populacijama u unutrašnjem dijelu Malostonskog zaljeva te u donjem dijelu estuarija Neretve. To su ujedno prvi detaljni podaci o sastavu morskog fitoplanktona u Bosni i Hercegovini.

Phytoplankton in the Bay of Neum (Bosnia and Herzegovina)

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Samples for the analysis of physico-chemical parameters and phytoplankton were collected at one station in the Bay of Neum (Bosnia and Herzegovina). The station was visited monthly in period from January to December 2011. The aim of this study was to analyze the composition of net-phytoplankton. For this purpose, vertical hauls with a 20 µm mesh-net have been used. Samples were preserved in 2 % neutralized formalin and observed with a light and scannning electon microscope. We identified 131 phytoplankton species, of which the most dinoflagellates. Phytoplankton composition is similar to the populations in the inner part of the Mali Ston Bay or the lower Neretva River estuary. Our study presents the first detailed data on the composition of marine phytoplankton in Bosnia and Herzegovina.

Alge – pluća zemlje koja nam daju svaki drugi udisaj

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Alge su velika i raznolika skupina autotrofnih organizama. Zbog činjenice da pripadaju dvamazasebnim životnim carstvima (monerai protista), pojam 'alge' ne označava nikakvu sistematsku kategoriju nego isključivo životni oblik. Generalno se dijele na zelene, crvene i smeđe alge. Veličine im se kreću od mikroskopskih oblika, građenih od jedne stanice, do višestaničnih organizama kao što su kelpovi koji mogu narasti do 60 metara. Alge su najvažniji proizvođači organske tvari i kisika u vodama i u moru. Zaslužne su za 40-50% proizvodnje kisika u procesu fotosinteze, a kisik koji uzimamo u svakom drugom udahu je od algi. Miksotrofne alge (uz heterotrofne bakterije i gljive) sudjeluju u razgradnji uginulih organizama te u regeneraciji hranjivih soli. Alge predstavljaju važnu ulogu u ekosustavu iz razloga što su dobri bioindikatori. Zbog tog svojstva mogu nam pokazati opće stanje ekosustava. Zbog njihove iznimne ljepote i bioraznolikosti, Sekcija za alge u sklopu Udruge studenata biologije - "BIUS" provela je projekte istraživanja biološke raznolikosti na određenim područjima u Hrvatskoj. Istraživanja su provedena naprokariotskim ieukariotskim algama. Rad Sekcije za alge potpomognut je također od strane Algološkog laboratorija Biološkog odsjeka Prirodoslovno-matematičkog fakulteta Sveučilišta u Zagrebu i Udruge Aurelia iz Zadra. Sekcija za alge provodila je samostalni projekt „Popisivanje lokacija populacija endemične alge *Fucus virsoides*" te sudjelovala na međunarodnom kongresu o vodi, klimi i okolišu – BALWOIS 2012. (Ohrid, Republika Makedonija). Od svog osnutka Sekcija za alge sudjelovala je na četiri velika BIUS-ova istraživačko – edukacijska projekta koji su se odvijali na području rijeke Zrmanje (2010.) i Cetine (2012.) te na otocima Hvaru (2011.) i Cresu (2013.). Na projektu Udruge Aurelia pod nazivom „Doprinos poznavanju morskih algi i cvjetnica Zadarske županije" i projektu PMF-a pod nazivom „Bioraznolikost fitoplanktona u odnosu na ekološke prilike u akvatoriju PP Telašćica" Sekcija za alge provodila je edukaciju za lokalno stanovništvo. Glavni cilj Sekcije za alge, uz znanstveno istraživačke projekte i radove, bila je i edukacija te popularizacija algologije i biologije.

Staying algaive – Every second breath you take comes from algae

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Algae are a large and diverse group of autotrophic organisms. Due to the fact that they are classified into two separate "kingdoms" (cyanobacteria and protista), the term 'algae' doesn't indicate any systematic category but only the life form. Generally they are divided into green, red and brown algae. Their size can range from microscopic form, built from a single cell, to multicellular organisms such as kelp, which can grow up to 60 meters. Algae are the most important producers of organic matter and oxygen in the water. Total of 40-50% of photosynthesis is from algae and every second breath of oxygen we take is from algae. Mixotrophic algae (with heterotrophic bacteria and fungi) participate in decomposition of dead organisms and also in recovery of nutrients. Algae play an important role in ecosystem because they are indicators of eutrophication and they can show the general state of an ecosystem. Due to their exceptional beauty and biodiversity, Student algology section (SAS) as a member of Biology Students Association - "BIUS" conducted biodiversity research projects of certain areas in Croatia. Studies were performed on prokaryotic and eukaryotic life forms of algae. Researches of SAS are also supported by Algological laboratory of Division of Biology, Faculty of Science, University of Zagreb and by

Aurelia association from Zadar. SAS conducted independent research project "Identification of locations of endemic algae *Fucus virsoides*" and participated on the International Scientific Conference on Water, Climate and Environment - BALWOIS 2012 (Ohrid, Republic of Macedonia). Since its establishment SAS has participated in four major BIUS research and educational projects that took place on the area of the river Zrmanja (2010) and Cetina (2012) and on the islands of Hvar (2011) and Cres (2013). Section of algae participated on the project of the Aurelia association - "Contribution of the knowledge of marine algae and flowering plants of Zadar county" and on the project of Faculty of Science - "Biodiversity of phytoplankton in relation to environmental conditions in the waters of Nature park Telašćica". As the main objective of the SAS beside scientific research projects and papers is also education and popularization in field of algology and biology.

Abundancija vrste *Dictyocha fibula* Ehrenberg (silikoflagelati) u zimskom razdoblju u Južnojadranskoj kotlini

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Vremenskai prostorna rasporedjela fitoplanktona je tijesno povezana sa ekološkim faktorima. U tom slučaju, moguće je izolirati okolišne signale iz podataka o rasporedu i količini fitoplanktona. Podaci o fitoplanktonu u otvorenom moru južnoga Jadrana tijekom zime su nedostatni. Zadnjih pet godina intenzivno se uzorkuje u zimskom razdoblju u okviru projekta Instituta za more i priobalje u Dubrovniku: „Struktura planktonskih populacija u trofičkom gradijentu u južnom Jadranu". Razultati istraživanja pokazuju veliku varijabilnost ekoloških faktora između godina. Glavni cilj ovoga istraživanja je odrediti korelaciju između abundancije vrste *Dictyocha fibula* i ekoloških faktora (temperature, saliniteta i hranjivih soli). Uzorci za analizu fizikalno-kemijskih parametara, klorofila *a* i fitoplanktona uzeti su na postaji P-1200, koja se nalazi u Južnojadranskoj kotlini, pomoću Niskinovog crpca volumena 5 litara sa standardnih oceanografskih dubina. Uzorci su sakupljeni u veljači 2009., 2011. i 2012. Konzervirani uzorci fitoplanktona su obrađeni inverznim mikroskopom metodom po Utermöhlu (1958). Prema podacima CTD sonde, temperatura i salinitet se nisu razlikovali između 2009. i 2012. Vodeni stupac je bio izmješan, a maksimalna temperatura je iznosila 13,58°C u 2009. i 13,83°C u 2012.Veća temperatura zabilježena je u 2011.,a maksimalna 15,54°C. Salinitet u sloju 0-200m je bio u rasponu od 38,55 do 38,68 u 2009. i 2012. te od 38,38 do 38,94 u 2011. Najveća abundancija vrste*Dictyocha fibula* je zabilježena u 2011. (378 stanicaL^{-1}) u stratificiranom i toplijem vodenom stupcu.

Abundances of *Dictyocha fibula* Ehrenberg (silicoflagellates) during winters in the South Adriatic Pit

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Phytoplankton spatial and temporal patterns may be tightly linked with ecological factors which effect their distribution. If so, one should be able to extract environmental signals from plankton abundance data. Data

on phytoplankton in the open waters of the South Adriatic in the winter period is very inadequate. In the last five years winter sampling was intensified, as part of the research project "Plankton population structure in the trophic gradient in the South Adriatic"carried out by the Institute forMarine and Coastal Research in Dubrovnik, which demonstrates high year-to year variability of ecological factors in the area.The main objective was to determine the relationship between the abundance of *Dictyocha fibula*and ecological factors (temperature, salinity, concentration of chlorophyll-*a* and nutrients).Samples for analysis of physical-chemical parameters and phytoplankton were taken at station P-1200situated in the South Adriatic Pit using 5 L Niskin bottles from standard oceanographic depths. The station was visited in February 2009, 2011 and 2012. Phytoplankton was counted using an inverted microscope with themethod described by Utermöhl (1958) from preserved samples.According to the CTD probe there were no significantly difference in temperature or salinitybetween 2009 and 2012.The whole water column was well mixed, maximum temperature was 13.58°C in 2009 and 13.83°C in 2012. Maximum temperature of 15.54°C was observed in 2011. Salinity in the 0-200m layer ranged from 38.55 to 38.68 in 2009 and 2012, and from 38.38 to 38.94 in 2011. The highest abundance of *Dictyocha fibula* was recorded in 2011 (378 cells L^{-1}) in the stratified and warmer water column.

Sukcesija zajednice fitoplanktona u ekstremnom sulfidnom okolišu (Rogozničko jezero, istočna obala Jadrana)

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Morsko jezero Rogoznica je malo, krško, prirodno eutrofno, sulfidno i ankosično jezero. Sastav fitoplanktona u jezeru katakterizira mala raznolikost i velika abundancija (do 10^7 stanica L^{-1}) dominantnih vrsta. Uobičajena dinamika razvoja fitoplanktona uglavnom je određena sa fizikalnim procesima miješanja vodenog stupca, a dominatne vrste koje se izmjenjuju u dominaciji (abundancija >2 x 10^5 stanica L^{-1}, učestalost pojavljivanja >30%) su dijatomeja *Chaetoceros curvisetus*, dinoflagelat *Prorocentrum arcuatum* i heterotrofni mikroflagelat *Hermesiunum adriaticum*. Sukcesija fitoplanktona istraživana je u 12 navrata tijekom 2011. – 2012. godine. Mikrofitoplankton dominira abundancijom nad nanofitoplanktonom, što ukazuje na dovoljnu količinu dostupnih hranjivih tvari. Zajednica mikroplanktona (maksimalna abundancija 3.2 x 10^6 stanica L^{-1}) sastoji se 17 rodova, uglavnom dijatomeja (94.94%), dinoflagelata (2.98%) i ebrioficeja (heterotrofni mikroflagelat *H. adriaticum* 2.91%). Dijatomeje *Thalassionema nitzschioides* (abundancija do 1.6 x 10^6 stanica L^{-1}, učestalost pojavljivanja 46%), *Cyclotella choctawhatcheeana* (abundancija do 2.8 x 10^6 stanica L^{-1}, učestalost pojavljivanja 46%), *Dactyliosolen fragilissimus* (abundancija do 2.5 x 10^6 stanica L^{-1}, učestalost pojavljivanja 57%) i *C. curvisetus* (abundancija do 2.3 x 10^5 stanica L^{-1}, učestalost pojavljivanja 52%) alternirale su u dominaciji u vodenom stupcu tjekom istraživanja. Uobičajeni proljetni maksimum razvoja fitoplanktona u 2011. nije zabilježen, a fitoplanktonska sukcesija naglo je prekinuta nakon maksimuma razvoja *T. nitzschioides* u ožujku. U svibnju dolazi do razvoja nove zajednice dijatomeja *C. choctawhatcheeana*/*C. curvisetus*/ *D. fragilissimus*, dok se ljeti populacija fitoplanktona nije razvila, vjerojatno zbog nedostatka nutrijenata u eufotičkom sloju. U jesen započinje novi razvoj zajednice fitoplanktona dominacijom *T. nitzschioide*s. U listopadu 2011. je došlo do anoksije u cijelom vodenom stupcu; međutim nakon toga se fitoplankton brzo oporavlja. U ožujku 2012. započinje proljetni maksimum razvoja dijatomeja *C. choctawhatcheeana* i *D. fragilissimus*, te je razvoj fitoplanktona slijedio svoj uobičajeni trend. Dominacija dijatomeja *T. nitzschioides, D. fragilissimus* i *C. curvisetus* u 2011. je zamjenjena sa *C. choctawhatcheeana* i *D. fragilissimus* u 2012.

Succession of phytoplankton in the extreme euxinic environment (Rogoznica Lake, eastern Adriatic coast)

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Marine Lake Rogoznica is a small, karstic naturally eutrophic and euxinic lake. The phytoplankton composition in the lake is characterised by low species diversity and high single species abundance (up to 10^7 cells L^{-1}). Phytoplankton development is determined by mixing of the water column and characterized by the dominance (abundance >2 x 10^5 cells L^{-1} and frequency of appearance >30%) of the diatom *Chaetoceros curvisetus*, the dinoflagellate *Prorocentrum arcuatum* and the heterotrophic microflagellate *Hermesiunum adriaticum.* Succession of phytoplankton was investigated on the bases of 12 samplings in the period during 2011-2012. Microphytoplankton abundance dominated over nanophytoplankton indicating nutrient sufficient environment. The microplankton community (max abundance 3.2 x 10^6 cells L^{-1}) was composed of 17 taxa, mainly diatoms (94.94 %), dinoflagellates (2.98 %) and ebridian flagellate (heterotrophic microflagellate *H. adriaticum* 2.91%). Dominant diatoms *Thalassionema nitzschioides* (abundance 1.6 x 10^6 cells L^{-1}, frequency of appearance 46%), *Cyclotella choctawhatcheeana* (abundance 2.8 x 10^6 cells L^{-1}, frequency of appearance 46%), *Dactyliosolen fragilissimus* (abundance 2.5 x 10^6 cells L^{-1}, frequency of appearance 57%) and *C. curvisetus* (abundance 2.3 x 10^5 cells L^{-1}, frequency of appearance 52%) alternated in domination in the water column over the research period. The spring bloom in 2011 did not develop. Phytoplankton succession was abruptly terminated after bloom of *T. nitzschioides* in March. In May we found the phytoplantkton community composed of *C. choctawhatcheeana/ C. curvisetus/ D. fragilissimus).* In summer, phytoplankton abundance was extremely low, probably due to nutrient depletion. In autumn, development of phytoplankton assemblage occurred with dominant *T. nitzschioide*s. In October 2011 an anoxic event occurred in the whole water column; however phytoplankton recovered fast after this event. Consequently, in March 2012 spring bloom of diatoms *C. choctawhatcheeana* and *D. fragilissimus* started and typical phytoplankton development. In general, domination of diatoms *T. nitzschioides, D. fragilissimus* and *C. curvisetus* in 2011 was replaced by *C. choctawhatcheeana* and *D. fragilissimus* in 2012.

Interspecific and temporal variation of total phenolic content in brown algae from southern Mediterranean Sea

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Phlorotannins are polyphenolic secondary metabolites found in almost all brown algal orders that function as defense against grazers, pathogens and epiphytes but are also involved in photoprotection mechanisms particularly in counteracting the cytotoxic effects of UV-radiation. These compounds, produced in the Golgi apparatus, are accumulated in cytoplasm, within vesicules called physodes or bound to the cell wall. The concentration of phlorotannins differs within and between species, shows geographical and seasonal variations as well as ontogenetic variation but may be also affected by environmental (e.g. temperature, intensity of light) or biotic (e.g. grazing, epiphytes) factors. Aims of this study were to evaluate: (i) the temporal variation of total phenolic content in two brown algae respectively belonging to Dictyotales and Fucales, and (ii) its relationship with depth. Thalli of *Dictyopteris polypodioides* and *Cystoseira amentacea* var. *stricta*, living respectively in the upper infralittoral zone and in the infralittoral fringe, were collected from the north-western coast of Sicily. Results

showed significant differences in total phenol content between *D. polypodioides* and *C. amentacea* var. *stricta* with a higher value observed in the first one. Both species showed a seasonal pattern of total phenolic contents and differences in the period of their maximum production were also observed between the two species. In *D. polypodioides* the peak was observed during winter and autumn (0.95 and 0.81% DW) whereas during spring and summer in *C. amentacea* var. *stricta* (0.17 and 0.57% DW). The phenol concentration resulted negatively correlated with the air temperature and the medium solar radiation in *D. polypodioides* (R^2=0.67 and R^2=0.96) whereas the correlation was positive in *C. amentacea* var. *stricta* (R^2=0.75 and R^2=0.49). Even though seaweeds living on the rocky intertidal habitats, subjected to large variations of environmental conditions essentially due to the alternation of emersion and immersion phases, should invest more energy in defences, *D. polypodioides* showed a phenolic content higher than *C. amentacea* var. *stricta*. Our results suggest that phenol content and seaweed zonation are not interdependent and that sheet-like algae such as *D. polypodioides*, resulting more attractive than thick leathery ones to herbivores, produce larger concentrations of these compounds in order to deter feeding by herbivores.

Zajednice makroalgi kao bioindikator ekološkog stanja priobalnih voda u srednjem Jadranu

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Na stjenovitim morskim dnima priobalnog pojasa zajednice makroalgi imaju značajnu ekološku ulogu. Obzirom na svoju raznolikost, biomasu, rasprostranjenost, ulogu u ekosustavu i trajnu pričvršćenost za podlogu, makroalge su vrlo pogodan bioindikator promjena u morskom okolišu. U ovom istraživanju razmatrana je pogodnost korištenja univarijatnih pokazatelja i biotičkih indeksa (broj svojti makroalgi, biomasa makroalgi, pokrovnost makroalgi, Margalefov indeks, Shannon-Wienerov indeks, R/P indeks, indeks onečišćenja, ekološke skupine prema Boudouresqueu, EEI indeks i CARLIT indeks) koji koriste makroalge za procjenu ekološkog stanja priobalnog mora. Uzorkovanje zajednica makroalgi je obavljeno u razdoblju od 2009. do 2010. godine na šest postaja u srednjem Jadranu gdje je uzorkovano kartografskom metodom i destruktivnom metodom na dubini od 0,5 m unutar kvadrata površine 0,04 m^2. Rezultati primjene svake bioindikatorske metode uspoređeni su s izmjerenim srednjim godišnjim vrijednostima koncentracije hranjivih soli kao pokazateljem razine onečišćenja na svakoj postaji. Na temelju rezultata istraživanja ustanovljeno je da ukupna biomasa makroalgi, ukupna pokrovnost makroalgi i EEI indeks nisu prikladni za procjenu ekološkog stanja mora na području istraživanja jer ne pokazuju povezanost s vrijednostima koncentracije hranjivih soli te se na osnovu njih ne može razlikovati onečišćeno od čistog područja. Broj svojti makroalgi, Margalefov indeks, Shannon-Wienerov indeks, R/P indeks te indeks onečišćenja mogli bi se koristiti u procjeni ekološkog stanja priobalnog mora na području istraživanja. Vrijednosti tih pokazatelja pokazivale su povezanost s razinom onečišćenja na postajama istraživanja, ali imaju i nedostatke koji onemogućuju njihovu sigurnu primjenu te su potrebna opširnija dodatna istraživanja. Ekološke skupine prema Boudouresqueu i CARLIT indeks pokazali su najbolju povezanost s razinom onečišćenja na postajama istraživanja.

Macroalgal communities as bioindicator of ecological status of coastal waters in the middle Adriatic Sea

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Macroalgal communities of the rocky bottom in the littoral zone have a significant ecological function. Their biodiversity, biomass, wide distribution, ecological role and permanent attachment to the substrate make them very appropriate bioindicator of changes in the marine environment. This study examines the advantages of using univariate indicators and biotic indices (number of macroalgal species, macroalgal biomass, macroalgal coverage, Margalef index, Shannon-Wiener index, R/P index, pollution index, ecological groups according to Boudouresque, EEI index and CARLIT index) that use macroalgae for estimation of ecological status of coastal waters. Sampling of macroalgal communities was performed from 2009 to 2010 at six stations in the middle Adriatic where littoral cartography was used along with destructive sampling from quadrates with the surface of 0.04 m^2 at the depth of 0.5 m. Results of the application of each bioindicator method was compared to measured mean annual values of nutrient concentrations as pollution indicator at the investigated stations. The analysis of the results showed that macroalgal biomass, macroalgal coverage and EEI index are not suitable for estimation of ecological status in the investigated area because they do not show any relation with the measured nutrient concentration values and therefore it is not possible to distinguish pristine from polluted areas. Number of species of macroalgae, Margalef index, Shannon-Wiener index, R/P index and pollution index could be used to evaluate the ecological status in the investigated area because values of these indices showed significant relation with the pollution level. However, methodological constraints limit their application and further investigation is needed. Ecological groups according to Boudouresque and CARLIT index showed the best relation with nutrient concentrations as pollution indicator at the investigated stations.

Dugoročna promatranja okolišnih parametara i biomase fitoplanktona u Malostonskom zaljevu (SE Adriatic)

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Cilj ovog rada je karakterizirati 14 godišnji niz podataka temperature, saliniteta i biomase fitoplanktona u Malostonskom zaljevu kako bi se utvrdila termohaline svojstva i raspodjela biomase na istraživanom području. Uzorkovanje je provedeno jednom mjesečno, dok je uzrkovanje svakih 15 dana obavljano tijekom ljetnih mjeseci na četiri postaje, na dvije različite dubine (površina i dno) tijekom razdoblja 1999-2012. Također, mjereno je zasićenje kisikom vodenog stupca. Malostonski zaljev je vrlo promjenjivi ekosustava zbog velikog dotoka Neretve u vanjskom dijelu i mnogih podvodnih vrela u unutarnjem dijelu zaljeva. Rezultati su pokazali raslojanost vodenog stupca tijekom cijelog istraživanog razdoblja. Također, promjene temperature i saliniteta između različitih godina su mnogo veće od promjena između postaja unutar zaljeva. Učinak temperatura na stratifikaciju je slabiji od učinka saliniteta.Fitoplanktonska biomasa pokazuju trend porasta tijekom istraživanog razdoblja 1999-2012, a u isto vrijeme trend smanjenja saliniteta u površinskom sloju. Opisana je vremenska i prostorna raspodjela fitoplanktona biomase, analizirana preko koncentracije klorofila a ($\mu g\ L^{-1}$). Korištene su prosječne mjesečne vrijednosti za svaku postaju kao bi se opisao sezonski ciklus raspodjele biomase. Anomalije su izračunate u odnosu na ukupni srednjak svih godišnjih srednjaka biomase tijekom 14 godina, dok histogram frekvencije distribucije prikazuje sve vrijednosti od 1248 izmjerenih uzoraka.

Long term observations of environmental characteristics and phytoplankton biomass in Mali Ston Bay (SE Adriatic)

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The aim of this work is to characterize 14 year data set of temperature, salinity and phytoplankton biomass in Mali Ston Bay in order to ascertain termohaline properties and biomass distribution in the area. Sampling was conducted monthly, whereas biweekly sampling was conducted during summer months at four stations, at two different depths (surface and bottom) throughout period 1999-2012. Also, oxygen saturation of water column was calculated.Mali Ston Bay is highly variable ecosystem due to large inflow of Neretva River in the outer part and presence of many underwater springs in the inner part of the bay. The results showed continuous stratification during the whole investigated period. Interannual changes of temperature and salinity are much larger than the changes among stations. The temperature effect on stratification is weaker than salinity effect. Phytoplankton biomass showed increasing trend throughout investigated period 1999-2012; in the same time trend of decreasing salinity in surface layer was occurred. Temporal and spatial distribution of phytoplankton biomass analyzed by the concentration of Chlorophyll *a* ($\mu g\ L^{-1}$) is presented. The average values for the month were taken to present the seasonal course of Chl-a at each station. Anomalies in the annual mean from the total annual Chl-a concentration is presented over 14 years, while frequency distribution histogram show total of 1248 samples values observed.

Masovno razmnožavanje algi roda *Ulva* (Chlorophyta) u Kaštelanskom zaljevu

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Usklađeno vrijeme ispuštanja gameta kod razmnožavanja sesilnih organizama nužno je da bi došlo do spajanja gameta različitih jedinki. Poznati primjeri usklađenog ispuštanja gameta u morusu razmnožavanje koralja, mnogočetinaša ili algi reda Bryopsidales. Ipak, za većinu sesilnih morskih organizama gotovo da nema informacija o reproduktivnoj fenologiji. Reproduktivna biologija alga roda *Ulva* dobro je poznata. U laboratorijima je utvrđeno kako se gamete i zoospore ispuštaju u zoru, međutim reproduktivna fenologija nikad nije bila promatrana u prirodi. Tijekom proljeća 2012. i 2013. na području Kaštelanskog zaljeva praćena je pojava fertilnih talusa raznih svojti roda *Ulva* i ispuštanje zooida. Ispuštanje zooida započinje u vrijeme oko izlaska sunca. U slučaju mirnog vremena i prisutnih brojnih fertilnih talusa, u plitkom moru tijekom nekoliko minuta nastaje okom vidljiv zooidni zeleni oblak koji ostaje vidljiv gotovo jedan sat. Oblak može smanjiti prozironost mora na manje od jednog metra. Više vrsta roda *Ulva* ispušta gamete u tom razdoblju (*U. lactuca* Linnaeus, *U. rigida* C.Agardh, *U. australis* Areschoug, *U. intestinalis* Linnaeus i vjerojatno *U. rotundata* Bliding).Međutim, kako svojte živeizmiješane, a njihovo razlikovanje u prirodi je upitno, nije moguće odrediti preciznije vrijeme ispuštanja za pojedinu vrstu. Masovno razmnožavanje algi roda *Ulva* fascinantan je događaj i pokazuje koliko je naše znanje o sasvim uobičajenim vrstama još uvijek nepotpuno.

Massive reproduction of *Ulva* (Chlorophyta) species in Kaštela Bay

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During sexual reproduction of sessile organismssynchronicity of gamete release is crucial to finalize with fusion of gametes of different individuals. Good examples of synchronized gamete release in the sea are reproduction of corals, polychaetes and algae of order Bryopsidales. Anyway, for the majority of marine sessile organisms, there is almost no information on reproductive phenology. The reproductive biology of the algae of genus *Ulva* is well studied. According to laboratory examination, it is known that gametes and zoospores are released in the early morning but reproduction event was never observed in the nature. During spring of 2012 and 2013, appearance of fertile thalii and zooides release of different *Ulva* species was followed in Kaštela Bay. Release of zooids started around sunrise. During a calm morning and presence of numerous fertile thalii, a green zooid cloud forms in few minutes and can persist up to one hour. Such a cloud can lower the visibility in the sea to less than one meter. More different *Ulva* species release gametes in the same period (*U. lactuca* Linnaeus, *U. rigida* C.Agardh, *U. australis* Areschoug, *U. intestinalis* Linnaeus and probably *U. rotundata* Bliding). As they are living mixed and theirrecognition in the nature is difficult, it is not possible to detect the exacttime of gamete release for each species. Massive reproduction of *Ulva* species is fascinating event which shows us how our knowledge abouteven ordinary species is still incomplete.

Analiza zbirke algi Giovanni Battista Sandrija u Prirodoslovnom muzeju u Splitu

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Giovanni Battista Sandrij rodio se 1787. u Zadru. Surađivao je s botaničarima i sakupljačima biljaka koji su tada djelovali u Dalmaciji: Alschingerom, Caribonijem, Pappafavom, Visianijem ili pak s onim koji su dolazili u Dalmaciju botanizirati: Biasolettom, Kützingom i drugima te je s njima razmjenjivao podatke i algološki materijal. Zbirka algi G. B. Sandrija smještena je u Prirodoslovnom muzeju u Splitu. Sadrži 25 porodica s 34 vrste i ukupno 35 primjeraka prepariranih algi. Najzastupljenije su crvene alge (Rhodophyta) s 22 vrste. Alge su postavljene na podložnim papirima različitih dimenzija uz koje se nalaze dvije etikete. Mala etiketa sadrži latinski naziv vrste, a velika etiketa sadrži: latinske nazive razreda, porodice, vrste, ime autora i dr.. Velike etikete nose naziv HERBARIJ BOTANIČKOG INSTITUTA UNIVERZE Zagreb i ispisane su na tanjem papiru dimenzija 14,5 x 10 cm. Male etikete su ispisane na nešto tvrđem papiru dimenzija 10,5 x 2,5 cm. Sve alge su sakupljene 1844., a kao nalazište navedena je Dalmacija.
Zbirka algi je obrađena 2000. godine (N. Ževrnja), a reviziju je 2011/2012. izvršio Boris Antolić iz Instituta za oceanografiju i ribarstvo iz Splita. Taksonomska nomenklatura bazirana je na AlgaBase: Listing the World's Algae. Zbirka je predložena za dobivanje svojstva pokretnog kulturnog dobra 2012. godine.

The analysis of the Giovanni Battista Sandrij's algae collection kept in the Natural History Museum in Split

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Giovanni Battista Sandrij was born in Zadar in 1787. He was working both with the botanists and plant collectors active in Dalmatia at the time (Alschinger, Cariboni, Pappafavo, Visiani) and with the ones who came to Dalmatia botanize (Biasoletto, Kützing and others) and with whome he was exchanging information and the algological material.
The Sandrij's algae collection from the Natural History Museum in Split contains algae from 25 families, 34 species of the 35 specimen of preserved algae altogether. The most frequent among them are the red algae (Rhodophyta) represented by 22 species. The algae are laid on the different sized sheets of paper, each of which is accompanied by two labels. There is Latin name of the species on the smaller label and on the bigger one there is Latin name of its class, family, species, author's name etc. The bigger labels are 14,5x10 cm in size where "HERBARIUM OF THE BOTANICAL INSTITUTE OF THE ZAGREB UNIVERSITY" is written. The smaller labels, 10,5x2,5 in size, are made of some card paper. All the algae were collected and found in Dalmatia in 1844. This algae collaction was worked on in 2000 (by N. Ževrnja) and in 2011/12 Boris Antolićfrom the Institute of Oceanography and Fishery in Split did its revision. The taxonomy nomenclature follows AlgaBase: Listing the World's Algae. In 2012 the collection was proposed to be declared a movable treasure.

Analiza zbirke algi Marije Selebam de Cattani u Prirodoslovnom muzeju u Splitu

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Marija Selebam de Cattani rođena je 20. svibnja 1789. u Splitu. Bogate zbirke algi slala je poznatim znanstvenicima: dr. Cariboniju, talijanskom liječniku u Pragu; Robertu Visianiju, upravitelju Botaničkog vrta u Padovi; Spiridonu Brusini, kojem je darovala zbirku za tadašnji Prirodoslovni muzej u Zagrebu i dr. Dio svog herbarija darovala je i zadarskoj gimnaziji, dopisivala se s upravom Gradskog muzeja u Rovertu, Pučkim muzejom u Milanu i dr.
Zbirka algi M. Cattani je utemeljena 1848. U dijelu zbirke koji se čuva u Prirodoslovnom muzeju u Splitu zastupljene su 34 porodice s 93 vrste i ukupno 104 primjerka. Najveći broj algi iz zbirke sakupila je u moru oko Splita, ali ima primjeraka i iz drugih područja, pa se spominju: Zadar, Krapanj, Kaštela Gomilica, Kaštel Lukšić, otok Šolta, te Piran. Podložni list na kojem se nalazi alga ujedno je i herbarijski list te etiketa sa svim podatcima. U zbirci su najzastupljenije crvene alge (Rhodophyta) s 53 vrste i 59 primjeraka.
Zbirka algi je obrađena 2000. (N. Ževrnja), a reviziju je 2011/2012. izvršio Boris Antolić iz splitskog Institut za oceanografiju i ribarstvo. Taksonomska nomenklatura bazirana je na AlgaBase: Listing the World's Algae. Zbirka je predložena za dobivanje svojstva pokretnog kulturnog dobra 2012.

The analysis of Marija Selebam de Catani's algae collection from the Natural History Museum in Split

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Marija Selebam de Catani was born in Split in 1789. She used to send her rich algae collections to the well known scientists and institutions of her time, for example to Carboni, an Italian doctor in Prague; to Robert Visiani, the manager of the Botanical Garden in Padova, to Spiridon Brusina to whom she donated a collection for the Natural History Museum in Zagreb, and to others.
She also donated a part of her herbarium to gymnasium in Zadar and she kept correspondence with the administration of the City Museum in Roverto, with the National Museum in Milan and so on.
Marija Cattani's algae collection was made in 1848. A part of it is kept in the Natural History Museum in Split and it contains 104 specimen from 34 families, 93 species. Most of the algae from this collection were found in the sea around Split but there are specimen taken at other localities such as Zadar, Krapanj, Kaštel Gomilica, Kaštel Lukšić, island Šolta and Piran. Each algae is laid on the paper which is also the herbarium sheet labeled with all the necessary specifications of the item. The collection's most frequent type of algae are the red ones (Rhodophyta), namely there are 53 species represented by 59 items.
The algae collection was worked on in 2000 (by N. Ževrnja) and in 2011/12 Boris Antolić from the Institute of Oceanography and Fishery in Split did the revision of the Collection. The taxonomy nomenclature follows AlgaBase: Listing the World's Algae. In 2012 the collection was proposed to be declared a movable culture treasure.

Analiza zbirke algi diplomanata više Pedagoške škole u Splitu

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Skupina diplomanata više Pedagoške škole, Kolegij botanike: Zvonko Hel, Srećko Piasevoli, Ante Irić, Dragica Župić i Jakica Župić, u akademskoj godini 1954/55., izradila je zbirku algi za seminarski rad. Zbirka je smještena u Prirodoslovnom muzeju u Splitu. Alge su sakupljene na lokalitetima: Kaštelanski zaljev, more oko Splita (Lubinov porat, Oceanografski institut, uvala Kašjuni, luka Split, luka Labud), otoci Šolta, Jabuka i Brusnik, te područje južnog Jadrana.
Zbirka sadrži 25 porodica s 47 vrsta i ukupno 55 primjerka. Najzastupljenije su smeđe alge (Phaeophyceae) s 32 vrste. Alge su postavljene na podložnim papirima dimenzija 24,7x35 cm na kojima su navedeni latinski nazivi porodice i vrste, te naziv nalazišta, ime autora te datum sakupljanja materijala.
Zbirka algi je obrađena 2001. (N. Ževrnja) kada je svaki primjerak dobio svoj inventarni broj. Reviziju zbirke je 2011/2012. izvršio Boris Antolić iz splitskog Instituta za oceanografiju i ribarstvo. Taksonomska nomenklatura bazirana je na AlgaBase: Listing the World's Algae. Zbirka je predložena za dobivanje svojstva pokretnog kulturnog dobra 2012.

The analysis of the algae collection made by the bachelors of the Teacher training College in Split

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A group of senior students of Teacher training College consisting of Zvonko Hel, Srećko Piasevoli, Ante Irić, Dragica Župić and Jakica Župić made the algae collection during their botany course as their seminar paper in academic year 1954/1955. The collection has been bestowed in the Natural History Museum in Split. The algae were collected on the following localities: the Kaštela bay, the sea around Split (the Lubinov Porat inlet, Institute of Oceanography and Fishery, the Kašjuni inlet, the Split harbor, the Labud harbor), sea around islands Šolta, Jabuka and Brusnik and the Southern Adriatic.
The collection contains 47 species from 25 families with 55 specimen in total. The most frequent algae are the 32 different brown ones (Phaeophyceae). They are laid on the sheets of papers 24,7x35 cm in size with the Latin names of family, species, its finding date and place written on them.
In 2001 the algae collection was worked on (by N. Ževrnja) when each item was given its inventory number. In 2011/12 the revision of the work was performed by Boris Antolić from the Institute of Oceanography and Fishery in Split. The taxonomy nomenclature follows AlgaBase: Listing the World's Algae. In 2012 the collection was proposed to be declared a movable cultural treasure.

Fitokemija - posterska priopćenja
Phytochemistry - poster presentations

Salvia ringens Sibth. & Sm. (Lamiaceae) stem: structure and antioxidant activity

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Salvia ringens Sibth. & Sm. (Lamiaceae) is a hardy herbaceous perennial plant, distributed in South and Eastern parts of Balkan peninsula. The aim of the present study was to examine anatomical structure of *S. ringens* stem. Since the glandular trichomes of the stem are sites of secreting different compounds which are proved to have various biological effects, we examined the antioxidative activity of stem ethanol extract. The aerial parts of *Salvia ringens* were collected in July of 2012. in Macedonia at flowering stage. Stem structure was examined using light and scanning electron microscopy. Antioxidant activity was evaluated by two comparative spectrophotometric assays, using the ability of extracts to scavenge DPPH and ABTS free radicals and results are presented as IC_{50} values (μg/ml) and mg ascorbic acid equivalents (AAE/g of dry plant material), respectively. Stems of *S. ringens* were atypically round-shaped. Epidermis was single-layered and covered with thick cuticle. Two types of trichomes were observed: short stalked capitate glandular trichomes with one basal cell, one stalk cell and unicellular secretory head and multicellular, elongated non-glandular hairs. The cortex comprised 3-4 continuous collenchyma layers and parenchyma. The phloem consisted of small thin-walled irregular cells; above the phloem small groups of sclerenchymatous cells can be noticed. Cambium was not clearly distinguished. The xylem was composed of numerous thick-walled tracheids and large, less frequent tracheas. The pith consisted of orbicular parenchymatous cells with abundant intercellulars and cavity in the center of the stem. In DPPH assay, IC_{50} value for ethanol extract of stems was measured as 50.88 μg/ml and indicated the concentration of the test sample providing 50% inhibition of DPPH radicals. Stems showed ABTS scavenging activity of 2.06 ± 0.019 AAE/g of dry plant material. The ethanol extract of stem showed lower activity comparing to BHT in DPPH test (17.94 μg/ml) and similar to BHT in ABTS test (2.82 ± 0.012 AAE/g of dry plant material).

Sinigrin, glavni glukozinolat iz biljke *Peltaria alliacea* Jacq., endemične biljke iz porodice krstašica (Brassicaceae)

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Rod *Peltaria* Jacq. se sastoji od četiri vrste, od kojih se dvije mogu pronaći u Europi. Peltaria alliacea Jacq. ili lukica (krstašice, Brassicaceae) je višegodišnja i endemična vrsta, dobro rasprostranjena u Hrvatskoj. Biljka raste do 60 cm u visinu, s ovalnim listovima, plosnatim plodom i bijelim cvjetovima. Uzgaja se kao začin ili povrće, listovi se mogu koristiti za pojačavanje ljutine salata, iako mogu postati gorki u ljetno doba. Karakterističan okus i miris svih krstašica (kupus, cvjetača, brokula, povrtnica, hren, gorušica, uljana repica) se javlja i kod ove biljke zbog hlapljivih spojeva koji sadrže sumpor koji nastaju hidrolizom djelovanjem enzima tioglukozidaze uslijed oštećenja tkiva. U ovom istraživanju korišteni su različiti dijelovi biljke P. alliacea (cvijet, list, stabljika, korijen) za izolaciju hlapljivih spojeva, hidrodestilacijom ili ekstrakcijom s CH2Cl2 nakon enzimske hidrolize te su analizirani GC/MS tehnikom. Glavni hlapljivi spoj razgradnje glukozinolata (GL), nađen u svim hlapljivim izolatima je bio alil-izotiocijanat, koji potječe od sinigrina (prop-2-enilglukozinolata).

Sinigrin, the main glucosinolate in *Peltaria alliacea* Jacq., an endemic plant of Brassicaceae

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Peltaria Jacq. genus comprises of four species, two of which occure in Europe. *Peltaria alliacea* Jacq. or lukica (Cruciferae, Brassicaceae) is a perennial and endemic species, well distributed in Croatia. The plant grows up to 60 cm, with ovate leaves, very flat silicula and white flowers. The plant is also grown as a herb or vegetable. The leaves can be used and add a spiciness to salads, although, they can become bitter in the summer. Characteristic flavour and odour of all *Brassicaceae* plants (cabbage, cauliflower, broccoli, radish, horseradish, mustard, oil rapeseed) has been attributed to volatile sulphur containing compounds that are developed through thioglucosidase hydrolysis of glucosinolates (GL) after tissue damage. In this research, volatiles of *P. alliacea* were extracted from different plant parts (flower, leaf, stem, root) by hydrodistillation or CH_2Cl_2 extraction after enzyme hydrolysis and analysed by GC/MS. The main volatile derived from GL degradation, found in all volatile isolates, was allyl isothiocyanate, which originate from sinigrin (prop-2-enylglucosinolate).

Glukozinolati iz biljke *Diplotaxis erucoides* (L.) DC. (Brassicaceae) i njihov kemotaksonomski značaj

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Rod *Diplotaxis* DC. (krstašice, Brassicaceae) se sastoji od oko 30 vrsta, među kojima su vrste *Diplotaxis tenuifolia*, *Diplotaxis muralis, Diplotaxis viminea* te *Diplotaxis erucoides* (L.) DC. koje samoniklo rastu u Hrvatskoj. To su jednogodišnje ili višegodišnje biljke, zeljaste ili grmolike s drvenastom stabljikom. Cvjetovi su većinom žuti, dok su kod vrste *Diplotaxis erucoides* bijeli s ljubičastim žilama. *Diplotaxis erucoides* je krstašica koja raste kao korov na širem području Mediterana od Pirinejskog poluotoka preko srednje i južne Europe i Sjeverne Afrike pa sve do zapadne Azije. Kao i druge srodne vrste, *D. erucoides* može se smatrati vrijednim fitogenetskim resursom jer se može koristiti kao povrće za salatu, izvor ulja iz sjemenki ili nektar za proizvodnju meda. Glukozinolati, pronađeni u ovoj biljci, predstavljaju metaboličke spojeve koji se često koriste kao kemotaksonomski markeri. Glukozinolati se razgrađuju bilo enzimatski bilo termalno na različite razgradne spojeve. Hidrodestilacija u aparatu tipa Clevenger se koristila kao metoda izolacije hlapljivih spojeva i hlapljivih aglukona dobivenih termalnom degradacijom glukozinolata (GL). Dobiveni izolati su potom analizirani GC/MS tehnikom. Glavni glukozinolati identificirani preko njihovih razgradnih spojeva su alilGL, uglavnom sinigrin (izvodi se od L-metionina) i 2-feniletilGL (izvodi se od L-homofenilalanina). Ovi spojevi predstavljaju vrijednu informaciju u sprezi s drugim izvorima taksonomskih dokaza kako bi se uspostavio potreban sustav klasifikacije koji što točnije odražava prirodne poveznice.

Glucosinolates and its chemotaxonomic significance of *Diplotaxis erucoides* (L.) DC. (Brassicaceae)

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Genus *Diplotaxis* DC. (Brassicaceae) includes about 30 species among which *Diplotaxis tenuifolia*, *Diplotaxis muralis, Diplotaxis viminea* and *Diplotaxis erucoides* (L.) DC. are native to Croatia. They are annual or perennial plants, either herbaceous or sub-shrubby with a woody base. The flowers are yellow in many species, while the species *Diplotaxis erucoides* has white flowers with purple veins in the petals. *Diplotaxis erucoides* is a widespread weedy crucifer around the Mediterranean extending from the Iberian Peninsula, across central and southern Europe and North Africa to western Asia. As with other allied species, *D. erucoides* might be considered a valuable phytogenetic resource because of its potential as a salad vegetable, a source of seed oil or nectar for honey production. Glucosinolates, found in this species, represent the metabolic compounds which have been frequently used as chemical markers in chemotaxonomy. They can degrade enzymatically and thermally into various volatiles. Hydrodistillation in Clevenger type apparatus was used for the isolation and concentration of the free volatile compounds and volatile aglucones obtained by thermal degradation of glucosinolates (GL) and the obtained isolate was analysed by GC/MS. The main glucosinolates identified by their degradation products were allyl GL, namely sinigrin (derived from L-methionine), and 2-phenylethyl GL (derived from L-homophenylalanine). These compounds can represent valuable information in conjunction with other sources of taxonomic evidence in order to establish a system of classification which reflects natural relationships as accurately as possible.

Glukozinolati u različitim dijelovima biljke *Arabis turrita* L. (Brassicaceae)

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Arabis L. je rod iz porodice krstašica *(*Brassicaceae*)* koji uključuje najmanje 17 poznatih vrsta koje rastu u R. Hrvatskoj [1]. Vrsta *Arabis turrita* L. je dvogodišnja ili višegodišnja biljka, 20-80 cm visoka, obično gusto dlakava, s jednostavnim cjelovitim ušiljenim listovima i žućkastim vjenčićem sastavljenim od četiri latice. Plod je duga komuška koja sadržava 10, 20 ili više sjemenki. Cilj istraživanja je bio utvrđivanje glukozinolatnog (GL) profila vrste *A. turrita*. GLi su multi-funkcionalni sekundarni biljni metaboliti velike važnosti za kemotaksonomsku podjelu unutar obitelji krstašica. GLi u vrste *A. turrita* identificirani su indirektno preko razgradnih produkata koji su nastali tijekom enzimske hidrolize. Produkti hidrolize su izolirani i analizirani GC/MS tehnikom. Analiza hlapljivih produkata izoliranih iz različitih dijelova biljke (sjeme, korijen, list) ukazuje prvenstveno na dugolančane olefinske i tiofunkcionalizirane GLe. Ovo je prvo istraživanje GLa samonikle vrste *A. turrita* koja raste u mediteranskoj vegetaciji Dalmacije kao i u širem području Hrvatske.

Glucosinolates in different plant parts from *Arabis turrita* L. (Brassicaceae)

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Arabis L. or rockcress is a genus of the family Brassicaceae which includes at least 17 known species that grow in the Republic of Croatia. Type *Arabis turrita* L. is a biennial or perennial herb, 20-80 cm tall, usually densely hairy, with simple integral pointed leaves and yellow wreath composed of four petals. The fruit is long silique containing 10, 20 or more seeds. *A. turrita* was investigated to establish its glucosinolate (GL) profile. GLs are multi-functional secondary plant metabolites of great chemotaxonomical importance for classification within the *Brassicaceae* family. The GL profile for *A. turrita* was investigated throughout the breakdown products resulting from enzyme hydrolysis. The hydrolysis products were isolated and analysed by GC/MS. The identification of volatile hydrolysis products isolated from different plant parts (seed, root, leaf) revealed mainly long-chain olefinic and thiofunctionalised GLs. This is the first study GLs wild *A. turrita* that grows in Mediterranean vegetation Dalmatian and Croatian wider area.

Određivanje sadržaja fenola i antioksidativnog kapaciteta različitih biljnih dijelova u tri vrste roda *Globularia* L.

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Rod *Globularia* L. pripada porodici Plantaginaceae i uključuje 22 do 23 vrste koje su uglavnom rasprostranjene u području Mediterana. Neke od ovih vrsta, kao što su *Globularia alypum* L., *G. trichosantha* Fisch. & C. A. Mey. i *G. arabica* Jaub. & Spach koriste se u narodnoj medicini i posjeduju poznate farmakološke aktivnosti (hipoglikemijsku, kolagognu, laksativnu itd.). Najbolje istražena *G. alypum* L. u Hrvatskoj je gotovo ugrožena vrsta i može se naći samo u okolici Dubrovnika. Cilj ovog rada bio je odrediti sadržaj bioaktivnih fenola u vrstama roda *Globularia* koje rastu samoniklo na području Hrvatske i šire su rasprostranjene, kao i njihov potencijalni antioksidativni kapacitet u *in vitro* uvjetima. Sadržaj ukupnih fenola, flavonoida i kondenziranih trjeslovina različitih biljnih dijelova u vrstama *G. punctata* Lapeyr., *G. meridionalis* (Podp.) O. Schwarz i *G. cordifolia* L. određen je spektrofotometrijski. Folin-Ciocalteuov reagens korišten je za mjerenje ukupnih fenola, a aluminijev klorid za određivanje sadržaja flavonoida. Količina kondenziranih trjeslovina određena je pomoću vanilin-H_2SO_4 testa, dok je antioksidativni kapacitet ekstrakata procijenjen pomoću DPPH i ABTS testa. Sadržaj ukupnih fenola kretao se između 13.61 i 42.57 mg ekvivalenta galne kiseline (GAE)/g suhog biljnog materijala (SM). Količina flavonoida varirala je od 0.84 do 14.47 mg ekvivalenta kvercetina (QE)/g SM. Antioksidativni kapacitet izražen kao mg GAE/g SM kretao se između 4.18 i 22.10 u DPPH testu, te između 4.34 i 19.88 u ABTS testu. Srednje vrijednosti antioksidativnog kapaciteta, te sadržaja ukupnih fenola i flavonoida bile su najviše u uzorcima *G. punctata*. Sadržaj kondenziranih trjeslovina kretao se u rasponu od 0.33 do 9.77 mg ekvivalenta katehina (CE)/g SM) i bio je najviši u uzorcima *G. cordifolia*. Visoka pozitivna korelacija primijećena je između kapaciteta hvatanja DPPH/ABTS radikala i sadržaja ukupnih fenola ($r_S = 0.8864$, $p < 0.001$; $r_S = 0.8712$, $p < 0.001$). Dobivenim rezultatima utvrđeno je da su ove vrste bogati izvori bioaktivnih fenola u usporedbi sa srodnom ljekovitom vrstom *G. alypum*. Dodatna istraživanja njihovog kemijskog sastava i biološke aktivnosti potrebna su kako bi se provjerila mogućnost njihove upotrebe u ljekovite svrhe.

Evaluation of phenolic content and antioxidant capacity of different plant parts in three *Globularia* sp.

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The genus *Globularia* L. belongs to the family Plantaginaceae and includes 22 to 23 species distributed mainly in the Mediterranean area. Some of the species, such as *Globularia alypum* L., *G. trichosantha* Fisch. & C. A. Mey. and *G. arabica* Jaub. & Spach, are used in folk medicine and have known pharmacological activities (hypoglycaemic, cholagogue, laxative etc.). The best explored *G. alypum* L. is a near threatened species in Croatia and can only be found around Dubrovnik area. The aim of the present study was to examine the content of bioactive phenolics in *Globularia spp.* that grow wild in Croatia and are more widespread, as well as their potential antioxidant capacity *in vitro*. Total phenolic, flavonoid and condensed tannin content of different plant parts in *G. punctata* Lapeyr., *G. meridionalis* (Podp.) O. Schwarz and *G. cordifolia* L. were determined spectrophotometrically. Folin-Ciocalteu's reagent was used for measuring total phenolic content and aluminium chloride for determining flavonoid content. Condensed tannin content was determined by vanillin-H_2SO_4 assay, while antioxidant capacity of the extracts was evaluated by DPPH and ABTS assays. Total phenolic content ranged

from 13.61 to 42.57 mg of gallic acid equivalent (GAE)/g of dry herbal material (DM). The amount of flavonoids varied from 0.84 to 14.47 mg of quercetin equivalent (QE)/g of DM. Antioxidant capacity expressed as mg GAE/g of DM varied from 4.18 to 22.10 in the DPPH assay and from 4.34 to 19.88 in the ABTS assay. Mean values of antioxidant capacity, total phenolic and flavonoid content were highest in *G. punctata*. Condensed tannin content varied from 0.33 to 9.77 mg of catechin equivalent (CE)/g of DM and was found to be highest in *G. cordifolia*. High positive correlation was observed between DPPH/ABTS radical scavenging capacity and total phenolic content ($r_S = 0.8864$, $p < 0.001$; $r_S = 0.8712$, $p < 0.001$). The results of this study show that the examined species are rich sources of bioactive phenolics in comparison to the related medicinal species *G. alypum*. Further investigation of their chemical composition and bioactivity is needed to verify the possibility of their medicinal use.

Antioxidant activity of *Satureja fukarekii* Šilić

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Satureja fukarekii Šilić is an endemic species of the Balkan peninsula. *S. fukarekii* Šilić, also known as *S. tenuis* Formánek and *S. montana* L. var. *kitaibelli* (Weirzb.) Briq. subvar. *tenuis* (Formánek), usually grows on karst rocks and serpentine sides of some river gorges of FRJ Macedonia. Three extracts (*n*-hexane, ethyl acetate and ethanol) of *S. fukarekii* Šilić were obtained by Soxlet apparatus. Antioxidant activities of these extracts were evaluated using different assays (DPPH, ABTS and FRAP). In addition, the total phenolic and flavonoid content in the extracts was determined. Total flavonoid and phenolic content was 124.2 μg/ml and 266.59 μg/ml, respectively. Ethyl-acetate extract showed the highest flavonoid content (51.54 μg/ml), while ethanol extract showed the highest phenolic content (223.59 μg/ml). DPPH test showed IC_{50} values 0.190 mg/ml for ethanol extract and 4.159 mg/ml for n-hexane extract. ABTS assay is showed the AAEC values 0.010±0.010 mg/ml for n-hexene extract and 0.206±0.027 mg/ml, for ethanol extract. Results of FRAP assay showed, similar trend as previous two; the highest antioxidant activitie was for 70 ethanol extract 1.080±0.050 mM/g. Ethanol extracts of *S. fukarekii* showed significat antioxidant activity.

Mikromorfološka obilježja i sastav eteričnog ulja Kernerove bresine (*Micromeria kerneri* Murb.)

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Kernerova bresina (*Micromeria kerneri* Murb.) je endemska Ilirsko-Balkanska vrsta raprostranjena na području Bosne i Hercegovine, Hrvatske i Crne Gore, od razine mora do 250 m nadmorske visine. Istraživani su tipovi i rasprosranjenost biljnih dlaka te fitokemijski sastav eteričnog ulja vrste *M. kerneri* prikupljene na lokalitetu Gradina u okolici Šibenika. Skening elektronskom mikroskopijom listova, stabljike i čaške utvrđeno je prisustvo ne-sekretornih i sekretornih (štitastih i dva tipa glavičastih) dlaka. Prvi tip glavičastih dlaka građen je od jedne bazalne epidermalne stanice i jedne eliptične vršne stanice, dok je drugi tip sastavljen od jedne bazalne epidermalne stanice, dvije stanice drške i jedne vršne stanice. Prvi tip glavičastih dlaka je više manje koso postavljen u odnosu na površinu organa, dok je drugi tip uspravan. Eterično ulje je izolirano vodenom destilacijom iz suhih nadzemnih dijelova, te analizirano plinskom kromatografijom i masenom spektrometrijom, koristeći VF-5ms kapilarnu kolonu za identifikaciju izoliranih spojeva. Postotak eteričnog ulja u odnosu na ukupnu težinu suhog uzorka iznosio je 0.06% i u njemu su određena pedeset i četiri spoja, tj. ukupno je određeno 96.9% sastava ulja. U sastavu ulja oksigenirani seskviterpenski spojevi (42.9%) čine najveću skupinu spojeva, s najzastupljnijim spojem kariofilen oksidom (39.2%). Od ostalih spojeva koji ulaze u sastav eteričnog ulja vrste *M. kerneri* najzastupljeniji su: β-pinen (6.3%), dokosan (5.4%), kamfor (4.3%) i E-kariofilen (2.9%). Predstavljeni rezultati mikromorfološke i fitokemijske analize endemične Kernerove bresine dio su istraživanja vrsta roda *Micromeria* s ciljem proširivanja spoznaja o morfološko-fizioloških značajkama ovih vrsta.

Micromorphological traits and essential oil contents of *Micromeria kerneri* Murb.

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Micromeria kerneri Murb. (Lamiaceae) is an endemic Illyric-Balcanic species distributed in Bosnia and Herzegovina, Croatia, and Montenegro from sea level up to 250 m. Types and distribution of trichomes, and chemical composition of the essential oil were investigated in *M. kerneri* growing in Gradina near Šibenik, Croatia. Non-glandular trichomes, peltate and two types of capitate trichomes (type 1: one basal epidermal cell, one elliptically shaped head cell; oblique; type 2: one basal epidermal cell, two stalk cells, and one head cell; upright) were observed on leaf, stem and calyx, using scanning electron microscopy. Water distilled essential oils from aerial parts of investigation plant have been analysed by GC and GC/MS using VF-5ms capillary column. The total yield of oil was 0.06%, based on dry weight of samples. Fifty-four compounds representing 96.9% of the total oil of *M. kerneri*. This essential oil was characterized by a high concentration of oxygenated sesquiterpenes (42.9%) of which caryophyllene oxide being the principal compound (39.2%). β-Pinene (6.3%), docosane (5.4%), camphor (4.3%), and E-caryophyllene (2.9%) were the other main components of the investigation oil.

The present study gives additional knowledge about micromorphological traits and essential oil contents on the genus *Micromeria*, and especially on endemic *M. kerneri*.

Composition of fatty acids and *n* – alkanes of some *Amphoricarpos* Vis. species

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n – alkanes from epicuticular waxes from the leaves and fatty acids from the cypselae from *Amphoricarpos neumayerianus* (Vis.) Greuter, *A. autariatus* Blečić & E. Mayer ssp. *autariatus* and *A. autariatus* Blečić & E. Mayer ssp. *bertisceus* Blečić & Mayer were investigated. Species of the genus *Amphoricarpos* were not investigated from this aspect so far. In all species alkanes from C_{25} to C_{33} were determined. Dominant alkanes are *n* - nonacosane (C_{29}) (43.8 %) and *n* - hentriacontane (C_{31}) (47.1%). Less dominant alkanes are *n* - heptacosane (C_{27}) (8.5 %), *n* - tritriacontane (C_{33}) (3.1 %) and *n* - triacontane (C_{30}) (1.6 %). Rest of the alkanes are represented by less than 1%. In the cypselae following fatty acids were found: levulinic (5:0), propionic (3:0), stearic (18:0), *cis*-7-hexadecenoic (16:1n-9), linoleic (18:2n6c), valeric (5:0), palmitic (16:0), oleic (18:1n9c), capric (10:0), and 11,14,17-eicosatrienoic (20:3n3).

Antigenotoksični potencijal biljnih flavonoida delfinidina i luteolina u citokineza-blokiranim humanim limfocitima

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Bioflavonoidi su prirodni polifenolni spojevi i predstavljaju sekundarne metabolite biljaka. Odgovorni su za boju nekih biljnih organa, ali i za zaštitu biljaka od različitih nepovoljnih uticaja životne sredine. Delfinidin je ljubičasti pigment (u ovisnosti od pH sredine boja varira od crvene do plave) koji je najviše zastupljen u bobičastom šumskom voću. Luteolin je žuti pigment i najviše je zastupljen u biljkama žutih cvjetova i plodova kao i u listovima zelenih začinskih biljaka. Delfinidin i luteolin su izuzetno zastupljeni u ljudskoj prehrani. Poznati su protektivni efekti mnogih bioflavonoida. Među njima su svakako najznačajniji antioksidativni, antimikrobni i antikancerogeni efekti. U ovom radu evaluiran je antigenotoksični potencijal delfinidina i luteolina *in vitro* u finalnoj koncentraciji od 50 μM. Primjenjen je citokineza-blok mikrinukleus citom test u humanim limfocitima periferne krvi. Odabrani flavonoidi su u kulture humanih limfocita dodati dva sata nakon tretmana halogeniranim boroksinom poznatog genotoksičnog potencijala. Preliminarni rezultati analize, provedene na uzorcima periferne krvi dva dobrovoljna donara, ukazuju da postoji signifikantno smanjenje frekevencije mikronukleusa u prisustvu delfinidina u odnosu na kulture tretirane samo halogeniranim boroksinom. S druge strane, nije utvrđeno signifikantno smanjenje frekvencije mikronukleusa u prisustvu luteolina, ali je frekvencija nuklearnih pupova u prisustvu ovog flavonoida bila signifikantno reducirana u odnosu na kulture tretirane

samo halogeniranim boroksinom. Signifikante razlike za mjere citotoksičnosti i citostatičnosti nisu utvrđene. Dobijeni rezultati ukazuju da odabrani bioflavonoidi pokazuju određenu antigenotoksičnu aktivnost *in vitro* i predstavljaju pouzdanu osnovu za dodatna istraživanja antigenotoksičnih efekata ovih, ali i drugih biljnih spojeva i njihovih derivata.

Antigenotoxic potential of plant flavonoids delphinidin and luteolin in cytokinesis-blocked human lympocytes

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Bioflavonoids are natural polyphenolic compounds, secondary plant metabolites. They are responsible for colour of some plant organs, as well as for plant protection from various adverse environmental effects. Delphinidin is violet pigment (depending on pH value, colour varies from red to blue) mostly present in forest berry fruits. Luteolin is yellow pigment, mostly found in plants that have yellow flowers and fruits but also in leaves of green condiments. Delphinidin and lutelolin are widely present in human diet. Protective effects of various flavonoids are well known. Among them the most important are antioxidative, antimicrobial, and anticancerogenic effects. In this study we have evaluated antigenotoxic potential of delphinidin and luteolin *in vitro* in final concentration of 50 μM. Cytokinesis-block micronucleus cytome assay in human peripheral blood lymphocytes has been applied. Selected bioflavonoids are added to the cultures of peripheral blood lymphocytes two hours upon the treatment with halogenated boroxine of known genotoxic potential. Preliminary results, conducted on peripheral blood samples from two volunteers, have revealed significant reduction of micronuclei frequencies in the presence of delphinidin when compared with the results from cultures treated only with halogenated boroxine. However, significant reduction of micronuclei frequency was not revealed in the presence of luteolin when compared to cultures treated only with halogenated boroxine. Significant differences for measures of cytotoxicity and cytostatisity were not detected. Obtained results have shown that selected bioflavonoids express certain antigenotoxic activity *in vitro* and present reliable basis for further investigation of antigenotoxic effects of those as well as other plant compounds and their derivates.

Antimicrobial activity of essential oil of *Ferulago macedonica* Micevski & Mayer

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Ferulago W. D. J. Koch species are used as spices, flavorings and in folk medicine. Macedonian endemic species *Ferulago macedonica* Micevski & Mayer (Apiaceae) was studied for the first time for antimicrobial activity of two essential oils, from aerial parts and inflorescence. Plant material was collected in 2011, in surrounding of Negotino city in Macedonia. Micro-well dilution technique was used for screening *in vitro* antimicrobial activ-

ity of *F. macedonica* essential oils on various pathogenic strains. Tested oils demonstrated strong antibacterial activity compared to streptomycin. Obtained MIC values were ranged between 0.6 – 2.4 mg/ml and MBCs between 2.2 – 9.0 mg/ml. It was observed that effectiveness on selected bacteria of oil obtained from inflorescence (MICs= 0.6 – 2.2 mg/ml; MBCs= 2.2 – 9.0 mg/ml) was stronger than other tested oil (MICs= 0.6 – 2.4 mg/ml; MBCs= 2.4 – 4.8 mg/ml). The most susceptible strain was *Bacillus cereus* (human isolate), followed by *Pseudomonas aeruginosa* (ATCC 27853). Compared to streptomycin (MIC= 15; MBC= 20 mg/ml), both oils showed much stronger effect on *Listeria monocytogenes* (NCTC 7973), (MIC= 0.6, MBC= 4.8 mg/ml). *Ferulago* oils were assayed for their antifungal potency and they showed inhibitory effect on mycelial growth at concentrations of 0.6 – 2.2 mg/ml, while MFCs were detected in range of 2.2 – 4.8 mg/ml. Results indicated that *Aspergillus fumigatus* (ATCC 9197), (MFCs= 2.2 and 2.4 mg/ml for both oils, respectively) was the most sensitive strain. According to data, there wasn't significant difference in antifungal potency between tested oils. However, it was noted that both oils had lower activity compared to fluconazole, sinthetic control that was used. Due to adverse effects of synthetic antibiotics and antimycotics on humans, it is reasonable to use compounds with antimicrobial effect from natural sources.

Composition and antimicrobial activity of essential oil of *Artemisia arborescens* L. grown in Libya

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In this work the essential oil of *Artemisia arborescens* L. obtained by hydrodistillation with Clevenger-type apparatus was analyzed by GC-MS. Fifty-one compounds were identified, representing 96.15% of the total of oil. The main components of the oil were camphor (24.70%) and chamazulene (20.90%), followed by: isomers $C_{14}H_{18}$ (6,34%), linalool (5,96%), $C_{21}H_{34}$ (5,77%), bronyll acetate (4,90%) and germacrene D (4,36%). According to our results samples of *A. arborescens* from Libya, can be classified as chamazulene chemotype according to abundance of chamazulene and thujone (dominant component was chamazulene, while thujone was absent). Antimicrobial activity of essential oil was tested, using microdilution method, against the following seven bacteria: *Bacillus cereus* (clinical isolate), *Micrococcus flavus* (ATCC 10240), *Listeria monocytogenes* (NCTC 7973), *Staphylococcus aureus* (ATCC 6538), *Escherichia coli* (ATCC 35210), *Pseudomonas aeruginosa* (ATCC 27853), *Salmonella typhimurium* (ATCC 13311), *Enterobacter cloacae* (human isolate), and eight fungal species: *Aspergillus niger* (ATCC 6275), *A. ochraceus* (ATCC 12066), *A. versicolor* (ATCC 11730), *A. fumigatus* (ATCC 1022), *Penicillium ochrochloron* (ATCC 9112), *P. funiculosum* (ATCC 10509), *Trichoderma viride* (IAM 5061) and *Candida albicans* (human isolate). The effect of tested oil showed higher activity against Gram (+) than Gram (-) bacteria. The best antibacterial activity was observed against *Listeria monocytogenes* and the less against *Pseudomonas aeruginosa*, *Escherichia coli, Enterobacter cloacae* (in comparison with Streptomycin and Ampicillin). The best antifungal activity was showed against *Penicillium ochrochloron* and *P. funiculosum* (in comparison with Bifonazole and Ketoconazole).

Campanula portenschlagiana Roem et Schult.: kemijski i biološki profil hlapljivih frakcija eteričnog ulja

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Ispitana je sastav i biološka aktivnost eteričnog ulja divlje endemične biljke iz Hrvatske -*Campanula portenschlagiana* Roem. et Schult. Pedeset i tri kemijska spoja su identificirana analizom eteričnog ulja plinskom kromatografijom i plinskom kromatografijom sa masenim spektrometrom. Diterpenski alkoholi činili su glavninu klase spojeva sa 13(16), 14-labdien-8-ol kao glavnim spojem. Biološka aktivnost određena je testiranjem aktivnosti eteričnog ulja na inhibiranje acetilkolin esteraze (AChE) i na antioksidacijske metode. Metodom po Ellmanu spektrofotometrijski je određena inhibicija AChE korištenjem uzoraka eteričnog ulja koncentracije 1mg/ml. Određen je i antioksidacijski kapacitet korištenjem 2,2-diphenyl-1-picrylhydrazyl (DPPH) testom uklanjanja radikala i metodom reduciranja željeznih iona (FRAP). Antioksidacijska svojstva eteričnog ulja vrste *C. portenschlagiana*, kao i inhibicija acetilkolin esteraze istim uljem nisu pokazali obećavajuće rezultate.

Campanula portenschlagiana Roem et Schult.: chemical and biological profile of volatile fractions

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The present study describes the phytochemical profile and the bioprotective effects of *Campanula portenschlagiana* Roem. et Schult., an endemic wild growing plant in Croatia, volatile oil. Fifty tree compounds were identified after gas chromatography and gas chromatography/mass spectrometry analyses of the volatile oil. Diterpene alcohols were the major compound class with 13(16), 14-labdien-8-ol as the main compound. Biological profile consisting of antioxidant and acetylcholinesterase inhibitory activity was obtained. The volatile oil of *C. portenschlagiana* was tested for its acetylcholinesterase (AChE) inhibition and antioxidant activity. Spectrophotometric assessment of AChE inhibition was carried out at concentration of a volatile oil of 1 mg/mL. Inhibition potential was determined using Ellman method. Antioxidant capacities were determined by 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging test and ferric reducing/antioxidant power assay (FRAP). Antioxidant capacity and acetylcholinesterase inhibitory activity testing of volatile oil did not show promising results.

Biljna fiziologija i molekularna biologija – usmena priopćenja

Plant physiology and molecular biology – oral presentations

Biljni LTR-retrotanspozoni: struktura i organizacija u genomu

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Pokretni genetički elementi (PGE) su širom rasprostranjeni u živom svijetu. Istraživali smo visoko zastupljene LTR-retrotranspozone iz porodice Ty3/*gypsy*, umnožene metodom PCR u sestrinskim rodovima *Anemone*, *Pulsatilla* i *Hepatica* (Ranunculaceae). Koristeći referentne porodice PGE u filogenetskim analizama uspjeli smo utvrditi da izolirani PGE pripadaju porodici *Tekay* iz skupine kromovirusa. U rodu *Anemone*, izolirani elementi su pokazali značajnu varijabilnost u strukturi, zastupljenosti i položaju na kromosomima. Unatoč raspršenoj organizaciji na kromosomima, u nekim anemonama elementi klasteriraju u interkalarnom heterokromatinskom području, dok u drugim vrstama isti izbjegavaju heterokromatinska područja. U svim istraživanim vrstama iz roda *Pulsatilla*, elementi se nalaze u centromernom/pericentrom području. Različita organizacija Ty3/*gypsy*-retrotranspozona u skupini Anemoninae ukazuje na njihovu značajnu ulogu u evoluciji i specijaciji.

Plant LTR-retrotransposons: a structural and cytogenetic perspective

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Eukaryotic transposable elements (TEs) are ubiquitous and widespread mobile genetic entities. Genome divergence through transposable elements activity and recombination are ongoing processes that occur within species. We have surveyed highly repeated Ty3/Gypsy families, amplified by PCR in the members of three sister genera *Anemone*, *Pulsatilla* and *Hepatica* of the Anemoninae tribe using degenerative primer pairs matching Reverse Transcriptase (RT) and Integrase (Int). The phylogenetic analyses using reference TEs identified all TEs as the Tekay family of chromoviruses suggesting that this element is the most abundant chromovirus family in the investigated Anemoninae taxa. In *Anemone*, isolated elements showed great variations considering size, structure and chromosomal position. Despite their dispersed organisation on chromosomes, in some *Anemone* species, the elements were absent from the DAPI positive heterochromatin regions, while in other species, they showed significant clustering in the DAPI positive heterochromatin regions. In all investigated *Pulsatilla* species, FISH showed pericentromeric localization of elements on chromosomes. Diverse organization of Ty3-*gypsy* elements in Anemoninae suggest that they play an important role in plant genome evolution and speciation.

Određivanje reproduktivne kompatibilnosti između sorti maslina (*Olea europaea* L.) praćenjem rasta i razvoja peludnih mješinica u cvijetu

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Produktivnost maslinika ovisi o odabiru sorti te njihovim reproduktivnim značajkama i potrebama. Autoinkompatibilnost kod masline je genetski uvjetovana, a veći uspjeh zametanja plodova bilježi se nakon stranooprašivanja. Uspjeh oplodnje i postotak zametanja plodova ovise o stupnju kompatibilnosti između sorte oprašivača i sorte primatelja peludi. U upotrebi su različite metode koje se koriste u svrhu određivanja kompatibilnosti među sortama, odnosno njihova uspjeha samooprašivanja i stranooprašivanja. Najzastupljenija metoda je određivanje uspjeha zametanja plodova. Međutim, procjena kompatibilnosti na temelju uspjeha rasta i razvoja peludnih mješinica u cvijetu je nedovoljno istražena. S ciljem određivanja uspjeha klijanja peludnih zrnaca, rasta peludnih mješinica i postotka oplodnje nakon samooprašivanja i stranooprašivanja, cvjetove sorti smo oprašili s vlastitom peludi te s peludi različitih sorti u ulozi oprašivača ('Lastovka', 'Leccino', 'Levantinka' i 'Oblica'). Rast i razvoj peludnih mješinica u cvijetu smo analizirali korištenjem metoda fluorescentne mikroskopije. Brzina rasta peludnih mješinica i uspjeh oplodnje ovisili su o genotipu sorte oprašivača. Postotak oplodnje je bio značajno veći kod cvjetova nakon stranooprašivanja, nego nakon samooprašivanja.

Pollen tube growth in compatibility assessment of olive (*Olea europaea* L.) cultivars

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The olive orchard productivity largely depends on the choice of planted cultivars and their pollination needs. The self-incompatibility has been widely reported in olive, and the cross-pollination usually enhances fertilization, fruit set and yield. The efficiency of fertilization and fruit set relies on compatibility between recipient and pollen donor trees. Different methods have been employed to study compatibility relationships between olive cultivars and to obtain reliable results on compatible and incompatible combinations. The fruit set has been the established method used to test cross-compatibility in this species but the assessment of compatibility relaying on pollen performance *in vivo* is insufficiently examined. With the aim to determine pollen germination, pollen tube growth and fertilization percentage in flowers of different olive cultivars ('Lastovka', 'Leccino', 'Levantinka' and 'Oblica'), the self-pollination and cross-pollination treatments were performed. Flowers were cross-pollinated with pollen of various pollen donor cultivars. The self-pollination treatment was also applied pollinating the flowers with their own pollen. Pollen performance in the pistil was assessed using fluorescence microscopy. Pollen tube growth and fertilization percentage depended on the genotype of pollen donor. The percentages of fertilization were significantly higher in cross-pollinated flowers than in self-pollinated flowers.

Biljna fiziologija i molekularna biologija – posterska priopćenja

Plant physiology and molecular biology – poster presentations

Citotoksično i genotoksično djelovanje *Helleborus multifidus* Vis.

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Helleborus multifidus Vis. je endemična ilirsko-jadranska vrsta rasprostranjena na području uz Jadransko more, u Sloveniji, Hrvatskoj, Bosni i Hercegovini, Crnoj Gori i Albaniji. U narodnoj medicini vrste roda *Helleborus* L. se smatraju toksičnim, dok potencijalno toksično djelovanje *H. multifidusa* do sada nije istraživano. Citotoksično i genotoksično djelovanje vodenih i etanolnih ekstrakata lista i korijena vrste *H. multifidus* je ispitivano na biljnim meristemskim (Allium test) i humanim (Citokineza-blok mikronukleus citom test) ćelijama. Analize su pokazale snažno citotoksično i genotoksično djelovanja ekstrakata vrste *H. multifidus*. Efekti citotoksičnog i citostatičkog djelovanja bili su od doze zavisni i najizraženiji u tretmanima s najvišom primjenjenom koncentracijom. Svi ekstrakti korijena su već pri najnižoj primjenjenoj koncentraciji zaustavili proliferaciju i uzrokovali destrukciju limfocita. Iste efekte na humane limfocite je imao i tretman etanolnim ekstrakatom lista u koncentraciji od 2 µl/ml.

Cytotoxic and genotoxic activity of *Helleborus multifidus* Vis.

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Helleborus multifidus Vis. is an endemic Illyrian-Adriatic species widespread in Adriatic area, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro and Albania. In folk medicine, species of the genus *Helleborus* L. are considered toxic. Potential toxic effects of *H. multifidus* have not been investigated until now. Cytotoxic and genotoxic effects of *H. multifidus* leaves and root extracts were evaluated on plant meristem (*Allium* test) and human (cytokinesis-block micronucleus cytom test) cells. Analysis have showed strong cytotoxic and genotoxic effects of *H. multifidus* extracts. Cytotoxic and cytostatic effects were dose-dependent and the highest in treatments with the highest concentration applied. All root extracts at the lowest applied concentration inhibited cell proliferation and caused destruction of lymphocytes. The same effects on human lymphocytes were expressed in treatments with ethanol extract of leaf at the concentration of 2 µl/ml.

Spinach leaf plasma membrane and chloroplast envelope redox activities

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Plasma membrane and chloroplast envelope were simultaneously isolated from spinach leaves (*Spinacia oleracea* L.). NADH and NADPH dependent redox activities of membrane preparations were monitored spectrophotometrically with respect to different electron acceptors. While plasma membrane showed higher NADH- than NADPH oxidase activity, chloroplast envelope preferentially catalysed NADPH oxidation. Both membranes show somewhat higher affinity for NADH as electron donor with different electron acceptors (ferrycianide, DCPIP and ascorbic acid). Similar NADH and NADPH dependent quinone (juglone and menadione) reductase activities, as well as GSSG reduction, were observed with both electron donors. Oxaloacetate reduction was almost exclusively dependent on NADH as an electron donor.

Peroxidase activity in black and gray alder (*Alnus glutinosa* (L.) Gaertn. and *A. incana* (L.) Moench) and their hybrid (*A.* x *pubescens* Tausch.)

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The species of genus *Alnus* Mill. (alder, Betulaceae) are used as a pioneer species to prevent soil erosion, for improvement of soil fertility (provided additional nitrogen), and as a source of anti-inflammatory and anti-tumorous compounds. Peroxidases are the most responsive enzymes to environmental stresses, and useful indicator of the plants' adaptability on different stressful conditions. In this study peroxidase activity in autumn leaves of *Alnus glutinosa* (L.) Gaertn., *A. incana* (L.) Moench and their hybrid *A.* x *pubescens* Tausch. was analyzed. Specimens for analysis were collected from six natural alder populations in Bosnia and Herzegovina (three were sympatric). Working hypothesis was that changes in peroxidase concentration, which has been associated with environmental stress, can be used to relate stress-adaptation of these taxa. Analyses showed there were no significant differences in peroxidase concentration between three investigated taxa. But, interpopulation significant differences in the peroxidase concentration have been found between populations Kladanj (sympatric, on serpentine, 750 m above the sea) and Boračko lake (allopatric, on limestone, 420 m above the sea) in relation to other investigated populations. The results suggest the greater resistance of individuals from these two localities to adverse conditions in ecosystems.

Characterization of bio-morphological, physiological and *ex situ* germplasm conservation of plants of the genus *Ramonda* from Kosovo, Albania and Macedonia

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The genus *Ramonda* Rich. includes three species, two closely related poikilohydric or resurrection plants, *Ramonda nathaliae* Pančić et Petrović and *Ramonda serbica* Pančić, survive as preglacial relicts and endemic species on specific refugia habitats in the Balkan Peninsula. The investigation presented here involved examination of some parameters of: biomorphology, physiology, *in vitro* propagations, and *ex situ* germplasm conservation of these species from different populations. The research was conducted with *R. nathaliae* plants from different localities of Macedonia, while *R. serbica* from different localities of Kosovo, Albania and Macedonia. Almost all examined morphological characteristics, plant density, phenological traits and physiological parameters were significantly different between the localities of these species. During desiccation, *R. nathaliae* was more resistant than *R. serbica*, and more rapid after rewatering recovery to normal physiological activity. Seeds treatment with GA_3 is the treatment which grows the germination up to 90% for *R. serbica* and 70% for *R. nathaliae*. The best nutrient media for micropropagation of these species was JG-B including combination of phytohormones cytokinin/auxin (BAP and IAA, 0.5 mg l^{-1} each). Callogenesis and meristemoid formation during indirect organogenesis in leaves pieces inoculated in MS medium with 0.5 mg l^{-1} NAA and 0.4 mg l^{-1} BAP were observed, while the formation of new plantlets has reached in MS medium with a high ratio of cytokinin/auxin. *In vitro* conservation with slow growth methods were applied for two species. With these *in vitro* conservation methods plantlets were preserved for 6-14 months and again regenerated. Protection by law, cultivation in Botanical Garden and *in vitro* conservation of these species are required.

The effect of the plant growth regulators on antimicrobic and antioxidative properties in basil (*Ocimum basilicum* L.)

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In vitro shoots of basil (*Ocimum basilicum* L.) were established from seeds on Murashige and Skoog medium (MS) supplemented with 0.15 mg L^{-1} Gibberelic acid (GA_3), 3% (w/v) sucrose and 0.8% (w/v) agar. The effect of BA (6-benzyladenine) and IBA (indole-3-butyric acid) on antioxidative and antimicrobic properties were tested on 4 week old shoots cultivated on MS medium containing different concentrations of BA or BA in combination with 0.1 mg L^{-1} IBA. Application of IBA in combination with lower concentrations of BA had stimulating effect on the level of the lipid peroxidation. For the treatment with 0.5 mg/l BA in combination with 0.1 mg L^{-1} IBA the highest level of lipid peroxidation (97.71%) was recorded. Gram positive bacteria were more susceptible to the antimicrobic effect of all tested basil extracts when compared to Gram negative bacteria. *Aspergillus brasiliensis* was also sensitive to basil extracts and inhibition zones were varying from 8.33 mm (control) up to 14.33 mm (1.0 mg L^{-1} BA + 0.1 mg L^{-1} IBA).

Photosynthetic content and total phenolics in *Mentha piperita* L. shoot cultures

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Surface-sterilised *Mentha piperita* L. seeds were cultivated on a Murashige and Skoog (MS) medium supplemented with 0.15 mg L^{-1} Gibberellic Acid (GA3). The effect of BA (6-benzyladenine) and IBA (indole-3-butyric acid) on photosynthetic pigments and total phenolics production were tested on 4 week old shoots cultivated on MS medium containing different concentrations of BA or BA in combination with 0.1 mg L^{-1} IBA. Different concentrations of BA alone generally induced variable changes in photosynthetic pigments contents as well as in total phenolics contents of *M. piperita*. Significant increase of photosiynthetic pigments contents induced concentration of 0.1 mg L^{-1} BA. Application of BA in combination with IBA had stimulating effect on phenolics production when compared to the corresponding BA treatments or control.

Different immobilization methods of soybean hull peroxidase on macroporous glycidyl methacrylate copolymers

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Wastewater treatment is a current and important environmental issue. Phenolic compounds most of which are toxic and many even carcinogens, found in various polluted waters are non-biodegradable and present a serious health hazard. Enzymatic treatment, using peroxidase and H_2O_2, provides a highly selective and efficient alternative to current phenol removal methods, with low energy requirements and minimal environmental impact. Soybean hull peroxidase (SHP) isolated from soybean hulls, which are inexpensive agricultural waste products, offers a cheap source of crude enzyme available for various applications. In this study we used macroporous glycidyl methacrylate based copolymers with various surface characteristics and mean pore size diameter ranging from 40-200 nm as carriers and compared two different immobilization methods for SHP – glutaraldehyde and periodate. Our results demonstrate that SHP immobilization with both methods is influenced by the pore size of the carrier matrix with both the specific activity of the immobilized enzyme and immobilization yeald increased with pore size. Glutaraldehyde immobilization method proved to be substantially better than periodate with the highest specific activities obtained 22.8 U/g and 3.4 U/g of carrier respectively. Thermal stability at 85°C and stability in 80% dioxane solution indicate a stabilization of the immobilized enzyme compared to the free form. Although having the same pH optimum, immobilized enzyme operates over a broader pH range. Obtained biocatalyst shows an increased specific activity, higher thermal and organic solvent stability and operates over wider pH range and it's suitable for wastewater treatment.

Teucrium species as natural sources of chlorogenic acid

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The genus *Teucrium* L. (germander) belongs to the family Lamiaceae, within the subfamily Ajugoideae. A large number of known medicinal plants belonging to this genus are used in folk medicine, pharmacy and in food industry as spices and for bitter beverages. Qualitative phytochemical analysis of *Teucrium* species revealed the presence of different secondary metabolites, such as phenolic acids with strong biological activity. Chlorogenic acid is a phytochemical in the class of hydroxycinnamic acids. Structurally, this acid is the ester of caffeic acid with the 3-hydroxyl group of quinic acid. It is a phenolic natural product found abundantly in dicotyledonous plants. Chlorogenic acid is an important factor in plant metabolism and also, compound with many health benefits. It has antioxidative, antimicrobial, antiinflamatory, antiproliferative, antiobesity and hepatoprotective effects. In this study quantitative analysis of chlorogenic acid in the above-ground parts of five species and two subspecies of *Teucrium* genus was carried out. Quantification of chlorogenic acid in methanolic extract was done by reversed phase HPLC analysis. Based on the obtained results, it was concluded that the quantity of chlorogenic acid was very different for the studied species of the genus *Teucrium*. Its concentration ranged from 0.75 to 243.90 μg/g (*T. chamaedrys* L. – 24.60 μg/g, *T. montanum* L. – 1.70 μg/g, *T. polium* L. – 0.75 μg/g, *T. arduini* L. – 4.20 μg/g, *T. botrys* L. 243.90 μg/g, *T. scordium* L. subsp. *scordium* – 197.70 μg/g, *T. scordium* subsp. *scordioides* Schreb. – 1.05 μg/g). The results suggest the great value of *T. botrys* and *T. scordium* subsp. *scordium* as a rich chlorogenic acid sources.

Inter-population variability in secondary metabolites content of *Teucrium polium* L. from the localities in the Balkan Peninsula

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Teucrium polium L. is a perennial herbaceous plant with little branched stems up to 40 cm high. Inhabit rocky limestones and dry mountain meadows in the Mediterranean region and Middle East. Numerous *in vitro* and *in vivo* tests of biological activity of secondary metabolites from *T. polium* prove antibacterial, antiinflammatory, antiproliferative, antinociceptive, antihypertensive, hepatoprotective and hypoglycemic properties. Synthesis and secondary metabolites accumulation in the plants are affected by numerous factors, among which the most important are: edaphic characteristics, altitude, habitat type, etc., which all affect their qualitative and quantitative variability within space and time. In this study, inter-population variability of *T. polium* secondary metabolites was determined using comparative analysis of plants from different habitats on the territory of Serbia and Montenegro. Total phenolic content, flavonoid concentrations and antioxidant activity of methanolic extracts obtained from *T. polium* from two populations from Serbia (Mt. Vidlic and Trgoviste - Southern Serbia) and one from Montenegro (Mt. Orijen, Crkvice) were investigated and compared. The total phenolic content was determined using Folin-Ciocalteu reagent and expressed as gallic acid equivalent - mg of GA/g of extract. The obtained values are: Mt. Vidlic - 131.92 mg GA/g, Trgoviste - 175.22 mg GA/g and Crkvice - 154.48 mg GA/g of extract. The concentration of flavonoids was determined using $AlCl_3$ and expressed as rutin equivalent - mg of Ru/g of extract. The obtained values are: Mt. Vidlic - 80.95 mg RU/g, Trgoviste - 96.46 mg RU/g and Crkvice - 100.61 mg RU/g of extract. Antioxidant activity was determined *in vitro* using DPPH reagent and expressed as IC_{50} values in μg/ml. The obtained values are: Mt. Vidlic - 54.49 μg/ml, Trgoviste - 33.85 μg/ml and Crkvice - 9.42 μg/ml of extract. The highest activity of *T. polium* secondary metabolites were measured in plants from Mt. Orijen, Crkvice, while the lowest values were in plants from Mt. Vidlic. The results obtained in the analysis point out that the concentration and activity of secondary metabolites depend on the ecological properties of the habitats. Investigated localities differ in ecological characteristics that affect the variability of the quantity and activity of secondary metabolites. Environmental factors that most influence the concentration and activity of secondary metabolites are altitude and substrate characteristics.

Biological effects of wall germander (*Teucrium chamaedrys* L.) secondary metabolites

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Teucrium chamaedrys L. (Lamiaceae) is a perennial herbaceous plant with half-ligneous and shrub-like aboveground part up to 30 cm high. It has little-branched stems with oval serrated leaves and tiny blooms on branchtops. The plant inhabits rocky limestone areas, dry mountain meadows and pastures, the edge of the sparse oak and pine forest up to 1000 meters above sea level in Central Europe, Mediterranean region and Western Asia. *T. chamaedrys* is used in the treatment of digestive disorders, abscesses, gout and conjunctivitis and in stimulation of fat and cellulite decomposition. In the present study, antioxidative potential, total phenolic content as well as flavonoid concentration of methanolic, acetone and ethyl acetate extracts from *T. chamaedrys* were investigated. Antioxidative potential was assayed using three methods: Ferric reducing/antioxidant power (FRAP), Briggs-

Rauscher oscillating reaction and ability to scavenge 1,1-diphenyl-2-picrylhydrazyl (DPPH) radicals. FRAP values were between 255 and 953 μmol Fe^{2+} equ/l. Results for Briggs-Rauscher oscillating reaction were expressed as a time (in minutes) requierd for regeneration of osscillations and obtained values were: 27.0 for methanolic, 2.0 for acetone, while ethyl acetate extract had no activity. DPPH results were expressed as IC_{50} values rangeing from 16.30 to 195.88 μg/ml. Total phenolic content was determined using Folin-Ciocalteu reagent and the values ranged from 53.33 up to 210.83 mg of GA/g of extract. The concentration of flavonoids in various plant extracts of *T. chamaedrys* was determined using spectrophotometric method with aluminum chloride. The values of flavonoid content in plant extracts ranged from 54.48 up to 82.20 mg of RU/g of extract. Methanolic extract was most active in comparison with other extracts for all measurments. The results suggest the great value of *T. chamaedrys* as a rich source of phenolic compounds with an effective biological activity.

Učinak ekstrakata usplođa ploda crnog oraha (*Juglans nigra* L.) na različite biljne vrste

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Od davnina je poznato da crni orah (*Juglans nigra* L.) aktivno izlučuje različite alelokemikalije koje mogu negativno utjecati na klijanje te rast i razvoj drugih biljnih vrsta. Međutim, mehanizmi djelovanja alelokemikalija na fiziološkoj razini slabo su istraženi. Cilj ovog rada bio je istražiti alelopatski učinak vodenog ekstrakta (10% i 20%, w/v) usplođa crnog oraha na rajčicu (*Lycopersicon esculentum* L.), radič (*Cichorium intybus* L.) i pšenicu (*Triticum aestivum* L.). Za određivanje alelopatskog učinka na klijavost i rast klijanaca sjemenke su bile izlagane ekstraktu orahu tijekom šest dana nakon čega je mjerena stopa klijanja te dužina korijena i izdanka klijanaca. U drugom djelu pokusa u biljaka starih četiri tjedna koje su bile izlagane ekstraktu oraha sedam dana kao fiziološki parametri određivani su učinkovitost fotosinteze metodom fluorescencije klorofila *a in vivo* te aktivnost antioksidacijskog enzima gvajakol peroksidaze spektrofotometrijski i u gelu. Izlaganje višoj koncentraciji (20%, w/v) ekstrakta oraha značajno je snizilo stopu klijanja sjemenki svih istraživanih vrsta te smanjilo rast korijena i izdanka pšenice i rajčice, a osobito radiča. Izlaganje nižoj koncentraciji (10%, w/v) ekstrakta snizilo je stopu klijanja sjemenki rajčice i radiča te smanjilo rast korijena svih vrsta, naročito rajčice dok je smanjeni rast izdanka primijećen u rajčice i pšenice. Optimalni prinos fotosinteze i stopa prijenosa elektrona bili su značajno sniženi u svih biljaka koje su rasle u 20%-tnoj otopini ekstrakta dok je pri nižoj koncentraciji ekstrakta stopa prijenosa elektrona bila niža samo u rajčice. Povišenje aktivnosti gvajakol peroksidaze primijećeno u izdancima radiča i rajčice izlaganih ekstraktu oraha te u korijenju pšenice i radiča pri nižoj koncentraciji ekstrakta kao i veća aktivnost pojedinih izoformi u korijenu rajčice izlagane višoj koncentraciji ekstrakta oraha ukazuju na pojavu oksidacijskog stresa. Iz dobivenih rezultata može se zaključiti da je ekstrakt usplođa crnog oraha imao negativan učinak na klijanje sjemenki i rast klijanaca, ali i na proces fotosinteze u svih istraživanih vrsta te da u to može biti uključen oksidacijski stres.

Effects of black walnut (*Juglans nigra* L.) pericarp extract on different plant species

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Since ancient times, it is known that black walnut (*Juglans nigra* L.) actively secretes various allelochemicals that may negatively affect germination, growth and development of other plant species. However, mechanisms of allelochemical's action at physiological levels are poorly explored. The aim of this study was to investigate allelopathic effect of aqueous extract (10% and 20%, w/v) of black walnut pericarp on tomato (*Lycopersicon esculentum* L.), chicory (*Cichorium intybus* L.) and wheat (*Triticum aestivum* L.). To determine allelopathic effect on germination and growth of seedlings, seeds were exposed to extract for six days, after which were measured rate of germination and length of roots and shoots of seedlings. In the second part of the experiment in four weeks old plants that were exposed to extract for seven days physiological parameters were determined by the efficiency of photosynthesis using chlorophyll a fluorescence and in vivo activity of antioxidant enzyme guaiacol peroxidase by spectrophotometry and gel. Exposure to higher concentrations (20% w/v) of extract significantly lowered the rate of germination of seeds of all species examined, and reduced growth of roots and shoots of wheat and tomato, especially chicory. Exposure to lower concentrations (10% w/v) of extract reduced the rate of germination of tomato and chicory seeds and reduced root growth of all species, especially tomato while reduced shoot growth was observed in tomato and wheat. Optimum yield of photosynthesis and rate of electron transfer were significantly decreased in all plants growing in the 20% solution of extract while at lower concentration of extract rate of electron transfer was lower only in tomato. Increase in guaiacol peroxidase activity observed in the shoots of chicory and tomato exposed to extract and in the roots of wheat and chicory at a lower concentration of extract as well as increased activity of individual isoforms in tomato roots exposed to higher concentration of extract indicate the occurrence of oxidative stress. From the results obtained it can be concluded that the extract of black walnut pericarp had a negative impact on seed germination and seedling growth, but also on the process of photosynthesis in all species examined, and that it can be included in oxidative stress.

Utjecaj osmotskog stresa na biljnu vrstu *Fibigia triquetra* (DC.) Boiss.

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Nedostatak vode u tlu u biljkama dovodi do osmotskog stresa koji može uzrokovati oštećenje stanica bilo poticanjem proizvodnje reaktivnih oblika kisika ili narušavanjem obrambenih mehanizama. Cilj ovog istraživanja bio je potaknuti osmotski stres u hrvatskoj endemskoj biljnoj vrsti Fibigia triquetra (DC.) Boiss. i procijeniti njegove učinke putem odabranih pokazatelja stresa. Ova vrsta je izabrana kao modelna jer živi na toplom i suhom staništu pa se pretpostavlja da je morala razviti vrlo učinkovit obrambeni mehanizam od suše i visokih temperatura. Biljke su izlagane osmotskom stresu dodatkom manitola ili polietilen glikola (PEG) tijekom 14 dana. Analizirani su relativni vodni status, masa suhe tvari, sadržaj prolina, fotosintetskih pigmenata, proteina (uključujući i stresnih proteina) te pokazatelji oksidacijskog stresa. Kod biljaka izloženih osmotskom stresu zabilježen je porast mase suhe tvari i sadržaja prolina te sniženje vodnog statusa posebice u biljaka izloženih PEG-u. Sadržaji klorofila *a* i *b* te karotenoida nisu se razlikovali od kontrolnih vrijednosti osim nakon prvog dana kada je uočen njihov porast. Oba su osmotika uzrokovala peroksidaciju lipida no sam je PEG izazvao i oksidacijsko oštećenje proteina. Sadržaj topivih proteina kao i stresnog proteina od približno 72 kDa bio je povećan u biljkama izloženim osmotskom stresu. Aktivnosti antioksidacijskih enzima bile su povećane na manitolu, posebice na PEGu. Ovi rezultati pokazuju sposobnost prilagodbe vrste *F. triquetra* na osmotski stres koja je rezultat učinkovitog mehanizma obrane od djelovanja suše.

Effects of osmotic stress on plant species *Fibigia triquetra* (DC.) Boiss.

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Water deficit in the soil leads to osmotic stress in plants. Osmotic stress can cause cell damage either by inducing active oxygen species production or by disrupting detoxification mechanisms. The goal of this study was to induce osmotic stress in Croatian endemic plant species Fibigia triquetra (DC.) Boiss. and assess its effects using certain stress indicators. F. triquetra was selected as a plant model as it lives on hot and dry habitat, thus assuming it developed very effective defense mechanisms in response to drought and high temperatures. Plants were subjected to mannitol- or polyethylene glycol- (PEG) induced osmotic stress over a period of 14 days. Relative water status, dry weight, accumulation of proline, photosynthetic pigments, proteins and oxidative stress parameters have been analyzed. Dry weight and proline content in *F. triquetra* shoots increased in response to osmotic stress while the relative water status decreased, especially in PEG-treated plants. Chlorophylls and carotenoids showed increase only following the first day of experiment. PEG both osmotica caused lipid peroxidation, but only PEG induced oxidative damage to proteins. Accumulation of soluble proteins, including heat-shock proteins of 72 kDa was noticed under osmotic stress. Antioxidative enzyme activities increased in response to both stressors, especially to PEG. The obtained results show the ability of *F. triquetra* to adjust to osmotic stress due to effective defence mechanisms against drought conditions.

Flora i bioraznolikost – usmena priopćenja

Flora and biodiversity – oral presentations

Rasprostranjenost svojte *Moehringia tommasinii* Marches. (Caryophyllaceae) u Hrvatskoj

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Moehringia tommasinii Marches. (*Caryophyllaceae*), stenoendemična je vrsta uskog graničnog pojasa, istočnih Alpa i sjeverozapadnih Dinarida (Ćićarija). U radu se prikazuje detaljna rasprostranjenost u Hrvatskoj te pojašnjavaju neke nedoumice o nalazima svojte u prošlosti. Ujedno se predstavlja rasprostranjenost u Sloveniji i Italiji te tako i ukupan svjetski areal svojte. Također se iznosi census svojte u Hrvatskoj sa usporedbom u Sloveniji i Italiji, te procjena udjela populacije u Hrvatskoj u svjetskoj populaciji vrste. Obzirom da je vrsta na Dodacima II i IV Direktive o staništima i na Dodatku I Konvencije o zaštiti europskih divljih vrsta i prirodnih staništa (Bernska konvencija) kratko se opisuju mogući uzroci i procjena ugroženosti.

Distribution of *Moehringia tommasinii* Marches. (Caryophyllaceae) in Croatia

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Moehringia tommasinii Marches. (*Caryophyllaceae*) is a stenoendemic species from a narrow border area of Eastern Alps and Northwestern Dinarides (Ćićarija). This paper presents detailed distribution in Croatia, and clears certain dilemmas about species findings in the past. It also presents the distribution in Slovenia and Italy, therefore the overall world distribution of the species. It states the species census in Croatia with a comparison to Slovenia and Italy, and the estimation of its Croatian population in the overall world population. As this species is listed on Annexes II and IV of the Habitats Directive and on Appendix I of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention), the paper shortly describes possible causes and the estimation of its endangerment.

Type material in the *Herbarium Dalmaticum* in Padova

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The *Herbarium Dalmaticum* in Padova (PAD), Italy, is a collection of about 10,000 specimens from the coastal areas of present day Croatia and Montenegro. It was put together by Dalmatian botanist Roberto de Visiani (1800-1878) during more than forty years, while he was working in Padova as professor of botany and head of the Botanical Garden. This collection and the works that are associated with it are of paramount importance in the history of botanical research along the eastern coast of the Adriatic sea and in the Balkans in general. Along with Visiani himself, about 50 other botanists contributed to enrich the *Herbarium Dalmaticum*, among which there are J. Pantocsek, J. Pančić, P. Ascherson and K. Maly. In 2011 a project was started to catalogue and study this collection. More than 300 specimens have been recognised to be potential types of legitimate names, most of which were published in Flora Dalmatica, the largest of the botanical works by Visiani. Almost none of these names has been effectively typified and many have been neglected. A large fraction of them, especially but not exclusively those of infraspecific units, do not appear in international databases. Research on these old names and specimens can provide new insights in modern botanical research; the recent re-establishment of *Linaria rubioides* Vis. & Pančić by G. Niketić & M. Tomović, whose type is in the *Herbarium Dalmaticum*, is an example of that. Much work is being done, in close collaboration with resarchers in Belgrade, to review the protologues and discuss the nomenclatural status of thirty-six names published together by Visiani and Pančić. Names published in the early works by Visiani are also being restudied. A thorough analysis of all the work associated with the *Herbarium Dalmaticum* will require to investigate about a thousand nomenclatural novelties.

Ljekovite i otrovne biljne vrste Plešivičkog prigorja (SZ Hrvatska)

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U tijeku floristićkih istraživanja različitih staništa Plešivičkog prigorja uočen je veći broj ljekovitih i otrovnih vrsta. Iz tog razloga izdvojena je flora koja obuhvaća 215 ljekovitih i/ili otrovnih biljnih svojti u okviru 54 porodice. Prema brojnosti vrsta najzastupljenije su porodice *Asteraceae, Lamiaceae* i *Fabaceae*. Zanimljivo je istaknuti velik broj vrsta koje su istovremeno i ljekovite i otrovne. Razlika je najčešće u biljnim dijelovima koji sadrže otrovne ili ljekovite tvari ili u dozi koja se koristi. Najveći broj ljekovitih i otrovnih vrsta zabilježen je na ruderalnim staništima uz rubove cesta i putova te u živicama (163 vrste), zatim uz rubove jaraka (111 vrsta), slijede vinogradi (89 vrsta), oranice (72 vrste), vrtovi (57 vrsta) te livade (52 vrste).

The medicinal and poisonous plants of Plešivica hills (NW Croatia)

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During the floristic research of different sites on Plešivica hills, the floristic composition shows a great number of medicinal and poisonous plants. They encompass 215 taxa that belong to 54 families. The most dominant families are *Asteraceae, Lamiaceae* and *Fabaceae*. It is interesting to point out the large number of plants which are at the same time medicinal and poisonous. The difference is plant part or dose in use. The highest number of species is noted on ruderal habitats such as roadsides, paths and hedges (163 species), the side of ditches (111 species), vineyards (89 species), plough-fields (72 species), gardens (57 species) and meadows (52 species).

Neobiota Sloveniae: vascular plants

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Main aim of a 2-year project Neobiota Sloveniae financed by Government of Slovenia was to collect and compile knowledge of neobiota in Slovenia with particular focus on invasive alien species. About a third of the species list represent vascular plant taxa. The oldest record of a neophyte for Slovenia is *Conyzacanadensis* (Scopoli 1760) and in the following decades number of neophytes have been gradually increasing with distinct acceleration in last 3 decades reaching close to 350 (including about 100 (potentially) invasive). Average age of first record of a species is forephemerophytes around 1980, and for completely naturalized and invasive in the second quarter of 20th century, but we can expect that several taxa, today recognized only as casuals, will turn into invasives in the next decades. Neophyte field records before 1950 were scarce and concentrated around some bigger cities, between 1950 and 1980 there were several more scattered records and after 1980 a clear distribution pattern of neophyte concentration is obvious along bigger lowland rivers and around cities butthe Alps and higher parts of Dinaric region are still almost without records. That distribution pattern is clearly mirrored also in altitudinal spectrum: only a tiny fraction of invasives can be found locally above 1000 m. For every neophytic taxon estimated date of first occurrence in Slovenia, country of origin, occurrence in neighboring countries, level of naturalization, frequency of occurrence, estimated population trend and data estimation quality have been scored. For invasives also rough distribution pattern, habitat types threatened, altitudinal belts and main spreading vectors were listed. As expected, casuals are mostly rare and invasives widespread, but there are some exceptions of scattered casuals (e.g. *Phacellia tanacetifolia*) and only locally distributed invasives (e.g. *Lonicera japonica*). About half of neophytes are from (North) America, less than third from Asia and almost none from Africa and Australia. Regarding invasive (32 taxa) and potentially invasive species (71) more than half of them normally grow in ruderal places, of the (semi)natural habitat types most threatened are: forests and forest fringes, river banks and regularly flooded areas, and various types of wetlands. Even extreme habitat types are threatened by some taxa e.g. salt marshes (*Conyzanthus squamatus*) and rock crevices (*Buddleja davidii, Thuja orientalis*). Main vectors for spreading within the country are anthropogenic (deliberate planting, non-intentional transport etc.) or natural (wind, birds, water etc.). Unfortunately the estimated data quality (especially for a big group of casuals and rare neophytes) is quite low, so most probably situation is even worse than presented.

Rasprostranjenost i morfološka varijabilnost invazivnih vrsta *Elodea nuttallii* (Planch.) H.St.John i *Elodea canadensis* Michx u Hrvatskoj

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Invazivna vrsta *Elodea nuttallii* prvi je puta zabilježena u flori Hrvatske. U slivu Dunava do sada je pronađena u svim državama i trenutno predstavlja invazivnu biljnu vrstu s najbržim širenjem u vodenim ekosustavima. U Hrvatskoj je zabilježena 2006. godine u melioracijskim kanalima Kopačkog rita (Baranja). Nakon naseljavanja populacije, *E. nuttallli* se počela širiti na istočni i sjeverni dio mreže kanala tijekom nekoliko zadnjih godina. Naši rezultati pokazuju smjer linearnog širenja vrste koji je također opisan u susjednim zemljama (Madžarska, Slovenija, Srbija). U istraživanom su području poplave ključni procesi koji povezuju glavni tok rijeke s mrežom melioracijskih kanala kao i stajaću vodu u kanalima, pa su stoga vjerojatno odgovorne za smjer širenja vrste *E. nuttallii* na istraživanom poplavnom području. *E. nuttallii* i *E. canadensis* morfološki su vrlo varijabilne vrste što je ključna osobina invazivnosti makrofita u vodenim ekosustavima, ali isto tako uzrokuje probleme prilikom determinacije. Zbog neslaganja između autora o glavnim razlikama unutar roda *Elodea* izmjerili smo najvažnije morfološke karakteristike navedene u literaturi: širinu srednjeg dijela lista, duljinu lista, omjer širine/duljine lista, širinu lista 0,5 mm ispod vrha, kut vrha lista i duljinu internodija. 24 svježa uzorka vrsta *E. canadensis* i *E. nuttallii* sa sedam lokaliteta u Hrvatskoj tijekom perioda istraživanja (2006-2009) analizirano je u laboratoriju. Unatoč preklapanjima između dviju vrsta u duljini i širini lista, sve su morfološke razlike osim duljine internodija statistički značajne. Veća morfološka varijabilnost širine, duljine lista i duljine internodija vrste *E. nuttallii* pokazatelj je bolje adaptacije ekološkim uvjetima. Širina listova 0,5 mm ispod vrha i kut vrha lista pokazali su se kao najpouzdaniji u razlikovanju vrsta *E. nuttallii* i *E. canadensis* i mogu se koristiti za brzu determinaciju pri terenskom istraživanju.

Distribution and morphological variations of invasive macrophytes *Elodea nuttallii* (Planch.) H.St.John and *Elodea canadensis* Michx in Croatia

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An invasive species *Elodea nuttallii* is recorded for the first time in Croatian flora. It has been recorded in all countries of the Danube River Basin and represents the most rapid current invader in water bodies. In Croatia *E. nuttalii* was recorded in 2006 in melioration channels of Kopački rit (Baranja). After its establishment, *E. nuttallii* begins to spread on eastern and northern part of drainage channel network in the few last years. Our results show the linear spreading direction of *E. nuttallii* that was also described in some neighbouring countries (Hungary, Slovenia, Serbia). High water levels are the key processes that link the main river with drainage network system, the stagnant water in channels and are probably responsible for spreading and directing pathway of *E. nuttallii* in the investigated flooded area. *E. nuttallii* and *E. canadensis* show wide range of morphological variation. It is a key characteristic of aquatic plant invasiveness but it has also caused many identification problems. Due to some disagreements among authors about the distinguishing characteristics of *Elodea* species,

we measured the most important characteristics indicated in literature: leaf width at the mid point, leaf length, width/length ratio, leaf width 0.5 mm below the tip, angle at the apex and internode length. 24 fresh collected samples of *E. canadensis* and *E. nuttallii* from the 7 sites in Croatia and from different years (period 2006-2009) were analysed morphometrically in the laboratory. In spite of some overlap in leaf length and width of two *Elodea* species, differences of all measured morphological traits except internode length are statistically significant. In *Elodea nuttallii* leaf width, length and internode length show a higher morphological variability as a result of higher adaptive strategy to environmental parameters. Leaf width 0.5 mm below the tip and the angle at the apex has been found as the most reliable to distinguish *E. nuttallii* and *E. canadensis* and they can be used for quick determination in field surveys.

Invazivna flora parka Maksimir u Zagrebu

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Ovim istraživanjem napravljena je analiza trenutne rasprostranjenosti invazivne flore parka Maksimira. Ukupno je zabilježeno 23 invazivne biljne vrste na 5 000 lokacija u parku. Rasprostranjenost zabilježenih vrsta analizirali smo s obzirom na: njihovu vezanost uz tip ili kombinaciju tipova staništa; učestalost pojavljivanja u zonama određenim na temelju načina korištenja i dominantnog tipa zemljišnog pokrova; prisutnost u kvadrantima pravilne mreže 250 x 250 m. Rezultati ove analize korišteni su za višekriterijsku klasifikaciju zabilježenih vrsta u tri kategorije: izrazito invazivne; umjereno invazivne i najmanje invazivne vrste. Analiza prisutne invazivne flore napravljena je i s obzirom na taksonomsku pripadnost, podrijetlo, životni oblik, tip rasprostranjivanja i Ellenbergove indikatorske vrijednosti. Zabilježene su vrste unutar 14 porodica, od kojih je porodica Asteraceae najbrojnija, najviše vrsta podrijetlom dolazi iz obiju Amerika, terofiti su najčešći životni oblik, najzastupljeniji načini rasprostranjivanja su zookorija i anemokorija, a najviše invazivnih biljnih vrsta obitava na osunčanim i dušikom bogatim staništima. Temeljem višekriterijske analize pet biljnih vrsta je određeno kao izrazito invazivne na području Maksimira od kojih su najrasprostranjenije *Erigeron annuus* (L.) Pers, *Robinia pseudoacacia* L. i *Veronica persica* Poir. Sedam vrsta je prepoznato kao umjereno invazivne, a 11 kao najmanje invazivne. Važnost ovog istraživanja proizlazi iz prepoznavanja najugroženijih dijelova parka te će se ono koristiti za usmjeravanje aktivnosti sa ciljem spriječavanja i/ili suzbijanja daljnjeg širenja invazivnih biljnih vrsta na području parka Maksimir.

Invasive flora of Maksimir park, Zagreb, Croatia

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This paper analyzes current spatial distribution of invasive flora in the Maksimir Park, Croatia. A total of 23 invasive plants on 5 000 locations have been recorded. Distribution of invasive plants have been analysed with respect to: their frequency in certain habitat type or combination of habitats; frequency in zones delineated based on landuse and landcover; presence in 250 x 250 m elements of regular grid throughout the complete

Park. These results we have used for multicriteria classification of invasive plants into three groups: extremely invasive; moderately invasive and least invasive species. Additionally, we have analysed invasive flora with respect to their systematic positions, origin, life form, types of seed dispersal and Ellenberg indicator values. Invasive plants originate mainly from both Americas, belonging to 14 families, with Asteraceae being the most frequent. Therophytes are the most common life form while zoochory and anemochory are the most frequent types of seed dispersal. Locations with high amount of light and nutrients are places where invasive plants most frequently occur. Based on multicriteria analysis five species have been identified as extremely invasive with *Erigeron annuus* (L.) Pers, *Robinia pseudoacacia* L. and *Veronica persica* Poir. as most widespread ones. Seven species has been classified as moderately invasive, and eleven as least invasive plant species. The significance of this research was in identifying the most endangered areas of the park that will enable to focus efforts on prevention and/or suppression of further spread of invasive plant species.

Does forest management support the plant species diversity in EU Natura 2000 forest habitats?

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Natura 2000 is a coherent ecological network of special areas, designated under the EU Habitat Directive (1992) and EU Bird Directive (1979), to preserve biodiversity and habitats in a favourable conservation status. Within the Natura 2000 network in Slovenia, managed forests dominate, and conflicts between nature conservation and timber productive roles are possible. Forest management is a robust driver of diversity and, according to the applied options, may act as a factor of enhancement or depletion of biodiversity. In the framework of the Life+ ManFor C.BD project, within the Dinaric fir-beech forest in Slovenia, the impacts of three key factors (forest management, dominant tree species, and location) on plant species diversity have been studied. Besides their significant forest-management and timber productive role of these forests, their ecological and nature-conservation aspects are also important. These forests are the central parts of the habitats of three large European predators, the brown bear, lynx and wolf, and of many other species of nature-conservation interest, and the major part of these forests has been designated as part of the Natura 2000 network (mostly habitat type of Illyrian *Fagus sylvatica* forests). According to climate change predictions, they might be also among the most threatened forests in Slovenia in the future. To mitigate the effects of climate change on these forests and to preserve the present biodiversity, appropriate forest management measures need to be applied. The plant species diversity has been tested before and will be assessed after implementation of forest management measures of three intensities. In this article, the status of plant species diversity before the implementation of forest management measures is presented. In three selected sites, 27 plots were set in the bottom of the karst terrain depressions (sinkholes). Among three groups of plots with different planned forest management measures and among three groups with different dominant tree species, there are no significant differences in the plant species diversity parameters. However, there are significant differences among groups of plots from different locations of Dinaric fir-beech forests. The number of species per 400 m^2 sized plots varies between 29 and 68 (mean: 48.8), and the value of the Shannon diversity index H' is between 1.23 and 3.30 (mean: 2.41). After the implementation of forest management measures, the plant species diversity will be assessed in order to optimize forest management system in these sensitive forests.

Biljna raznolikost Značajnog krajobraza Gornji Kamenjak, Istra (Hrvatska)

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Na području Značajnog krajobraza Gornji Kamenjak u južnoj Istri, provedeno je kartiranje vaskularne flore unutar osam MTB 1/64 polja u različitim vegetacijskim periodima 2012. i 2013. godine. Ovim istraživanjem ukupno je zabilježeno 486 biljnih svojti na 53 istraživana lokaliteta. Najzastupljenije porodice u flori Gornjeg Kamenjaka su trave (*Poaceae*), mahunarke (*Fabaceae*) i glavočike cjevnjače (*Asteraceae*). Dominantni životni oblici, terofiti i hemikriptofiti su zastupljeni s preko 30% u cjelokupnoj flori te slijede s 10% geofiti. Ovim je istraživanjem potvrđena vrlo rijetka i kritično ugrožena vrsta paprati, *Ophioglossum lusitanicum* L., te je po prvi puta za floru Hrvatske otkrivena vrsta *Catapodium pauciflorum* (Merino) Brullo, Giusso del Galdo, Minissale et Spampinato u sastavu halofilne vegetacije uz obalu mora. Pored toga zabilježeno je 13 endemičnih, 15 ugroženih i devet invazivnih svojti, te nekoliko rijetkih vrsta hrvatske flore kao što su *Koeleria australis* A. Kern., *Ranunculus paludosus* Poiret., *Serapias* x *todari* Tineo i *Allium chamaemoly* L. S obzirom na veliki udio suhih kamenjarskih travnjaka na Gornjem Kamenjaku je zabilježno 15 svojti orhideja, od kojih su tri endemične (*Ophrys incantata* Devillers et Devillers-Tersch, *O. untchjii* (M.Schulze) P.Delforge i *O. medea* Devillers et Devillers-Tersch.). Velik broj biljnih svojti na ovom relativno malom području koji zajedno sa zabilježenim vrstama na području Donjeg Kamenjaka prelazi preko 500 svojti, ukazuje na visok stupanj očuvanosti i biljne raznolikosti koji bi u budućim akcijskim planovima Javne ustanove «Kamenjak» trebao biti vrijedan zaštite i očuvanja.

Plant diversity of significant landscape Gornji Kamenjak, Istria (Croatia)

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The vascular flora of significant landscape Gornji Kamenjak in southern Istria, was mapped within eight MTB 1/64 fields in different vegetational periods of 2012 and 2013. A total number of 486 plant taxa within 53 investigated locations were recorded. The most dominant families in the flora of Gornji Kamenjak are grasses (*Poaceae*), legumes (*Fabaceae*) and aster familiy (*Asteraceae*). The dominant life forms represented with more than 30% of the entire flora are therophyta and hemicryptophyta, then follows geophyta with 10%. A very rare and critically endangered species of ferns, *Ophioglossum lusitanicum* L. was confirmed in this study. The species *Catapodium pauciflorum* (Merino) Brullo, Giusso del Galdo, Minissale et Spampinato that grows within the halophilous vegetation along the coast was found for the first time in the Croatian flora. Besides, there were 13 endemic, 15 threatened, nine invasive taxa and several rare species of the Croatian flora such as *Koeleria australis* A. Kern., *Ranunculus paludosus* Poiret., *Serapias* x *todari* Tineo and *Allium chamaemoly* L. Given the large proportion of dry rocky grasslands on the area of Gornji Kamenjak 15 orchid taxa were recorded, and three of them are endemic (*Ophrys incantata* Devillers et Devillers-Tersch, *O. untchjii* (M.Schulze) P.Delforge and *O. medea* Devillers et Devillers-Tersch.). High number of plant taxa in this relatively small area, that together with the species recorded in the area of Donji Kamenjak exceeds 500. This fact implicates that the area is of great plant diversity importance and should be better protected and preserved throughout future action plans of the Public Institution "Kamenjak" because of good preservation and high level of plant diversity.

Adventitious sprouting in Croatian flora

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Adventitious sprouting is rare neglected phenomenon known by morphologists already from 19th century. At that time, it was considered as evolutionary rarity, but recent studies of adventitious sprouting in experimental and natural conditions showed its ecological importance enabling to survive severe disturbance removing whole above part of plant biomass. This trait was studied mostly in Central Europe. However, in Mediterranean area we can expect higher occurrence of adventitiously sprouting species since intensity and frequency of disturbance (by fire ect.) are there higher than in temperate zone. Nevertheless, adventitious sprouting has been there almost not studied so far. The frequency of adventitious sprouting varies according to life-span - in annuals (2% of species), biennials (14%), perennials (12%), trees (31%). All sprouting species are dicots, families with most frequent occurrence of adventitious sprouting are Asteraceae, Scrophulariaceae, Brassicaceae, Euphorbiaceae, Linaceae, Fabaceae. Starting of vegetative season 2012, adventitious sprouting has been checked in Croatia in about 140 species in which we expect this ability or belong to congeners of them. Sprouting of 20 species was studied in natural populations. 15 species of annuals (belonging to genus *Euphorbia, Linum, Misopates, Chaenorhinum* ect.) were studied in 95 natural populations on habitats differing by low and high disturbance. Selected species (*Misopates orontium* and *Euphorbia peplus*) were researched in the field and their offsprings were planted in experimental conditions (with disturbance treatment and without it) with aim to reveal if maternal effect plays any role. Adventitious sprouting of trees were studied in invasive species (*Amorpha fruticosa, Robinia pseudoacacia, Ailanthus altissima*) with aim to find out, if adventitious sprouting is responsible for their fast spreading in Croatia.

Prikaz novijih istraživanja flore Parka prirode „Kopački rit"

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Floristička terenska istraživanja provedena su u Parku prirode „Kopački rit" tijekom trogodišnjeg razdoblja (2010.-2012.), na odabranim lokalitetima u različitim tipovima kopnenih, vodenih i močvarnih staništa. Park prirode „Kopački rit" nalazi se u sjeveroistočnoj Hrvatskoj, u poplavnom području između rijeka Dunava i Drave. Ovo područje zaštićeno je od 1967., a 1999. godine proglašeno je parkom prirode na 231 km^2 površine. Na popis močvara od međunarodne važnosti (Ramsarska područja) uvršten je 1993. godine. Kao polazište za analizu korišten je popis vaskularne flore izrađen za nacrt Plana upravljanja 2002. godine, a koji navodi ukupno 380 svojti. Na temelju ranije objavljenih podataka i rezultata terenskih istraživanja utvrđeno je da floru Parka prirode „Kopački rit" čini ukupno 468 svojti, svrstanih u 281 rod i 92 porodice vaskularnih biljaka. Zabilježene su 82 nove svojte. Porodice koje sadrže najviše vrsta su: *Asteraceae* (42 vrste), *Poaceae* (36), *Lamiaceae* (33) i *Cyperaceae* (26). U spektru životnih oblika dominiraju hemikriptofiti (41%), zatim terofiti (23%), geofiti (13%) i hidrofiti (11%). Fitogeografska analiza pokazuje da 34% svojti pripada euroazijskom flornom elementu; 27% svojti su biljke široke rasprostranjenosti; 11% pripada europskom; 7% južnoeuropskom i 3% srednjoeuropskom flornom elementu. Prisutno je 47 alohtonih biljnih vrsta, među kojima i viseći šaš (*Scirpus pendulus* Muhl.), nova vrsta u flori Hrvatske, zabilježena u srpnju 2011. godine. Ukupno 47 svojti (10%) uvršteno je u Crvenu knjigu vaskularne flore Hrvatske, od čega su 5 kritično ugroženih, 9 ugroženih i 15 osjetljivih svojti. Terenskim

istraživanjima zabilježena su nova nalazišta mnogih rijetkih i ugroženih svojti makrofitske i kopnene flore. Aktivnosti inventarizacije flore Parka prirode „Kopački rit“ se nastavljaju s ciljem praćenja promjena u stanišnim tipovima, te veličine populacija i rasprostranjenosti pojedinih biljnih svojti.

Review of the recent flora surveys in the Kopački rit Nature Park

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Floristic field researches were carried out in the area of the Kopački rit Nature Park during three-year period (2010-2012), at selected localities in various terrestrial, aquatic and wetland habitats. The Kopački rit Nature Park is located in northeastern Croatia, in flooded area between the Danube and the Drava Rivers. This area is protected since 1967, and proclaimed as nature park in 1999 on the surface of 231 km^2. In 1993 it is listed among wetlands of international importance (Ramsar areas). The starting point for the analyses was list of vascular flora prepared in 2002 for draft of the Management Plan, which registered 380 plant taxa. Based on the previously published data and results of fieldwork, it is determined that vascular flora of the Kopački rit Nature Park includes 468 taxa, classified into 281 genera and 92 families. A total of 82 new plant taxa were recorded. The largest number of taxa belong to the families *Asteraceae* (42 taxa), *Poaceae* (36), *Lamiaceae* (33) and *Cyperaceae* (26). In the life-form spectrum dominate hemicryptophytes (41%), terophytes (23%), geophytes (13%) and hydrophytes (11%). Phytogeographical analyses pointed out that 34% of taxa belong to the Euro-Asiatic floral element; 27% are widespread plants; 11% belongs to the European; 7% to the South-European, and 3% to the Central-European floral element. A total of 47 alochthonous plant taxa were recorded, among which the rufous bulrush (*Scirpus pendulus* Muhl.) was found in July 2011 as the new taxon to the Croatian flora. The Red Book of the Vascular Flora of Croatia includes 47 taxa or 10%; classified into categories: critically endangered (5 taxa); endangered (9) and 15 vulnerable taxa. New localities for many of rare and endangered taxa of the macrophytic and terrestrial flora were recorded during the fieldwork. The activities of floristic inventarization in the Kopački rit Nature Park are continuing, with the accent on monitoring changes in habitat types, as well as on population size and distribution of particular plant taxa.

Vaskularna flora kamenjarskih travnjaka sjeverne padine planine Matokit te obradivih površina okolice Vrgorca

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Tijekom istraživanja 2010. i 2011. godine na istraživanom području sjeverne padine planine Matokit i okolice grada Vrgorca inventarizirano je 477 svojti samonikle vaskularne flore; od toga 14 endema izdvojenih prema Flora Croatica Database, 29 ugroženih svojti prema Crvenoj knjizi, te 17 invazivnih svojti prema Preliminarnom popisu invazivnih stranih biljnih vrsta (IAS) u Hrvatskoj. Dominantni florni element je mediteranski 21,4 %, a od životnih oblika prevladavaju hemikriptofiti (45 %). Stanište kamenjarskih travnjaka nalazi se u fazi sukcesije, a na antropogeniziranim staništima uslijed socio-ekonomskih promjena (napuštanje poljoprivrede i stočarstva, depopulacija stanovništva) postoji opasnost širenja invazivnih svojti. Istraživano područje predstavlja novo nalazište za floru Hrvatske. Rezultati ovog istraživanja osim što su prilog poznavanju vaskularne flore Hrvatske, rasprostranjenosti endema, ugroženih i invazivnih svojti na teritoriju Hrvatske, također mogu doprinijeti očuvanju svojti i staništa istraživanog područja, kao i sprječavanju daljnjeg širenja invazivnih svojti.

Vascular flora of the northern slopes of mountain Matokit rocky grasslands and arable land surrounding Vrgorac city

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During this research 2010 and 2011, the study area on the northern slopes of the mountain Matokit and surrounding of the city Vrgorac inventoried 477 autochthonous species of vascular plants, of which 14 are endemic according to Flora Croatica Database, 29 threatened species according to the Red Book, and 17 invasive species, according to a preliminary list of invasive alien species (IAS) in Croatia. The dominant flora element is Mediterranean (21.4%), and predominate life forms are Hemicryptophytes (45%). Rocky grasslands habitat are in the phase of succession, and on anthropogenized habitats there is a danger of the spread of invasive species due to socio-economic changes (abandonment of agriculture and animal husbandry, population reduction). The studied area represent a new locality for Croatian flora. Results of this study can contribute not only to understanding of Croatian vascular flora and distribution of endemic, endangered and invasive species on Croatian territory, also to the conservation of species and habitats of the researched area, as well as preventing further spread of invasive species.

Flora i bioraznolikost – posterska priopćenja

Flora and biodiversity – poster presentations

Vaskularna flora predloženog značajnog krajobraza „Lunjski maslinici“ (otok Pag)

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„Lunjski maslinici“ smješteni su na poluotoku Lun na sjevernom dijelu otoka Paga, a predstavljaju jedinstvene prirodne maslinike. Oni su nastali nacjepljivanjem pitomih sorti, prvenstveno Oblice, na divlju maslinu (*Olea europaea* L. var. *sylvestris* Brot.) koja ovdje prirodno raste. Na pojedinim mjestima unutar maslinika razvijena je endemična zajednica *Asphodelo-Chrysopogonetum grylli* H-ić. (1956) 1958 (NKS C.3.5.1.3.) u kojoj dominira razgranjeni čepljez (*Asphodelus aestivus* Brot.).
Tijekom 2012. godine istraživana je vaskularna flora na području „Lunjskih maslinika“, na površini od 131,29 ha. Za istraživano područje maslinika zabilježeno je ukupno 206 biljnih vrsta i podvrsta, od kojih je 27 zaštićeno, a tri su strogo zaštićene temeljem Zakona o zaštiti prirode (70/05, 139/08, 57/11). Zabilježene svojte karakteristične su za vegetaciju kamenjarskih pašnjaka. To su jednogodišnje vrste ili trajnice koje rastu na otvorenim, osunčanim mjestima (uz suhozide, na prokrčenim putevima unutar maslinika itd.). Budući da na ovom području pasu ovce, među njima izrazito su rasprostranjene bodljikave svojte, odnosno svojte otporne na ispašu iz porodica Asteraceae s.l. i Fabaceae. S druge strane, na području maslinika prisutni su i elementi vazdazelenih eumediteranskih šuma, koji su posebno dobro razvijeni na zapuštenim područjima maslinika. Kao značajan nalaz istaknuli bismo nalaz rijetke, endemične vrste orhideje *Ophrys medea* Devillers et Devillers-Tersch. koja je dosad bila poznata jedino iz južnog dijela Istre te s kvarnerskih otoka Krka i Cresa.
Istraživano područje „Lunjskih maslinika“ predloženo je za zaštitu u kategoriji značajnog krajobraza (IUCN kategorija V).

Vascular flora of proposed significant landscape “Olive groves of Lun” (island of Pag)

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“Olive groves of Lun” are located on the peninsula of Lun, in the northern part of the island of Pag. They represent unique natural olive groves originated by grafting of olive varieties, primarily Oblica, on wild olive (*Olea europaea* L. var. *sylvestris* Brot.) which grows naturally here. In some places in the olive groves endemic community of *Asphodelo-Chrysopogonetum grylli* H-ić. (1956) 1958 (NKS C.3.5.1.3.) is developed, with the domination of species *Asphodelus aestivus* Brot.
Vascular flora on the area of 131.29 ha of “Olive groves of Lun” has been researched during the year 2012. For the researched area of olive groves 206 plant species and subspecies were recorded. Out of them 27 are protected, while three are strictly protected under the Nature Protection Act (Official Gazette 70/05, 139/08, 57/11). Recorded taxa are characteristic for the vegetation of rocky pastures. These are annual or perennial species growing in open, sunny places (the stone walls, the ragged roads within olive groves, etc.). Because this area is being grazed by sheep, among them are extremely widespread prickly species i.e. species resistant to grazing of the family Asteraceae s.l. and Fabaceae. On the other hand, on the area of olive groves there are also elements

of the eumediterranean evergreen forests, which are especially well developed on the neglected parts of olive groves. As an important finding we would like to highlight the rare, endemic species of orchid *Ophrys medea* Devillers et Devillers-Tersch., which has hitherto been known only from the southern part of Istria and the Kvarner islands of Krk and Cres.
Researched area "Olive groves of Lun" has been proposed for protection as a significant landscape (IUCN category V).

Prilog poznavanju vaskularne flore srednjeg Velebita – lokalitet Lisac

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Lisac (1450 m n.m.) je šumoviti brijeg u srednjem Velebitu koji nadvisuje Smojversku dulibu, a smješten je južno od Šatorine (1634 m n.m.), najvišeg vrha srednjeg Velebita. Cijeli Lisac je smješten u MTB 64 polju 1356.342. Do vrha je obrastao šumom i to na sjevernoj i istočnoj strani pretplaninskom bukovom šumom (NKS E.6.1.), a na jugu i zapadu dinarskom bukovo-jelovom šumom (NKS E.5.2.). Tijekom 2009.g. (06. kolovoza) i 2010.g. (17. lipnja), vršena su floristička istraživanja Lisca, prilazeći prema vrhu sjeveroistočnim dijelom brijega iz smjera planinarske kuće „Kugina kuća" na uzdužnoj velebitskoj cesti Šušanj-Štirovača. Savladavana je nadmorska visina između 1185 i 1447 m.Vršni dio Lisca je proplanak, a na primorskoj strani ima stijena i kamenjara. Floristički je Lisac slabo istražen, budući da je lociran dublje u unutrašnjosti planine. Ukupno je pronađeno 145 vrsta razvrstanih u 58 porodica. Najzastupljenije su porodice Lamiaceae (8,2%), Rosaceae (7,5%), Asteraceae (6,9%), Fabaceae (6,2%) i Brassicaceae (5,5%). U spektru životnih oblika prevladavaju hemikriptofiti (58%), a slijede ih geofiti (15%) i fanerofiti (14,1%). Fitogeografska analiza ukazuje na najveću zastupljenost euroazijskog flornog elementa sa 25,96%. Prema „Crvenoj knjizi vaskularne flore Hrvatske" 14 svojti svrstano je u neku od kategorija ugroženosti. Lisac je do danas ostao dio Velebita netaknut u smislu najrazličitijih antropogenih utjecaja i zahvata. Površina takvih dijelova Velebita se sustavno i značajno smanjuje.

Contribution to the knowledge of vascular flora of Middle Velebit – Lisac locality

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Lisac (1450 m a.s.l.) is a forested hill in Middle Velebit. It rises over Smojverska duliba and it is located to the south of Šatorina (1634 m a.s.l.), the highest peak of Middle Velebit. The whole of Lisac is located in MTB 64 field 1356.342. It is covered with forest up to the summit. Its northern and eastern sides are covered with Subalpine beech forest (NKS E.6.1) and its southern and western sides are covered with Dinaric fir-beech forest (NKS E.5.2.). During 2009 (6 August) and 2010 (17 June) a floristic survey was conducted on Lisac, moving towards the summit on the north-eastern part of the hill from the direction of the mountain house ''Kugina kuća" on the longitudinal Velebit road Šušanj-Štirovača. The survey was carried out between 1185 and 1447 m above sea level. The summit part of Lisac is a glade and on the seaward side there are rocks and karst areas. Floristically Lisac is underexplored because it is located deep in the mountain range's interior. Altogether 145 species were found, belonging to 58 families. The most common families are Lamiaceae (8.2%), Rosaceae (7.5%), Asteraceae (6.9%), Fabaceae (6.2%) and Brassicaceae (5.5%). In the spectrum of life-forms hemicryptophytes predominate (58%), followed by geophytes and phanerophytes (14.1%). Aphytogeographic analysis suggests that the Eura-

sian floral element predominates with 25.96%. According to ''The Red Book of Vascular Flora of Croatia" 14 species fall under one of the categories of threatened species. To this day Lisac remains pristine in relation to anthropogenic influences. However, such areas on Velebit are systematically and significantly shrinking.

Mikroklimatske i florističke značajke urušne ponikve i špilje Samograd kod Perušića (Lika, Hrvatska)

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Špilja Samograd najpoznatiji je speleološki objekt Pećinskog parka Grabovača kod Perušića.Ulaz se nalazi u 17 m dubokoj urušnoj ponikvi na istočnoj padini brda Grabovača. Morfologija ulaza i ponikve te nadmorska visina (684 m) bitni su za specifične mikroklimatske uvjete većih krških depresija: manju osunčanost, nižu temperaturu zraka s pojavom temperaturne inverzije te poseban režim relativne vlažnosti zraka u odnosu na okolna površinska staništa. Takvi specifični uvjeti odražavaju se na floristički sastav ponikve. Tijekom vegetacijske sezone 2012. godine obavljena su floristička i mikroklimatska istraživanja ponikve i ulaznog dijela kanala špilje. U smjeru pružanja špilje u ponikvi su, radi izrade mikroklimatskog profila, na različitim dubinama i ekspozicijama memorijskim termohigrografima i svjetlomjerima mjereni temperatura i relativna vlažnost zraka, temperatura rosišta i insolacija. Na različitim udaljenostima od ulaza u špilju i ekspozicijama popisivane su biljke koje rastu unutar ponikve i oko nje. Zabilježene biljke podvrgnute su taksonomskoj i fitogeografskoj analizi, analizama prema životnim oblicima, te ekološkim indikatorskim vrijednostima za svjetlost (L), temperaturu (T) i vlažnost tla (F). Ukupno je zabilježeno 111 biljnih svojti, od kojih su 3 endemične, 2 rijetke, 3 gotovo ugrožene i 1 osjetljiva. Zakonski je zaštićeno 24, a strogo zaštićeno 7 biljnih svojti. Na temelju analize mikroklime ponikve i okolnog staništa utvrđene su mikroklimatske zone čiji je prostorni raspored uvjetovao raspodjelu biljnih svojti. U I. zoni (najniži dio ponikve i ulazni dio špiljskog kanala dubine do 17 m) rastu biljke smanjene potrebe za svjetlom, kojima odgovaraju niže temperature zraka i veća vlažnost tla te male promjene spomenutih parametara. II. zona (dno ponikve) i po izmjerenim vrijednostima i po biljnom sastavu predstavlja prijelaznu zonu, ali sadrži i jedinstvenu floru svojstvenu samo za nju. U njoj je zabilježena najveća brojnost i raznolikost biljnih svojti. III. zona obuhvaća površinsko šumsko stanište koje više nije pod utjecajem mikroklime ponikve i špilje. U sve tri zone od životnih oblika dominiraju hemikriptofiti, s velikim zaostatkom slijede geofiti, dok se u II. zoni još ističu fanerofiti i nanofanerofiti. Najveći broj svojti zabilježen je u II. zoni (76), zatim slijedi III. (48) i I. zona (37).

Microclimate and floristic characteristics of collapsed doline and Samograd cave near Perušić (Lika region, Croatia)

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Samograd cave is the best known speleological feature of the Cave Park Grabovača. Its entrance is located in a 17 m deep collapsed doline located on the eastern slope of Grabovača hill. Entrance and doline morphology, as well as its altitude (684 m) are important for specific microclimate conditions of larger karst depressions: lower values of insolation, lower air temperature with occurrence of temperature inversion, and specific regime of air humidity compared to surrounding surface habitats. Such specific conditions influenced thedoline floristic composition. During vegetational season of 2012 floristic and microclimate measurements were performed. To create microclimate profile of the doline, data loggers were used to measure air temperature, relative humidity, dew point and insolation on different depths and expositions.At different distances from the cave entrance and various expositions plants that grow within and around the doline were inventoried. Recorded plants were analyzed taxonomically and phytogeographically, and also according to life forms and ecological indicator values for light (L), temperature (T) and soil moisture (F). In total 111 plant taxa were recorded, of them 3 endemic, 2 rare, 3 nearly threatened and 1 vulnerablespecies.Among them 24 taxa are protected by law and 7 are strictly protected. Based on the analysis of the microclimate parameters in doline and surface habitat, microclimate zones were also determined. Their spatial position influenced the spatial arrangement of plant species. In Zone I (the lowest doline part and cave entrance, depth up to 17 m) grow plants with reduced need for light, adjusted to lower temperatures, higher soil moisture and small variations of these parameters. According to the microclimate values and plant compositionZone II (doline bottom) is a transitional zone of unique flora with the greatest number and diversity of species. Zone III includes surface forest habitat without any influence of the doline and the cave. In all three zoneshemicryptophytesdominate, followed by much less numerous geophytes. In Zone II phanerophytes and nanophanerophytes are also significant. The largest number of species was recorded in Zone II (76), followed by Zones III (48) and I (37).

Prilog boljem poznavanju korologije biljnih svojta u Hrvatskoj na temelju florističkih istraživanja na Korčuli i Pelješcu

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U razdoblju od 2006. do 2013. intenzivno smo istraživali floru na otoku Korčuli i poluotoku Pelješcu. Utvrdili smo svojte za Korčulu i Pelješac koje do sada nisu bile zabilježene u literaturi. Među endemima, na Korčuli smo zabilježili vrstu *Trifolium mutabile* Port., koja je do sada bila poznata s Hvara, Visa i Lastova. Među kaćunovkama (*Orchidaceae*), na Korčuli smo pronašli *Orchis purpurea* Huds. (VU) i *Cephalanthera damasonium* (Miller) Druce, a na Pelješcu *Epipactis microphylla* (Ehrh.) Sw. Utvrdili smo kako je Korčula najjužnije hrvatsko nalazište triju novih svojta na otoku: *Adonis aestivalis* L. (EN), *Avellinia michelii* (Savi) Parl. (NT) i *Trifolium incarnatum* L. ssp. *molinerii* (Balb.ex Hornem.) Syme. Među ostalim novim svojtama na otoku su: *Cynanchum acutum* L. (EN), *Marrubium peregrinum* L. (EN), *Narcissus serotinus* L., *Legousia falcata* (Ten.), *Ornithopus compressus* L., *Pistacia* x *saportae* Burnat, *Plantago bellardii* All., i druge. Vrste *Valeriana tuberosa* L. i *Ranunculus illyricus* L. su nove na Korčuli, ali i na Pelješcu. Posebno vrijedan je nalaz vrste *Serratula radiata* (Waldst. et Kit.) M. Bieb. na Pelješcu. Tu je biljku u Dalmaciji zadnji put zabilježio Visiani (1847) u 19. stoljeću. Nalaz *Rorippa pyrenaica* (Lam.) Rchb. na Pelješcu prvi je u Dalmaciji. U radu su detaljno prikazana nalazišta i staništa tih i drugih vrsta, čime se upotpunjuje slika o njihovoj korologiji. Nalazi novih vrsta pokazuju kako flore otoka Korčule i poluotoka Pelješca još uvijek nisu u potpunosti istražene.

Contribution to a better knowledge of plant chorology in Croatia based on the floristic research of the island of Korčula and the Pelješac Peninsula

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We have extensively studied the flora of the island of Korčula and the Pelješac Peninsula in the period from 2006 to 2013. We have identified plant species on the island and peninsula, which have still not been reported in the literature. Among the endemics, we recorded *Trifolium mutabile* Port. on the island of Korčula. Until now, this species has been reported from the islands of Hvar, Vis and Lastovo. Among the orchids (*Orchidaceae*), we found *Orchis purpurea* Huds. (VU) and *Cephalanthera damasonium* (Miller) Druce on the island of Korčula, and *Epipactis microphylla* (Ehrh.) Sw. on the Pelješac Peninsula. Island of Korčula is the southernmost Croatian locality for three new island's species: *Adonis aestivalis* L. (EN), *Avellinia michelii* (Savi) Parl. (NT) and *Trifolium incarnatum* L. ssp. *molinerii* (Balb.ex Hornem.) Syme. Among others, new records for the island flora belonged to: *Cynanchum acutum* L. (EN), *Marrubium peregrinum* L. (EN), *Narcissus serotinus* L., *Legousia falcata* (Ten.), *Ornithopus compressus* L., *Pistacia* x *saportae* Burnat, *Plantago bellardii* All, etc. The species *Valeriana tuberosa* L. and *Ranunculus illyricus* L. are new for both the island and peninsula. We find particularly interesting record of *Serratula radiata* (Waldst. et Kit.) M. Bieb. on the Pelješac Peninsula. Last information on presence of this species in Dalmatia originated from Visiani (1847) in the 19th century. Finding of *Rorippa pyrenaica* (Lam.) Rchb. on the Pelješac Peninsula represents the first record of the species in Dalmatia. This study includes the detail information on the localities and habitats of these species and many others, and completes the knowledge of their chorology. The results suggest that floras of the island of Korčula and the Pelješac peninsula have not yet been fully investigated.

New floristic data on the flora of Croatia and Slovenia

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During field excursions between 2006 and 2013 in Slavonia, Croatia and in Prekmurje region of Slovenia we collected several noticeable floristic records, mainly in wetland habitats. *Elodea nuttali* (which has been only recently found in northern Slovenia) was discovered along the river Drava in Croatia as well. The enigmatic *Hypericum dubium* was found in the Međimurje region as a probably new species for Croatia. *Lindernia dubia* (mentioned from several localities in Slovenia, Central and Eastern Croatia, and in south-western Hungary) spreads also on further stretches in Croatia along Drava and Mura rivers. *Carex buekii*, a hitherto often overlooked sedge species proved to be widespread in Prekmurje region and also collected near Varaždin in Croatia. The taxonomical status of neglected pear taxon, *Pyrus austriaca* in Goričko, Slovenia and in Međimurje, Croatia has been explained. New localities of *Leontodon saxatilis* and *Chaenorrhinum litorale* in secondary habitats are also shown.

Halophilous flora and vegetation of Migliarino, S. Rossore, Massaciuccoli Regional Park (Northern Tuscany-Italy)

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The Regional Park of Migliarino, San Rossore, Massaciuccoli, established 1979, extends over a territory of approximately 24,000 hectares situated along the coast of North Tuscany (Italy). Although it lies in the middle of a strongly urbanized area, this territory has maintained considerable natural features, and here it is possible to find one of the rare examples of non-built coastal area. The territory of the park belongs to an area once inundated by marshlands and lagoons that have, with time, been covered by debris brought by two main rivers Serchio and Arno. The park is characterized by a remarkable variety of habitats: from sandy shores and dunes to wet forests to marshes and brackish. In this great variety the water plays without a doubt an essential role in the Park: as a matter of fact, the area covered with marshes, rivers, lakes and ponds is of about 3,000 hectares of which almost 500 are brackish areas. The wetlands and marshes are therefore the main features of the area, of special interest for their rare plants. As an example of the floristic and vegetational pattern of brackish areas of the park are analyzed those found along the coast of San Rossore Estate that represents the heart of the Park not only for its geographical position, but also for the richness of its environments and biodiversity. The attention focuses on the salt-tolerant species able to colonize more saline habitats located mostly in the so-called "lame" (marshes) situated along the coast, in the southern part of the Estate, in the north of the river Arno and subject to seasonal flooding. The total flora of the coast of San Rossore (~ 11 km length, 300 m depth) amounts to about 245 species some of which are of nature-conservation interest. Among the surveyed species, more than 50 are considerate required or optional halophytes. The most representative halophilic communities found in the area, are the following: *Suaedo maritimae-Salicornietum patulae* and *Parapholido incurvae-Catapodietum balearici* (habitat 1310), *Juncetum acuti, Juncetum maritimi-Spartinetum junceae, Limonio narbonensis-Juncetum gerardii* (habitat 1410) forming a mosaic mixed with *Schoeno nigricantis-Erianthetum ravennae* (habitat 6420). In these areas the presence of rare species such as *Crypsis aculeata* and *Artemisia caerulescens* is detected.

Invazivna flora porječja rijeke Krapine i Bedekovčanskih jezera

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U radu su prikazani rezultati istraživanja invazivne flore porječja rijeke Krapine i Bedekovčanskih jezera. Istraživanje je provedeno na tri lokaliteta (korito rijeke Krapine, mrtvice rijeke Krapine i Bedekovčanska jezera) u razdoblju od svibnja do listopada 2012. g. Primijenjene su uobičajene metode determinacije, prikupljanja i bilježenja biljnih vrsta. Ukupno je evidentirano, uz rijeku Krapinu 57 biljnih vrsta, uz Mrtvice 41 biljna vrsta, uz Bedekovčanska jezera 38 biljnih vrsta. Najvećim udjelom alohtonih i invazivnih vrsta od 17,5% ističe se porječje rijeke Krapine. Analiza životnih oblika invazivnih vrsta uz porječje rijeke Krapine i na Mrtvicama pokazala je dominaciju terofita, dok na Bedekovčanskih jezerima invazivne vrste ravnomjerno pripadaju fanerofitima, terofitima, hemikriptofitima i geofitima.

Invasive flora of the Krapina river basin and Bedekovčanska jezera lakes

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The paper brings results of the research into invasive flora of the Krapina river basin and of Bedekovčanska jezera lakes. The research was done at three localities (Krapina river watercourse, Krapina river oxbows and Bedekovčanska jezera lakes) in the period from May to October of 2012. Standard methods were applied in identifying, collecting and noting plant species. In total we registered 57 plant species along the Krapina river, 41 plant species along oxbows and 38 plant species at Bedekovčanska jezera lakes. The biggest portion of 17,5% of alien and invasive species was noted along the Krapina river watercourse. Life form analysis of alien species along the Krapina river watercourse and mrtvice showed domination of therophytes, while at Bedekovčanska jezera lakes invasive species are equally distributed among phanerophytes, therophytes, hemicryptophytes and geophytes.

New plant species of the Republic of Kosovo and their conservation status

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During 2011-2013 we have found some new plant species for flora of Kosovo. These species have very limited distribution area and are threatened by different factors that affect directly in the degradation of their habitat and this way reduce population of these species. In the serpentines of Kosovo we have found these new plant species for Kosovo's flora: *Viola herzogii* (W. Becker) Bornm, *Minuartia baldaccii* (Halacsy) Mattf. subsp. *baldaccii* and *Epimedium alpinum* L. On the calcareous substrate we found three new species for Kosovo's flora: *Onosma visianii* G.C. Clementi, *Iris sambucina* L. and *Ramonda nathaliae* Panč. et Petrov. Species *Viola herzogii* is found in the place known as Bokat e Krevenikut (near to the border with Macedonia) in the serpentine substrate near the population of the endemic species *Tulipa scardica* Bornm.. Species *Epimedium alpinum* L. that is distributed in European Alps, Northern Italy and in parts of Balkans is found in a place known as: Bokat e Morinës (near to the border with Albania), on the altitude from 500 up to 1100 m. Species *Minuartia baldacci* subsp. *baldacci* and *Iris sambucina* are found in serpentines substrate, near to the border with Albania, in a very narrow locality. Species *Onosma visianii* is found in Pashtriku mountain in the subalpine calcareous dry grasslands and has very limited distribution area and less than 60 mature individuals. Two small populations of the *Ramonda nathalie* species are found on the Sharri Mountains. All these species have very limited area, are threatened and should be protected by law.

Novi lokaliteti išaranoga šafrana (*Crocus reticulatus* Steven ex Adams) u Sloveniji i Hrvatskoj

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Išarani šafran (*Crocus reticulatus*, por. Iridaceae) pripada podskupini treće divizije *Nudiflori* i sekciji *Reticulati*. Rasprostranjen je travnjacima i svijetlim šumama jugoistočne Europe, do sjeverozapadne Italije, Mađarske i juga Rusije. U Sloveniji raste na krškim travnjacima te uz osunčane rubove šuma na Krasu i u slovenskom dijelu Istre, gdje je relativno česta svojta. Tijekom protekle tri godine u Sloveniji su zabilježena tri nova lokaliteta žuto-bijele forme išaranoga šafrana, koju prethodno navode Herbert (1847) i Rukšans (2010). Tri nova nalazišta ove rijetke dvobojne forme išaranog šafrana otkrivena su na lokacijama Dol pri Vogljah, Dutovlje i Komen, sve na području slovenskog Krasa. U Hrvatskoj je išarani šafran zakonom zaštićena svojta, koja raste uglavnom u nižim područjima obalnih planina te na većini većih otoka, od rta Kamenjaka u Istri sve do dubrovačkog područja. Početkom ožujka ove godine potvrdili smo nekoliko otprije poznatih nalazišta prema Bazi hrvatske flore (*Flora Croatica Database*): uz mjesto Rudine na otoku Krku te iznad Kolana na otoku Pagu. Također, pronašli smo i četiri nova lokalitetaove vrste: dva na otoku Pagu (povrh skretanja za Košljun i uz ornitološki rezervat Velo polje) tedva na otoku Viru (šire područje Radnjače, uz samu obalu mora).

New localities of striped crocus (*Crocus reticulatus* Steven ex Adams) in Slovenia and Croatia

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Striped crocus (*Crocus reticulatus*, family Iridaceae) belongs to the subgroup of third Division *Nudiflori* and Section *Reticulati*, respectively. It is widespread in the meadows and open woodlands of Southeastern Europe, extending to North-Eastern Italy, Hungary and Southern Russia. In Slovenia, the striped crocus is growing in the karstic grasslands and sunny forest edges of Slovenian Karst and the peninsula of Istria, where it is a quite common species. However, at only few sites one can find a bi-coloured form with white flowers and yellow throat, which was previously mentioned by Herbert (1847) and Ruksans (2010). Three new localities of that unusualwhite-yellow form are found in Dol pri Vogljah, Dutovlje and Komen, all in the Slovenian Karst region. In Croatia, this legally protected species found its habitats mainly in the lower areas of the coastal mountains and most of the larger islands, from the Cape of Kamenjak in Istria, to the broader Dubrovnik area. In early March of this year, we confirmed some previous findings (*Flora Croatica Database*) of this crocus at several sites in the islandsof Krk (Rudine)and Pag (Kolan). Also, we found four new localities of striped crocus in Croatia:two in the Island of Pag (above Košljun and nearbyVelo polje ornithological reserve) and two in the Island of Vir (near Radnjača, just above the sea-level).

The annual pansies (*Viola* Section *Melanium*) in Italy. Is it possible to define the real distribution area of *Viola kitaibeliana*?

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Among *Viola* species, there are no more than 10 annuals and most of them belong to *Melanium* Section, closely related to *Viola tricolor* L., the common pansy. In Italy, according to the recent Checklist (2005, 2007), the annual taxa are *V. kitaibeliana* Schultes, *V. hymettia* Boiss. & Heldr., *V. parvula* Tineo, *V. arvensis* Murray, and *Viola tricolor* subsp. *tricolor. Viola kitaibeliana* is a Mediterranean-Caucasian species which extends to Central Europe where different cytotypes are reported. It is found in open grasslands, stony slopes, and screes, but also in fallow land and other open places. The abundance of doubtful references of *V. kitaibeliana* emphasizes the difficulty in its identification and distinction from *V. hymettia* and especially from unusual forms of *V. arvensis*. The aim of this work is to provide diagnostic characters to discriminate *V. kitaibeliana* from *V. arvensis* and to present an update of its distribution in Italy. The Italian Checklist reports a scattered distribution of *V. kitaibeliana*, from the Alps to Sicilia. A first distribution update by Scoppola and Lattanzi (2012) has highlighted the lack of recent data for Veneto, Calabria, and Sicilia while reporting a new record for Umbria. Our cytological and morphological studies on fresh material, collected and reproduced *ex situ* from different Italian regions, led us to confirm only a few records of *V. kitaibeliana* limited to Central Italy. We cannot confirm its presence in Valle d'Aosta, Lombardia, Friuli, Toscana. From the revision of a large number of *exsiccata* (AO, APP, C, CAT, CLU, FI, IS, LEC, RO, S, SIENA, TO, TSB, UTV, Herb. Bartolucci, Herb. Espeut, Herb. Lattanzi) we concluded that a correct identification of poor or immature specimens is not possible, while analysis of mature and well developed specimens allows to separate *V. kitaibeliana* from *V. arvensis* even on morphological basis. Among the previously reported diagnostic characters, we highlight in particular the size of floral parts and their ratio, mature seeds length, and etero- or omophyllous habitus. In order to define the whole range of *V. kitaibeliana* it is necessary to extend the analysis of living material through further seed accessions.

Floristička istraživanja na planini Svilaji (1508 m), Dalmacija

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Tijekom proljeća i u ljeto 2013. intenzivno smo istraživali floru na planini Svilaji (1508 m n.v.). Svilaja je planina u Dalmatinskoj Zagori i sastavni je dio NATURA 2000 mreže s vrijednim ilirskim bukovim šumama (Aremonio-Fagion (Horvat 1938) Törek et al. 1989), istočnomediteranskim suhim travnjacima (Scorzoneretalia villosae Horvatić 1975) te mnogim špiljama i jamama. Planina je floristički još uvijek slabo istražena. Strmije sjeveroistočne padine iznad Cetine su većinom obrasle šumama bukve (Fagus sylvatica L.) i planinskog javora (Acer obtusatum Waldst. et Kit. ex Willd.), koje su dijelom uništene požarima. Suhi i položeni jugozapadni obronci prema Drnišu su mozaično prekriveni šikarama crnog graba (Ostrya carpinifolia Scop.) i niskim kamenitim travnjacima. Cilj našeg rada bio je detaljnije floristički istražiti područje od Štikova do Maovica na sjeveru te od Sinjskog Zelova do iznad planinarskog doma Orlove Stine (1139 m) na jugu. U visinskom rasponu istraživano područje obuhvaća pojas od 400 do 1150 m. Floristička istraživanja provedena su standardnom metodom (Nikolić et al. 1998). Podaci su pohranjeni u bazu podataka Flora Croatica Database. Analiziran

je taksonomski sastav, životni oblici i florni elementi biljaka te fitocenološka pripadnost. Flora je istraživana na različitim tipovima staništa: u šumama i šikarama medunca te crnog graba (sveze Aremonio-Fagion i Ostryo carpinifoliae-Carpinion orientalis Horvat 1959) i u zajednicama kamenjarskih pašnjaka i suhih travnjaka (Scorzoneretalia villosae Horvatić 1975). Tijekom proljeća utvrđena su brojna nalazišta proljetnica, kao što su Fritillaria orientalis Adams, Narcissus radiiflorus Salisb., Hyacinthella dalmatica (Baker) Chouard, Pulsatilla grandis Wender., Tulipa sylvestris L. i dr. U šumskoj vegetaciji to su bile sljedeće vrste: Erythronium dens-canis L., Anemone nemorosa L., Corydalis solida (L.) Swartz, i dr. Preliminarna istraživanja su pokazala veliku raznolikost flore s nizom vrijednih endemičnih, ugroženih i zaštićenih vrsta. Rezultati istraživanja prilog su poznavanju flore na planini te, istovremeno, korologiji biljnih vrsta u Hrvatskoj.

Floristic investigation on the Mt. Svilaja (1508 m a.s.l.), Dalmatia (South Croatia)

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Intensive floristic investigations were carried out on the Svilaja mountain (1508 m a.s.l.) in spring and summer 2013. Mt. Svilaja is located in Dalmatinska Zagora in the hinterland of central Dalmatia. The mountain is included in Croatian NATURA 2000 network due to valuable Illyrian beech forests (the *Aremonio-Fagion* (Horvat 1938) Töreki et al. 1989 alliance), eastern sub-mediteranean dry grasslands (the *Scorzoneratalia villosae* Horvatić 1975 order), and many caves. Flora of the Mt. Svilaja is still poorly known. The steeper northeastern slopes located above the Cetina River are mostly covered with beech forests (*Fagus sylvatica* L.) and mountain maple (*Acer obtusatum* Waldst. et Kit. ex Willd.), and they are partially destroyed by the fires. Dry and laid southwestern slopes near the town of Drniš are covered by low forest of European hop-hornbeam (*Ostrya carpinifolia* Scop.) and low dry grasslands. The aim of our study was to investigate the flora of Mt. Svilaja in the area between villages of Štikovo and Maovice on the north and village of Zelovo and to up above the chalet Orlove Stine (1139 m) on the south. Investigated area ranges in elevation from 400 to 1150 m a.s.l. Standard methods for floristic studies were applied (Nikolić et al. 1998). Data were stored in the Flora Croatica Database. We analyzed the taxonomic composition, life forms, floral elements and phytosociological characteristics of the species. Flora was studied in the different types of habitats: in forests and thickets of pubescent oak and European hop-hornbeam (the alliances *Aremonio-Fagion* and *Ostryo carpinifoliae-Carpinion orientalis* Horvat 1959), and in communities of rocky pastures and dry grassland (the order *Scorzoneretalia villosae* Horvatić 1975). In spring 2013, we identified numerous sites with spring-blooming plants: *Fritillaria orientalis* Adams, *Narcissus radiiflorus* Salisb., *Hyacinthella dalmatica* (Baker) Chouard, *Pulsatilla grandis* Wender., *Tulipa sylvestris* L., etc. The following species have been found within the forests: *Erythronium dens-canis* L., *Anemone nemorosa* L., *Corydalis solida* (L.) Swartz, and others. According to the preliminary results, a great diversity of flora with many endemic, threatened and protected species has been shown. Our study considerably contributes to the knowledge of the mountain flora and species chorology in Croatia.

Korovna flora okopavina Hercegovine

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Na 25 istraživanih lokaliteta, zabilježeno je ukupno 50 svojti vaskularne flore iz ukupno 25 porodica. Najbrojnije su porodice *Asteraceae* (s 10 vrsta) i *Poaceae* (s 5 vrsta). Analizom biološkog spektra asocijacije *Panico-Portulacetum oleraceae* Lozanovski 1962 može se konstatirati terofitsko-hemikriptofitski karakter, s nešto većim sudjelovanjem terofita, a manjim sudjelovanjem hemikriptofita, što je svakako rezultat isključivo mehaničkih mjera kontrole korova bez primjene herbicida. U areal spektru asocijacije *Panico-Portulacetum oleraceae* Lozanovski 1962 konstatirano je 7 grupa flornih elemenata, među kojima dominiraju elementi široke rasprostranjenosti. Kozmopolitskoj grupi flornih elemenata pripadaju 32 biljne vrste. Sastojine asocijacije *Panico-Portulacetum oleraceae* Lozanovski 1962 u okopavinama Hercegovine izgrađuje 50 korovnih vrsta, što predstavlja izvjesno floristično bogatstvo u odnosu na istoimenu asocijaciju opisanu na drugim lokalitetima. Posebno treba naglasiti zajedničke vrste na svim lokalitetima koje pripadaju karakterističnim vrstama sintaksonomskih jedinica (asocijacije, sveze, reda i klase): *Portulaca oleracea* L., *Echinochloa crus-galli* (L.) Beauv., *Setaria glauca* (L.) Beauv., *Amaranthus retroflexus* L., *Chenopodium album* L. i *Solanum nigrum* L. Najčešći tip strategije u korovnoj flori je R (28%), zatim slijede biljke CR strategije (16%).

Weed flora of arable crops in Herzegovina

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On 25 research localities, overall 50 species of vascular plants from total of 25 families was noted. The highest share had family *Asteraceae* (10 species) and *Poaceae* (5 species). The analysis of biological spectrum of association *Panico-Portulacetum oleraceae* Lozanovski 1962 terophyte-hemicriptophyte character can be determined, with slightly higher share of terophytes, and smaller share of hemicriptophytes, resulting from exclusively mechanical measures of weed control without herbicide usage. In areal spectrum of association *Panico-Portulacetum oleraceae* Lozanovski 1962, 7 groups of floral elements were asserted; among which widespread plants dominate. 32 plant species appertain to the cosmopolite group of floral elements. Constituent In stands of arable crops in Herzegovina, belonging to ass. *Panico-Portulacetum oleraceae* Lozanovski 1962, occur 50 weed species, which represents higher floristic richness in comparison to the same association from other areas. Special emphasis has to be set on species common for all localities which are the typical species of syntaxonomic units (association, alliance, order and class): *Portulaca oleracea* L., *Echinochloa crus-galli* (L.) Beauv., *Setaria glauca* (L.) Beauv., *Amaranthus retroflexus* L., *Chenopodium album* L. and *Solanum nigrum* L. The most common type of strategy in weed flora is R (28%), folowed by plants of CR strategy (16%).

Makrofitska flora Parka prirode „Kopački rit“

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Prostor Parka prirode “Kopački rit” nalazi se na krajnjem sjeveroistoku Republike Hrvatske, u području sutoka rijeka Dunava i Drave. Kao poplavno područje međunarodnog značaja, proglašen je Ramsarskim područjem 1993. godine. Površina Kopačkog rita iznosi 231 km^2, od čega današnje poplavno područje zauzima 124 km^2. Dinamika poplavnih voda, kao osnovno ekološko obilježje Kopačkog rita, neposredno utječe na bogatsvo makrofitske flore. Terenska istraživanja flore Parka prirode „Kopački rit“ provedena su u periodu od 2010. do 2012. godine kada su zabilježene 164 svojte makrofita, odnosno 159 vrsta i 5 podvrsta raspoređenih unutar 100 rodova i 54 porodice. Popis makrofita prilagođen je listi makrofita MIDCC-a (the Multifunctional Integrated study Danube Corridor and Catchment). Najbrojnija porodica je *Cyperaceae* s 19 svojti makrofita. Analizom životnih oblika utvrđena je dominacija hemikriptofita (57 svojti) i hidrofita (48 svojti), dok se prema korološkoj analizi, kao najbrojniji, ističu euroazijski florni element (60 svojti) te biljke široke rasprostranjenosti (51 svojta). Crvenoj listi pripada 25 svojti makrofita Kopačkog rita, od toga su 4 kritično ugrožene (CR), 3 ugrožene (EN), 11 osjetljivih (VU), 6 gotovo ugroženih (NT) i 1 nedovoljno poznata svojta (DD). Dodatno, 51 svojta nalazi se pod zakonskom zaštitom, a sastoji se od 29 zaštićenih i 22 strogo zaštićene svojte makrofita. Posebno vrijedne nalaze predstavlju svojte: *Scirpus mucronatus* (CR), *Typha laxmannii* (CR), *Typha minima* (CR), *Hippuris vulgaris* (EN), *Hottonia palustris* (EN) i *Stratiotes aloides* (VU). *Salvinia natans* i *Trapa natans* međunarodno su zaštićene Bernskom konvencijom. Kompoziciju flore makrofita sačinjava i 15 alohotnih svojti od čega je 8 invazivnih. Raznolikost i gustoću populacija makrofita može ugroziti povećano kolebanje u intenzitetu plavljenja, produljena sušna razdoblja te akumulacija nanosa i prirodna sukcesija močvarnih staništa. Posljedično, planirana su nova floristička istraživanja kroz inventarizaciju vaskularne flore te praćenje postojećih populacija i stanišnih tipova.

Macrophyte flora of Kopački rit Nature Park

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Kopački rit Nature Park is located in the far northeastern part of Republic of Croatia, in the confluence area of rivers Danube and Drava. In 1993, Kopački rit was declared on the List of Ramsar areas as internationally important wetland. The total area of Kopački rit is 231 km^2, of which the currently flooded area occupies 124 km^2. Floodwater dynamics, as the fundamental ecological characteristic of Kopački rit, directly affects the diversity of macrophyte flora. Field research in Kopački rit Nature Park was conducted during the period of 2010-2012 when a total of 164 macrophyte taxa was recorded, containing 159 species and 5 subspecies classified into 100 genera and 54 families. The macrophyte inventory has been adjusted according to the checklist of MIDCC (the Multifunctional Integrated study Danube Corridor and Catchment). The most numerous family is *Cyperaceae* with 19 macrophyte taxa. The analysis of life forms determined the domination of hemicryptophytes (57 taxa) and hydrophytes (48 taxa), whereas the chorological analysis points to Eurasian floristic element (60 taxa) and plants of wide distribution (51 taxa) as the most numerous. Macrophytic flora of Kopački rit contains 25 Red List taxa of which 4 are critically endangered (CR), 3 endangered (EN), 11 vulnerable (VU), 6 near threatened

(NT) and 1 data deficient taxon (DD). Furthermore, 51 taxa is protected by the law which consists of 29 protected and 22 strictly protected macrophytes. Particulary notable findings are represented by the following taxa: *Scirpus mucronatus* (CR), *Typha laxmannii* (CR), *Typha minima* (CR), *Hippuris vulgaris* (EN), *Hottonia palustris* (EN) and *Stratiotes aloides* (VU). *Salvinia natans* and *Trapa natans* are internationally protected by the Bern Convention. The composition of macrophyte flora consists of 15 allochthonous taxa of which 8 are invasive. Increased fluctuations in flooding intensity, prolongation of the dry season, accumulation of bed loads and natural succession of the marshland present a threat to the diversity and population density of macrophytes. Consequently, new floristic studies will continue through inventarisation of vascular flora and monitoring of current populations and habitat types.

Ekološke značajke makrofita mrtvice Budakovac

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Mrtvica se nalazi u blizini naselja Budakovac, oko kilometar od rijeke Drave, s kojom je od 2010. godine povezana preko Županijskog kanala. Kao važno Natura stanište (3150) s vegetacijom *Hydrocharition ili Magnopotamnion* u sastavu je Nacionalne ekološke mreže. Istraživanjem je obuhvaćen jugozapadni dio mrtvice gdje su u periodu od 2004. godine do 2010. godine prikupljeni podatci o makrofitskim vodenim biljkama i fotografirana staništa. Tijekom 2009. i 2010. godine provedena su ekološka istraživanja makrofita koja su obuhvaćala ekološku analizu flore prema Hejnýu (1960) i analizu ekoloških indeksa prema Kojić i sur. (1997) te fizikalno-kemijska analiza vode gdje je određena temperature vode, pH, količina nitrata i fosfata u vodi. Zabilježena je ukupno 31 svojta. Najveću pokrovnost u vodi imaju svojte *Ceratophyllum demersum i Nymphoides peltata* dok su obale obrasle svojtama *Mentha aquatica, Myosotis scorpioides, Lycopus europaeus* i dr. od kojih poneke rastu i u vodi. Na popisu ugroženih svojti Republike Hrvatske su *Stratiotes aloides,* osjetljiva svojta, *Hippuris vulgaris*, ugrožena svojta i *Salvinia natans* i *Trapa natans, g*otovo ugrožene svojte. Među životnim oblicima prevladavaju hidrofiti (74,19%), a zabilježeni su manje zastupljeni hemikriptofiti (19,36%) i terofiti (6,45%) što ukazuje na raznolike uvjete staništa. Zastupljeno je šest ekoloških klasa prema Heýniju od kojih prve dvije klase čine 41,95 % svojti. Analiza ekoloških indeksa ukazuje da je mrtvica vodeno stanište neutralne do bazične reakcije tla s povoljnim uvjetima osvijetljenosti za poluskiofite do heliofite gdje prevladavaju mezotrofne i mezotermne biljke. Prema fizikalno–kemijskoj analizi vode mrtvica pripada staništima s neutralno-bazičnim reakcijama, siromašnim nitratima i povremeno bogatim fosfatima. Iako lokalni mještani kose obale i zadržavaju se uz vodu, pogotovo u ljetnim mjesecima, to bitnije ne utječe na pokrovnost svojti. Predložene su smjernice zaštite koje obuhvaćaju osiguravanje povoljnog režima vode, neunošenje stranih vrstane unositi strane vrste, te očuvanja vodenog staništa očuvati vodeno stanište u što prirodnijem obliku.

Ecological features of the macrophytes of the Budakovac oxbows

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Oxbow lake is situated in vicinity of municipality Budakovac, around one kilometre away from the river Drava, with which it is connected since the year 2010 by the channel Županijski kanal. As important Natura 2000 habitat (3150) with vegetation *Hydrocharition* or *Magnopotamnion* it is included in the National ecological network. A research was performed in the period from the year 2004 to 2010 on the south-western part of the lake where the data about macrophyte aquatic plants were collected and photographs of habitats taken. During years 2009 and 2010 ecological investigations of macrophytes were carried out that included ecological analysis of flora in accordance with Hejný (1960) and ecological index analysis in accordance with Kojić et al (1997) as well as physical and chemical analysis of water in regards to temperature, pH and the amount of nitrates and phosphates. In total 31 taxa were recorded. Greatest coverage in water have species *Ceratophyllum demersum* and *Nymphoides peltata* while the banks are covered with species *Mentha aquatica, Myosotis scorpioides, Lycopus europaeus* some of which also grow in water. On the IUCN Red list of threatened species of the Republic of Croatia are *vulnerable* (VU) *Stratiotes aloides, endangered* (EN) *Hippuris vulgaris*, and *near threatened* (NT) *Salvinia natans* and *Trapa natans,*. Among life forms hydrophytes (74.19%) predominate, less represented are hemicryptophytes (19.36%) and therophytes were also recorded (6.45%), indicating various habitat conditions. Six classes in accordance Hejný are present of which first two classes make 41.95 % of the taxa. Analysis of the ecological indices point out that oxbow lake is an aquatic habitat of neutral to basic soil reaction with favourable lighting conditions for hemisciophytes to heliophytes and where mesotrophic and mesothermal plants predominate. Based on physical and chemical analysis water of the oxbow-lake belongs to the habitats with basic-neutral reaction, poor in nitrates and intermittently rich in phosphates. Though mowing of the banks is performed by local inhabitants and they stay near the water, in particular during summer months, this does not impact significantly the species' coverage. Conservation guidelines were proposed that include maintenance of the favourable water regime, non-introduction of foreign species and conservation of the water habitat in as natural state as possible.

Analiza flore otoka Šolte

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U okviru mediteranskog bazena osobito je velika floristička raznolikost vezana uz otoke. Otoci se s biološke točke gledišta odlikuju brojnim specifičnim posebnostima, a osobito je značajan utjecaj veće ili manje izoliranosti od matičnog kopna. Poznavanje flore i vrednovanje njezinog kvalitativnog i kvantitativnog sastava jedan je od nužnih preduvjeta održivog gospodarenja i planiranja zaštite. Otok Šolta pripada Južnom Hrvatskom primorju, srednjodalmatinskim otocima, zajedno s Bračom, Hvarom i Visom, a svi zajedno pripadaju Splitsko–dalmatinskoj županiji. Površina otoka je 519 km^2, najveći vrh je Vela straža na 237 m. Šolta u fitogeografskog pogledu smještena je u eumediteranskoj zoni mediteranske vegetacijske regije. Otok Šolta je jedan od slabije floristički istraženih otoka istočne obale jadranskog mora. Cilj ovog rada je istraživanje raznolikosti flore, utvrditi kvalitativni i kvantitativni sastav vaskularne flore otoka Brača direktnim točkastim kartiranjem, te indirektnim kartiranjem na MTB 64 poljima, istražiti vaskularnu floru otoka, njezinu pripadnost flornim elementima i životnim oblicima, istražiti endemične, ugrožene i zaštićene vrste te alohtone vrste s naglaskom na invazivne svojte. Ovo istraživanje je doprinos utvrđivanju bogatstva flore otoka kao i doprinos raznolikosti flore Hrvatske.

Analysis of flora of the Island of Šolta

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The islands in the Mediterranean basin have particularly high floristic diversity. From the biological point of view, the islands are featured by numerous specific characteristics, and the influence of greater or smaller isolation from the mainland is of particular importance. The knowledge of flora and assessment of its qualitative and quantitative composition is a necessary precondition of sustainable management and protection planning. The Island of Šolta belongs to the southern Croatian coast, i.e. the Central Dalmatian islands, together with Brač, Hvar, and Vis. They are all administered by the Split-Dalmatia County. The surface area of the island is 519 km^2, and its highest peak, Vela straža is at 237 m. Phytogeographycally, Šolta is situated in the Mediterranean zone of the Mediterranean vegetation region. The Island of Šolta is among less researched eastern Adriatic coast islands.

The aim of this paper is research of the flora diversity, establishing qualitative and quantitative composition of the island of Brač flora by means of direct dotted mapping in MTB 64 fields, research of the island vascular flora, its belonging to the flora elements and live forms, research the endemic, endangered and protected species, and autochthonous species, focusing particularly on invasive species. This research is a contribution to establishing the island flora richness and its contribution to Croatian flora diversity.

Analiza flore okolice sela Gornje i Donje Jesenje (sjeverozapadna Hrvatska)

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Tijekom 2011. godine istraživana je samonikla flora okolice sela Gornje i Donje Jesenje smještenih u sjeverozapadnoj Hrvatskoj između Maceljskog gorja i Strahinjščice. Na području veličine 3,5 km^2 za koje do sada ne postoje podaci o flori, zabilježene su ukupno 324 svojte vaskularne flore iz 215 rodova i 75 porodica. Najzastupljenije porodice su Fabaceae (9,26%), Lamiaceae (6,79%), Asteraceae (6,17%), Poaceae (6,17%) te Rosaceae (4,94%). U spektru životnih oblika hemikriptofiti su dominantni (50,93%), a slijede fanerofiti (13,89%), geofiti (13,58) i terofiti (13,27%). Na temelju omjera flornih elemenata istraživano područje pripada eurosibirsko-sjevernoameričkoj regiji. Od zabilježenih svojti dvije (*Carex panicea* L. i *Platanthera bifolia* (L.) Rich.) su ugrožene te su prema Crvenom popisu označene kao osjetljive (VU). Waldsteinova režuha (*Cardamine waldsteinii* Dyer) jedina je zabilježena endemična svojta. Pravilnikom o proglašenju divljih svojti zaštićenim i strogo zaštićenim zaštićeno je 66 zavičajnih divljih svojti, što čini petinu (20,37%) od ukupnog broja zabilježenih svojti. Zabilježeno je 18 alohtonih svojti od čega je sedam invazivnih. Istraživano područje bit će dijelom planiranog Regionalnog parka Hrvatsko zagorje.

Analysis of the flora in the surroundings of the villages Gornje and Donje Jesenje (northwest Croatia)

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Research of the native flora in the surroundings of the villages Gornje and Donje Jesenje in the northwest Croatia, between Maceljsko gorje and Strahinjščica was carried out during the year 2011. In the area of 3.5 km^2, for which so far there is no information about the flora, a total of 324 taxa of vascular plants from 215 genera and 75 families were found. Of the identified taxa, most belonged to Fabaceae (9.26%), Lamiaceae (6.79%), Asteraceae (6.17%), Poaceae (6.17%) and Rosaceae (4.94%). Regarding the life form spectrum hemicryptophytes (50.93%) were dominant, followed by phanerophytes (13.89%), geophytes (13.58%) and therophytes (13.27%). Based on phytogeographical analysis investigated area belonges to the Euro-Siberian-North American region. From the recorded taxa two (*Carex panicea* L. and *Platanthera bifolia* (L.) Rich.) are endangered and belong to VU category according to IUCN Red list. *Cardamine waldsteinii* Dyer is the only recorded endemic species. 66 of the recorded taxa are protected by law and they represent one fifth (20.37%) of the total number of recorded taxa. Also, 18 allochthonous plants were recorded from which seven were invasive alien species. Investigated area will be a part of the planed Regional park Hrvatsko zagorje.

Novi podaci o vaskularnim biljkama na otoku Molatu (sjeverna Dalmacija, Hrvatska)

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Otok Molat, površine 22,8 km^2, nalazi se u zadarskom arhipelagu, jednoj od najbrojnijih otočnih skupina na Jadranu. Sukladno geografskom položaju, otok Molat biogeografski pripada eumediteranskoj vegetacijskoj zoni mediteranske regije. Dominirajući tip vegetacije je šuma hrasta crnike s mirtom (*Myrto-Quercetum ilicis* (Horvatić 1958)). Na istraživanom području zabilježeni su jaki sukcesijski procesi, uzrokovani depopulacijom i napuštanjem otoka, te je uslijed toga uočena prisutnost različitih tipova staništa. Otok Molat je prvi put floristički istraživao Domac prije 60 godine kada je zabilježeno 289 svojti. Uz navedeno Rac i Lovrić su prije 10 godina zabilježili 24 nove svojte, uključujući morske cvjetnice. Terenski dio ovog istraživanja izveden je između 2007. i 2010. godine za vrijeme vegetacijske sezone. Ukupno su zabilježene 303 biljne svojte od kojih je 168 novih za otok. Dvanaest novo zabilježenih svojti klasificirano je unutar jedne od pet kategorija ugroženosti: jedna kritično ugrožena, dvije osjetljive, četiri gotovo ugrožene, dvije nedovoljno poznate i tri najmanje zabrinjavajuće. Ovo je istraživanje rezultiralo ukupnim brojem od 481 biljne svojte zabilježene na otoku.

New records of vascular plants for the island of Molat (northern Dalmatia, Croatia)

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The island of Molat, with area of 22.8 km^2, is situated in the Zadar archipelago, one of the most numerous group of islands on the Adriatic. According to its geographical position, the island of Molat biogeographically belongs to the Eumediterranean vegetation zone in the Mediterranean region. Vegetation dominating the island is the holm-oak woodland with common myrtle (*Myrto-Quercetum ilicis* (Horvatić 1958)). On the researched area, however, high level of successional processes, due to depopulation and land abandonment, have been noticed which caused the presence of many different habitat types. The first floristic research of the island of Molat was done by Domac 60 years ago, during which a total of 289 plant taxa were recorded. In addition, Rac and Lovrić recorded 24 new taxa, including seagrasses, 10 years ago. Field work for this research was carried out between years 2007 and 2010, during the vegetation season. A total of 303 plant taxa were recorded with 168 new for the island. Twelve of the newly recorded species are classified inside one of five threat categories: one critically endangered, two vulnerable, four near threatened, two data deficient and three least concern. This research resulted with a complete of 481 plant taxa recorded on the island.

Floristično istraživanje OPG-a Livak (Kutjevo)

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Obiteljsko poljoprivredno gospodarstvo (OPG) Livak nalazi se jugoistočno od grada Kutjeva, na južnim obroncima Krndije. Područje Kutjeva je floristički relativno slabo istraženo, te su za šire područje istraživanog lokaliteta (MTB ¼ 0573.4) u vrijeme istraživanja zabilježene tek 52 svojte vaskularne flore.Istraživanje je provedeno na poziv vlasnika, tijekom vegetacijske sezone 2011. godine. Istraživana ploha prostire se na 0,40 ha površine, a sastoji se od tri morfološki jasno odijeljene cjeline koje karakteriziraju različiti ekološki uvjeti i kojima se različito gospodari. Tijekom četiri jednodnevna terenska izlaska, zabilježene su 174 svojte vaskularne flore, od čega 81 svojta do tada nije bila zabilježena za šire područje Kutjeva.Rad prikazuje metodologiju floističkog istraživanja, floističke razlike između pojedinih cjelina istraživane plohe te rezultate analize flornog sastava-udjele pojedinih porodica, životnih oblika i flornih elemenata, te ugroženost zabilježenih biljnih svojti.

Floristic research of the family farm Livak (Kutjevo)

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Family Farm Livak is located southeast of the Kutjevo City, on the southern slopes of Krndija. The area of Kutjevo is floristically relatively poorly explored - at the time of the survey only 52 species of vascular plants were recorded for the wider study area (MTB ¼ 0573.4).The survey was conducted at the invitation of the owner, during the vegetation season of 2011. The investigated area covers 0.40 hectares and consists of three morphologically clearly separated units that are characterized by different environmental conditions and are differently managed. During four one-day field surveys, 174 species of vascular plants were recorded, of which 81 species has not been previously recorded within the wider Kutjevo area. This paper presents methodology of floristic research, floristic differences between units of the investigated area and results of the analysis of floral composition - shares of individual families, life forms and chorological elements, as well as vulnerability of recorded plant species.

Orchidaceae u flori planine Trebević (Bosna i Hercegovina)

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Detaljni osvrt na Orchidaceae u flori planine Trebević do sada nije dat. Floristički podaci su uglavnom starijeg datuma (Beck 1903). Tijekom dužeg vremenskog perioda, a posebno u posljednjoj deceniji, svake godine u većem dijelu vegetacijskog perioda, obavljena su terenska istraživanja u visinskom rasponu od oko 500 do 1629 m (najviši vrh), na svim ekspozicijama i na različitim staništima (šume, livade, rudine, pukotine stijena, obale potoka, rubovi šumskih putova). Napravljena je bogata fotodokumentacija. Takodjer je obavljen pregled Herbarske zbirke u Herbariju Zemaljskog muzeja BiH, a isto tako dostupnih literaturnih izvora. Nomenklatura u ovom radu je usuglašena s Delforge (2006) i Govaerts *et al.* (2013). Na temelju svih sabranih podataka, iz različitih izvora, utvrđeno je da je u flori planine Trebević porodica Orchidaceae zastupljena s 33 vrste iz 15 rodova kako slijedi: *Orchis* (9), *Dactylorhiza* (6), *Cephalanthera* (3), *Neottia i Gymnadenia, Ophrys* (2), a ostali rodovi: *Anacamptis*, *Coeloglossum*, *Corallorhiza*, *Epipactis, Himantoglossum, Limodorum, Platanthera, Spiranthes* i *Traunsteinera* zastupljeni su samo po jednom vrstom. Ako se uzme u obzir da se u flori Bosne i Hercegovine nalazi 69 vrsta (Šilić *in* Redžić, Barudanović & Radović 2008) onda se može zaključiti da je raznovrsnost orhideja s 33 vrste na planini Trebević na visokoj razini. Ovako veliki broj vrsta orhideja na jednoj planini i na relativno malom prostoru može se povezati s velikom raznovrsnošću staništa na njoj. Najveći broj vrsta je vezan za otvorena staništa. Analiza spektra flornih elemenata pokazala je da najveći procent vrsta pripada supramediteranskoj flornoj oblasti (56,6%) što ukazuje da su zastupljene vrste prilagođene na topla, otvorena i osunčana staništa. Značajna je zastupljenost vrsta sjevernoeuropskog rasprostranjenja (26,6%). Oko 40% registriranih vrsta ima neki status ugroženosti prema Spisku za Crvenu knjigu BiH (Šilić 1996), a prema listi za Crvenu knjigu Europe (Biltz *et al.* 2011) sve vrste (100%) su ugrožene. S obzirom da je Trebević pod jakim uticajem antropogenog faktora u pojedinim dijelovima ove planine naveliko je ugrožen opstanak orhideja.

Family Orchidaceae in Flora of Mountain Trebević (Bosnia and Herzegovina)

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Comprehensive overview of family Orchidaceae in Flora of Mt. Trebević hasn't been given until now. Existed Floristic data were mostly from older ages. During extensive time, especially in last decade, each year, in the mainly part of vegetating period, floristic research were done in altitude range from approximately 500 to 1629 m (highest pick), at all expositions and different habitats (woods, meadows, mountain meadows, crack rocks, coast streams, edges of forest roads). Rich photo documentation was also made. In addition, Herbarium collection of Herbaria of National Museum of Bosnia and Herzegovina and literature sources were consulted. Nomenclature in this work was adjusted with Delforge (2006) and Govaerts *et al.* (2013). According to all collected data form different sources it was detected in flora of Mt. Trebević that family Orchidaceae were represented with 33 species from 15 genera: *Orchis* (9), *Dactilorhyza* (6), *Cephalanthera* (3), *Neotia* and *Gymnadenia, Ophrys* (2), and other genera: *Anacamptys*, *Coeloglossum*, *Corallorhiza*, *Epipactis, Himantoglossum, Limodorum, Platanthera, Spiranthes* and *Traunsteinera* were represented with only one species. Considering that 69 species is registered in flora of Bosnia and Herzegovina (Šilić *in* Redžić, Barudanović & Radović 2008), it could be concluded that the species diversity of orchids with 33 species on Mt. Trebević is on high level. This significant number of species on one mountain and on relatively small area could be connected with important diversity of its habitats. The most important number of species exists on open habitats. Analyses of Spectrum of floral elements showed that the highest percentage of species belonged to Supramediterranean element (56.6 %), what pointed out that the species are adapted on hot, opened and solar habitats. Important presence of species of North European distribution is also detected (26.6 %). About 40% of registered species have some kind of endangered status according to the list for the Red Book of BH (Šilić 1996). According to the List for the Red Book of Europe (Biltz *et al*. 2011) all species (100%) are endangered. Since Mt. Trebević is under high anthropogenic pressure in some parts of this mountain survivor of orchids is highly endangered.

Analiza porodica iz herbarija Carla Studniczke (III)

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Analizirane su porodice Compositae, Hippuridaceae i Hydrangeaceae (Ord.Compositeen, Hippurideen i Philadelpheen) u kojima se nalazi 688 herbarijskih listova. Najveći dio herbarijskog materijala sakupljen je u Europi (599 herbarijskih listova). Najviše herbarijskog materijala sabrano je s područja Austrije (138 herbarijskih listova). Prema pripadnosti pojedinim herbarijima ističu se herbarijski listovi iz zbirke Flora Dalmatiens (83). Na 143 herbarijske etikete nije navedeno kojoj zbirci pripadaju. U odnosu na dosada obrađeni dio herbarija navode se nove zbirke i to:Ex herbario C.G. Nees ab Esenbeck, Ex herbario C.H. Schultz Bipont, Ex herbario D.F. Ressmann, Flora Hispanica, Flora Mährens, Flora Marchica, Flora von Magdeburg, Flora von Unt. Oesterreich, Flore de Bormio, Gandoger Flora Americana exsiccata, Herbarium Normale Flore Transsilvaniae, Hort. Bot. Berol e. i Puel et Maille. - Herbier des Flores Locales de France. Najviše herbarijskih listova sakupio je sam Studniczka (321). U odnosu na dosada obrađeni dio herbarija po prvi put se spominju sljedeći botaničari ili sakupljači biljnog materijala: Babcock, Biner, Brotherus, Crawfurd, Doms, Engelmann, Gallasch, Gander, Grantzow, Griewank, Hall, Hervier, Lojka, Nees, Parker, Prahl, Schäfer, Schultz, Sommier, ValoniVater. Ukupno je u herbarijskom materijalu koji pripada porodicama Compositae, Hippuridaceae i Hydrangeaceae osim

Studniczke, zabilježeno 99 sakupljača ili botaničara. Najstariji herbarijski list je iz 1855. god., a najmlađi iz 1904. god. Najveći broj herbarijskih listova, njih 386, sakupljeno je u razdoblju od 1871-1880. god. Na 57 herbarijskih etiketa nije navedena godina sakupljanja. Prema Studniczki unutar 688 herbarijskih listova nalaze se 93 roda s 412 vrsta, u okviru kojih su zabilježena 93 varijeteta. Prema djelu Flora Europaea zastupljeno je 89 rodova s 362 vrste biljaka unutar kojih su zabilježene 62 podvrste.

Analysis of some families from Carl Studniczka's herbarium (III)

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Most of the analysed herbal material (688 herbarium sheets, with 1406 samples of herbal plants) in this part of the C. Studniczka's herbarium (families: Compositae, Hippuridaceae and Hydrangeaceae/Ord. Compositeen, Hippurideen and Philadelpheen) were collected in Europe (599 herbarium sheets). Most of the herbarium samples were collected in the area of Austria (138 herbarium sheets). According to the affiliation to particular herbarium collections, the most representative plants are those from Flora Dalmatiens collection. In the part of the herbarium which has already been analysed new collections is mentioned and there are: Ex herbario C.G. Nees ab Esenbeck, Ex herbario C.H. Schultz Bipont, Ex herbario D.F. Ressmann, Flora Hispanica, Flora Mährens, Flora Marchica, Flora von Magdeburg, Flora von Unt. Oesterreich, Flore de Bormio, Gandoger Flora Americana exsiccata, Herbarium Normale Flore Transsilvaniae, Hort. Bot. Berol e. and Puel et Maille. - Herbier des Flores Locales de France. There are 143 herbarium sheets that are unlabeled and therefore we do not know which herbarium collection they belong to. Apart from Studniczka, additional 99 collectors or botanists are registered. Most herbarium sheets were collected by Studniczka himself (321). Following botanist or collectors of herbarium material are mentioned for the first time, in the part of the herbarium which has already been analysed, and there are: Babcock, Biner, Brotherus, Crawfurd, Doms, Engelmann, Gallasch, Gander, Grantzow, Griewank, Hall, Hervier, Lojka, Nees, Parker, Prahl, Schäfer, Schultz, Sommier, Valon andVater. The oldest herbarium sheet dates from 1855, where as the newest ones date from 1904. The exact year of collection is missing from 57 herbarium labels. According to Studniczka, within 688 herbarium sheets, in analysed part of the herbarium (families: Compositae, Hippuridaceae and Hydrangeaceae) there are 93 genera with 412 species, and 93 varieties. According to Flora Europaea there are 89 genera with 362 species of plants and 62 subspecies.

Rasprostranjenost invazivnih vrsta *Impatiens balfourii* Hooker f. i *Impatiens glandulifera* Royle na urbanim područjima Zagrebačke županije

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Zbog svog položaja, veličine te broja stanovnika Zagrebačka županija važno je tranzitno raskrižje europskih prometnih puteva, te je iznimno izložena unosu invazivnih stranih vrsta koje dospijevaju s geografski udaljenih područja. Takav je i primjer vrste *Impatiens balfourii* Hooker f., koja je početkom 20.stoljeća unešena s Himalaje u područje južne Europe, a prvi nalaz u Hrvatskoj zabilježen je u Istri 1992. god. Analiza rasprostranjenosti dviju invazivnih vrsta roda *Impatiens* provedena je u razdoblju 2006.-2010.god. u 10 gradova Zagrebačke županije i to: Samobor, Sveta Nedjelja, Jastrebarsko, Zaprešić, Velika Gorica, Sveti Ivan Zelina, Dugo Selo, Ivanić Grad, Vrbovec i Sesvete. Za svaku zabilježenu GPS poziciju utvrđen je i tip staništa na kojem je nađena, prema Klasifikaciji staništa Republike Hrvatske. Prisutnost vrste *Impatiens balfourii* utvrđena je u svim gradovima županije. Prema broju lokacija prednjači Samobor (21 lokacija), Sveti Ivan Zelina (14 lokacija), Dugo Selo (12 lokacija), Ivanić Grad (11 lokacija), slijede Velika Gorica (10 lokacija), Vrbovec (9 lokacija), Sesvete (9 lokacija), Zaprešić (8 lokacija), Jastrebarsko (7 lokacija) te Sveta Nedjelja (3 lokacije).Vrsta *I. balfourii* uspješno se održala na 16 različitih staništa, od čega prednjače: dvorišta i kućni vrtovi (37 nalaza), stambene kuće u nizu sa stražnjim vrtovima (23 nalaza), mozaik složene strukture usjeva s kućama(9 nalaza), gradske jezgre(7 nalaza), stambeni blokovi rubnog tipa (6 nalaza), površine za cestovni promet (5 nalaza). Vrsta se pokazala manje uspješna na sljedećim staništima: novoizgrađene nastanjene seoske kuće(3 nalaza), zapuštene poljoprivredne površine zarasle grmovitom vegetacijom (3 nalaza) te ekstenzivno njegovani parkovi u sklopu naselja (2 nalaza). Sa po jednim nalazom, vrsta nastanjuje: tradicionalni seoski vrt, pojedinačne vikendice, izgrađene površine za sport, rekreaciju i razonodu, površine za pružni promet, gradska groblja velike gustoće-izgrađeni dijelovi groblja, zgrade javne namjene s pripadnim površinama, te industrijska i obrtnička područja. Vrsta *Impatiens glandulifera* Royle u Zagrebačkoj županiji nađena je samo u Svetoj Nedjelji na jedinoj lokaciji Svetonedjeljska 10, u dvorištu obiteljske kuće i to sa 8 primjeraka.

Distribution of invasive species *Impatiens balfourii* Hooker f. and *Impatiens glandulifera* Royle in the urban areas of Zagreb County

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Zagreb County, because of its location, size and number of inhabitants, is an important transit intersection of European traffic roads, and as such is extremely exposed to entries of alien invasive species which come from geographically distant areas. Such is the example of *Imatiens balfourii* Hooker f. species that was carried from the Himalayas at the beginning of the 20th century to the area of Southern Europe. The first finding registered in Croatia was in Istria in 1992. The analysis of the spread of the two invasive species of genus *Impatiens* was carried out in the period from 2006 to 2010 in ten towns in Zagreb County. These were: Samobor, SvetaNedelja, Jastrebarsko, Zaprešić, VelikaGorica, Sveti Ivan Zelina, DugoSelo, Ivanić Grad, Vrbovec and Sesvete. The type of habitat, where it was found, has been determined for each noted GPS position, according to the Classification of habitats of the Republic of Croatia. In all towns of the county the presence of the *I. balfourii* species was

determined. By the number of locations at the front is Samobor (21 locations), Sveti Ivan Zelina (14 locations), DugoSelo (12 locations), Ivanić Grad (11 locations), followed by VelikaGorica (10 locations), Vrbovec (9 locations), Sesvete (9 locations), Zaprešić (8 locations), Jastrebarsko (7 locations) and Sveta Nedelja (3 locations). The species *I. balfourii* survived successfully in 16 different habitats, out of which at the front are: yards and home gardens (37 findings), detached houses with backyards (23 findings), mosaics of complex crop structures with houses (9 findings), city centers (7 findings), border type apartment blocks (6 findings), road traffic areas (5 findings). The species appeared less successful in the following habitats: newly built settled village houses (3 findings), untended bush-covered agricultural areas (3 findings) and extensively cared for parks that are parts of settlements (2 findings). With only one finding, the species inhabits: a traditional village garden, individual holiday houses, areas built for sport, recreation and fun, railway traffic areas, city cemeteries of high density - built parts of cemeteries, public buildings with surrounding areas, and industrial and trade areas. Species *Impatiens glandulifera* Royle was found in Zagreb County only in Sveta Nedelja in one location, Svetonedeljska 10, in the backyard of a family house, and this with 8 individuals.

Flora Samoborske Plešivice i okolnih područja

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Tijekom vegetacijskih sezona od 2003. do 2006. godine istraživana je flora Samoborske Plešivice i okolnih područja, što je prvo sustavno istraživanje flore ovog područja. Pronađeno je ukupno 404 svojti vaskularnih biljaka, svrstanih u 260 rodova i 80 porodica. Na području Plešivice prevladavaju šumska staništa (41,5%). Floristički najbogatija nalazišta su livade i termofilni rubovi šuma (144 vrste po nalazištu). Analizom životnih oblika utvrđeno je najviše hemikriptofita (55,2%), zatim slijede geofiti (16,3%), fanerofiti (14,6%), terofiti (8,7%) te hamefiti (5,2%). Analizom flornih elemenata utvrđeno je 11 glavnih skupina: mediteranski florni element (2,7%), ilirsko-balkanski (3,5%), južnoeuropski (14,1%), istočnoeuropsko-pontski (1,2%), jugoistočnoeuropski (1,7%), srednjeeuropski (10,9%), europski (9,2%), euroazijski (30,9%), cirkumholarktički (4,5%), široko rasprostranjene biljke (17,3%) te alohtone biljke (4,0%). Analizama ekoloških indikatorskih vrijednosti utvrđeno je da na istraživanom području dominiraju biljke neutralnih tala, srednje toplih do toplih područja, prilagođene na život pri polusvjetlu. Tlo ukazuje na optimalne količine hranjivih tvari. Analizom flore utvrđeno je pet endemičnih, dvije ugrožene (EN) te devet osjetljivih (VU) svojti. U flori gorja Plešivice utvrđeno je 16 alohtonih svojti, od kojih je osam invazivnih neofita.

Flora of Samoborska Plešivica and surrounding areas

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During the vegetational seasons 2003 and 2006 the area of Plešivica and surrounding areas has been floristical researched. This was the first systematic research of flora of this area. The total of 404 vascular plants found. They belong to 260 genera and 80 families. In the area of Plešivica dominate forest habitats (41.5%). The ex-

tremely rich floristic habitats are meadows and thermophylous margins of forest (144 species each resourse). Phytogeographical analysis showed that Euroasiatic element is predominant, with 30.9% of taxa, followed by widespread plants 17.3%, European 9.2%, South-European 14.1%, Circumholarctic 4.5%, Central-European 10.9%, Easteuropean-Pontic 1.2%, South-Easteuropean 1.7% and Illyrian-Balcanplants 3.5% oftaxa. Alochthonous plants encompass 4% of taxa. In the life form spectrum hemicryptophyta are dominant (55.2%), followed by geophyta (16.3%), phanerophyta (14.6%), therophyta (8.7%) and chamaephyta (5.2%). According to the analyse of the ecological indices it was established that on the research area dominate the plants of neutral soils, moderately warm to warm climate and moderately sheltered habitats. The soil indicates the optimum amounts of nutrients. According to threatened categories two endangered (EN) species were noted, and nine vulnerable (VU). In the flora of researched area 16 alochthonous plant species were established, among them eight are invasive species.

Flora Atlas of Pécs (South Hungary): database, structure, examples

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This study presents some of the main results of the fine-scale flora mapping of the administrative area of Pécs (South Hungary), as well as the proposed flora atlas of the city. The city has an area of 163 km^2 and approx. 157,000 inhabitants. To collect floristic data (between the years 2008-2012) the authors used the grid system of Király et al. (2003), which has been further refined by dividing the city area into 104 rectangles, each of 2.2 km^2, which resulted in a 64 times finer scale. In the course of flora mapping the Hungarian Flora mapping protocol was followed; each quadrat has been recorded at least twice a year (in spring and in summer). Only the species spreading naturally (i.e. native, archeophyte and spontaneous) were recorded. The completed database contains the following data for each recorded species: presence/absence data; flora element types; social behaviour types according to Borhidi, as well as the indicator values; type of pollination, spreading and life-form; types of archeophyte and neophyte species; protection statuses and IUCN types. The resulting database includes 1417 species out of which 1094, 45 and 278 species are native, archeophytes and neophytes, respectively. The average species richness of the quadrats was 328. The most common tree-sized taxon is *Acer campestre* (93%), the most frequent shrub is *Sambucus nigra* (96%), the most common perennial herb is *Geum urbanum* (100%) and the most frequent annual herb is *Erigeron annuus* (99%). The most common protected plants are typical South Transdanubian species: *Helleborus odorus* (63%), *Primula vulgaris* (51%) and *Tamus communis* (44%). The planned flora atlas would include the following information for each species: Hungarian and scientific names according to Király (2009), distribution maps, photos, habitat preferences (aquatic, wet, mesic and dry; woody or herbaceous-dominated; natural or disturbed habitats), flowering period, life form according to Raunkier, plant height, adventive character (archeo- or neophyte), conservation status, as well as the IUCN classification (local and national). The fine-scale flora mapping and the resulting flora atlas of Pécs can be considered as unique not only in Hungary, but also worldwide.

Invazivne korovne vrste u Požeškoj kotlini

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Invazivne alohtone vrste su unesene u područja izvan njihovog prirodnog staništa te se brzo prilagođavaju, razmnožavaju i povećavaju brojnost i gustoću. Praćenje rasprostranjenosti i kartiranje invazivnih korovnih vrsta izvršeno je tijekom ljetnih mjeseci od 2008.do 2011. u sklopu istraživanja invazivnih biljnih vrsta Požeške kotline. Utvrđena je prisutnost ukupno 34 invazivne svojte od čega 17 (50%) pripada korovnim vrstama. Najveći broj vrsta pripada porodici *Asteraceae* (52,9%). Životnom obliku terofita pripada 70,6%, a hemikriptofitima 29,4% invazivnih korovnih vrsta.Prema porijeklu13 svojti (76,5%)dolazi iz Sjeverne ili Južne Amerike.Analiza ekoloških indeksa za ukazala je na dominaciju: mezofita(41,2%), vrsta vezanih za staništa bogata dušikom (58,8%) te onih koje uspijevaju na izrazito termofilnim (52,9%) ili termofilnim staništima (41,2%) staništima. Veliku prijetnju poljoprivrednim površinama u Požeškoj kotlini predstavlja sedam biljnih svojti, srednju pet, malu tri, a neznačajnu dvije biljne svojte. Nakon provedenih istraživanja invazivnih biljnih svojti na području Požeške kotline proizlazi da su najinvazivnije korovne svojte na tom području *Ambrosia artemisiifolia* L., zatim slijede *Amaranthus retroflexus* L., *Conyza canadensis* (L.) Cronquist, *Erigeron annuus* (L.) Pers., *Galinsoga parviflora* Cav, *Artemisia annua* L. i *Sorghum halepense* (L.) Pers.10 vrsta na istraživanom području (58,8%) su vrste čije biološke karakteristike u velikoj mjeri utječu na biološki potencijal i mogućnost rasprostiranja. Neke od karakteristika koje su znatno izražene kod tih biljnih vrsta su da proizvode preko 1000 sjemenki, da se razmnožavaju vegetativno i sjemenom, imaju brzi rast, sjemenke su im sposobne za klijanje u tlu više od 2 godine, lako se obnove i vrlo su dobri kompetitori. Ta svojstva posebno su izražena kod vrsta *Abutilon theophrasti* Medik, *Ambrosia artemisiifolia*, *Amaranthus retroflexus*., *Galinsoga parviflora*, *Sorghum halepense*, *Xanthium strumarium* L. ssp. *italicum* (Moretti) D. Löve, ali i kod vrsta kao što su: *Conyza canadensis* i *Erigeron annuus*.

Invasive weed species in Pozega Valley

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Invasive alien species are introduced into areas out their natural habitat. They are very quick to adapt, reproduce and increase their number and density. Monitoring and mapping of the distribution of invasive weeds in Pozega Valley was performed during the summer months from the year 2008 to 2011. The presence of a total of 34 invasive species, of which 17 (50%) belongs to weeds were recorded in the study period. The largest number of species belongs to the family Asteraceae (52.9%). To the therophytes belong 70.6%, and to the hemicryptophytes 29.4% of total invasive weeds. According to the geographical origin, 13 species (76.5%) come from North or South America. Regarding ecological indices, analysis show the dominance of: mesophytes (41.2%), plants adapted to habitats rich in nitrogen (58.8%) and those that thrive in extremely thermophilic (52.9%) or thermophilic habitats (41.2%). A major threat to agricultural land in the Pozega Valley represent seven plant species, there five species of high importance, three species are minor and insignificant are two plant species. The most invasive weeds in the investigated area are *Ambrosia artemisiifolia* L., followed by *Amaranthus retroflexus* L., *Conyza canadensis* (L.) Cronquist, *Erigeron annuus* (L.) Pers., *Galinsoga parviflora* Cav, *Artemisia annua* L. and *Sorghum halepense* (L.) Pers. There are 10 species in the study area (58.8%) whose biological characteristics greatly influence the biological potential and the possibility of spread. Some of the characteristics of these species are: production more than 1,000 seeds per plant annually, propagation vegetative and byseed, rapid growth, capability of seeds to germinate in the soil for more than two years, easy to restore and very good competitive ability. These properties are particularly expressed in the species *Abutilon theophrasti* Medik, *Ambrosia artemisiifolia*, *Amaranthus retroflexus*, *Galinsoga parviflora*, *Sorghum halepense*, *Xanthium strumarium* L. ssp. *italicum* (Moretti) D. Love, but also in species such as: *Conyza canadensis* and *Erigeron annuus.*

Gljive i lišaji – usmena priopćenja
Fungi and lichenes – oral presentations

Lišajevi kao bioindikatori kvalitete zraka u Tuzli (Bosna i Hercegovina)

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Rad se temelji na istraživanju lišajeva kao bioindikatora kvalitete zraka na području Tuzle. Terenskim istraživanjima provedenim tokom 2011. , obuhvaćeno je deset različitih lokaliteta sa kojih je prikupljen uzorak lišajskog materijala sa pogodnih vrsta drveća, nakon čega se pristupilo determinaciji sakupljenih vrsta u laboratoriji, upotrebom ključeva, mikroskopa i posebnih hemikalija. Na području Tuzle pronađeno je ukupno 23 taksona lišajeva determinisanih do nivoa roda ili vrste. Najveća brojnost vrsta lišajeva konstatovana je u Gornjoj Tuzli 18, Donjoj Obodnici i Ljubačama 7, Slavinovićima 6, Dobrnji, Husinu i Lipnici 5, Dokanj 4 i park u Tuzli 1, dok u Bukinju nisu utvrđene vrste lišajeva zbog velikog onečišćenja zraka. Pronađene vrste lišajeva nalaze se unutar 9 porodica: *Pertusariaceae, Lecanoraceae, Cladoniaceae, Stereocaulaceae, Parmeliaceae, Ramalinaceae, Physciaceae, Teloschistaceae* i *Candelariaceae*. Statističkom analizom vrsta lišajeva i njihovih ekoloških i bioloških odlika dobijeni su rezultati procjene onečišćenja zraka na istraživanom području. Vrijednosti Indeksa čistoće atmosfere ukazuju na prisustvo četiri zone. Zona I sa veoma lošim kvalitetom zraka sa vrijednostima 0,0 za lokalitet Bukinje do 9,5 za park u Tuzli. Zonu II odlikuje loš kvalitet zraka sa vrijednosti 13,0 za Slavinoviće. Zonu III odlikuje umjeren kvalitet zraka sa vrijednostima od 21,0 za Lipnicu do 32,0 za Dobrnju. Zonu IV odlikuje dobar kvalitet zraka sa vrijednostima od 40,0 do 44,0 za Gornju Tuzlu i Donju Obodnicu.

Lichens as bioindicators of air quality in Tuzla (Bosnia and Herzegovina)

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This study is based on research lichens as bioindicators of air quality the area of Tuzla. Field research, which has been implemented during year 2011, ten different locations have been covered, from which had been gathered samples of lichen material from suitable tree species, after which has been approached to determination of gathered species in laboratory, by using keys, microscopes and special chemicals. The area of Tuzla of 23 taxa of lichens has been found that were determined to the level of genus or species. Greatest number of lichen species was concluded in Gornja Tuzla 18, Donja Obodnica and Ljubače 7, Slavinovići 6, Dobrnja, Husino and Lipnica 5, Dokanj 4 and park in Tuzla 1, while in Bukinje no lichen species was concluded due to great air pollution. The lichen species that were found are among 9 families: *Pertusariaceae, Lecanoraceae, Cladoniaceae, Stereocaulaceae, Parmeliaceae, Ramalinaceae, Physciaceae, Teloschistaceae* i *Candelariaceae*. By statistic analasys of lichen species and their ecological and biological characteristics the results that were gathered estimate air pollution on studied area. Values of Index of Atmospheric Purity (IAP) indicate presence of four zones. Zone I with very bad air quality with values from 0,0 for area of Bukinje to 9.5 for area park in Tuzla. Zone II is characterized by bad air quality with values 13.0 for area of Slavinovići. Zone III is characterized as moderate air quality with values from 21.0 for area of Lipnica to 32.0 for area of Dobrnja. Zone IV is characterized by good air quality with values from 40.0 to 40.4 for Gornja Tuzla and Donja Obodnica.

Rak kore pitomog kestena (*Castanea sativa* Mill.) ugrožava lovranski marun unatoč prisutnosti hipovirulentnih sojeva gljive *Cryphonectria parasitica* (Murrill) Barr

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Vrlo karakteristična šuma/voćnjak na području Lovrana, koja se sastoji od prirodne populacije pitomog kestena (*Castanea sativa*) unutar koje se nalaze stabla maruna, izuzetno cijenjenog kultivara, lokalnom stanovništvu stoljećima je služila kao značajan izvor prihoda. Marun, karakterističan po svojim velikim i ukusnim plodovima, vegetativno je razmnožavan cijepljenjem izdanaka ovog kultivara na postojeće sjemenjake, što je rezultiralo nastankom ove miješane šume/voćnjaka. Upravo na ovom području u Hrvatskoj je 1955. godine prvi puta zabilježena pojava raka kore kestena, bolesti uzrokovane gljivom *Cryphonectria parasitica*, što se odrazilo na lokalnu populaciju maruna, smanjujući im broj s preko 10 000 na svega nekoliko stotina stabala. Od 2009. do 2011. godine s ovog područja sakupljeni su uzorci kore koji su pokazivali patološke promjene, a iz kojih je u laboratoriju izolirana gljiva *C. parasitica*, kao i listova koji su služili za genotipizaciju drveća. Utvrđeno je da sva stabla karakterizirana kao maruni (vidljiv cijep, karakteristični plodovi) pripadaju jednome klonu, dok su ostali kesteni pokazivali veliku raznolikost, očekivanu za prirodnu populaciju. Analiziranjem uzoraka kore maruna utvrđen je gotovo potpuni nedostatak površinskih nekroza ili kalusirajućih rakova, koji bi ukazivali na oporavak stabala od ove bolesti. U 62% uzoraka kore prirodne populacije kestena, odnosno 42% uzoraka kore maruna, utvrđena je prisutnost virusne dsRNA u gljivi *C. parasitica*, što ukazuje na visoku zastupljenost *Cryphonectria hypovirusa 1* (CHV-1) u populaciji i uspostavljenu prirodnu biološku kontrolu bolesti raka kore kestena. Međutim, Fisherov exact test pokazao je da se aktivni rakovi mnogo češće javljaju na marunima nego na prirodnoj populaciji kestena (p vrijednost 0,00082), kao i da postoji veća vjerojatnost nalaženja aktivnih rakova u kojima je utvrđena prisutnost hipovirulentnih uzoraka gljive *C. parasitica* na marunima (p vrijednost 0,00017). Zastupljenost tipova vegetativne (ne)kompatibilnosti uzoraka *C. parasitica* bila je slična na kestenima i marunima, stoga se nerazmjerna zastupljenost hipovirulentnosti među uzorcima može eliminirati kao mogući uzrok slabijeg oporavka maruna od ove bolesti. Pošto su u analizu uzimana stabla starosti iznad 70 godina, te s istog područja, fiziološki i ekološki čimbenici također se mogu isključiti. Čini se da je genotip maruna posebno osjetljiv na rak kore kestena i da je unatoč prisutnosti CHV-1, čimbenika biološke kontrole, oporavak ovog vrijednog genotipa značajno slabiji od oporavka prirodne populacije kestena.

Chestnut blight disease threatens Lovran marron despite the presence of hypovirulent strains of the fungus *Cryphonectria parasitica* (Murrill) Barr

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A characteristic chestnut (*Castanea sativa*) forest/orchard consisting of naturally-growing chestnuts and chestnut cultivar – marron has served for centuries as a main source of income for the inhabitants of Lovran county. Marrons, characterized by their large and tasty fruits, have been vegetatively propagated by grafting shoots of this cultivar onto the existing naturally-growing chestnuts which eventually resulted in the creation of the existing forest/orchard. Chestnut blight was first observed in this county in 1955. The disease is caused by fungus *Cryphonectria parasitica*, which devastated the local chestnuts, reducing the number of marrons from over 10 000 to only a few hundred trees. From 2009 to 2011 bark samples shoving pathological change were collected and *C. parasitica* was isolated from them in the laboratory. Leaves were utilized for genotyping the trees. It was determined that all trees characterized as marrons (distinguished from naturally-growing trees by the graft and characteristic fruits) were in fact a single clone, while other chestnuts showed very high diversity, as expected for a natural population. It was determined that superficial cankers and healing cankers were almost completely absent from marrons. The presence of viral dsRNA was confirmed in 62% of the bark samples from chestnuts and in 42% from marrons, indicating high prevalence of *Cryphonectria hypovirus 1* in population which indicated an established natural biological control of the chestnut blight disease. However, Fisher's exact test showed that active, aggressive form of canker was more likely to occur on marrons than on naturally-growing trees (p value 0.00082). It was also determined that active cankers from which hypovirulent strains of the fungus were isolated occurred much more frequently on marrons than on naturally-growing trees (p value 0.00017). The frequency of the vegetative (in)compatibility types of the *C. parasitica* strains was similar for isolates from both chestnuts and marrons and therefore disproportion in prevalence of hypovirulence could be ruled out as the cause of the apparently slower/weaker recovery of the marrons. All trees were at least 70 years old and collected from the same area. Therefore, physiological and ecological factors as reasons for weaker recovery of marrons can also be rouled out. It seems that marron genotype is especially vulnerable to the chestnut blight and despite the presence of CHV-1, a biological control agent for the disease, the recovery of this valuable genotype is compromised.

Lišajska flora Nacionalnog parka „Una“ i Parka prirode „Blidinje“ (Bosna i Hercegovina)

Siniša Ozimec

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Lihenološka terenska istraživanja provedena su na područjima Nacionalnog parka „Una“ u razdoblju od 6. do 9. lipnja 2012. i Parka prirode „Blidinje“ u razdoblju od 6. do 9. srpnja 2012. godine. Na odabranim lokalitetima sakupljani su i determinirani primjerci lišajeva koji rastu na drveću i grmlju, mahovinama, stijenama, u pukotinama stijena i na tlu. Utvrđen je kvalitativni i kvantitativni sastav lišajske flore. Nacionalni park „Una“ nalazi se na području Unsko-sanskog kantona, a proglašen je 2008. godine. Na površini od 198 km^2 obuhvaća dolinske dijelove rijeka Une i Unca, te padine planina Plješevice, Grmeča i Osječenice. Prema podacima iz literaturnih izvora i terenskoga istraživanja, za lišajsku floru Nacionalnog parka „Una“ zabilježeno je 111 vrsta, što čini udjel od 18 % ukupne lišajske flore Bosne i Hercegovine koja broji 624 vrste. Sistematski, pripadaju u 26 porodica i 56 rodova lihenizirаnih gljiva. Vrstama su najbrojniji rodovi: *Lecanora* (10 vrsta); *Cladonia* (8); *Pertusaria* (7) i *Caloplaca* (4 vrste). Lišajevi istraživanog područja rastu na organskim i anorganskim podlogama. Najčešća stabla nositelji epifitskih lišajeva su: *Acer pseudoplatanus*, *Alnus glutinosa*, *Carpinus orientalis*, *Cornus mas*, *Crataegus* sp., *Fagus sylvatica*, *Fraxinus excelsior*, *Quercus cerris*, *Q. pubescens*, *Tilia* sp. i *Ulmus glabra.* U šumama planine Veliki Ljutoč zabilježene su rijetke i ugrožene lišajske vrste iz sveze *Lobarion pulmonariae,* čiji je opstanak povezan s dugim ekološkim kontinuitetom staništa i životnim vijekom stabala. Park prirode „Blidinje“ nalazi se na područjima Hercegovačko-neretvanske, Zapadnohercegovačke i Herceg-bosanske županije, a proglašen je 1995. godine. Na površini od 364 km^2 obuhvaća planinske masive Čvrsnice (2.228 m) i Vrana (2.074 m) odijeljene 12 km dugom udolinom Dugog polja na čijem južnom dijelu je Blidinjsko jezero. Prema podacima iz literaturnih izvora i terenskoga istraživanja, za lišajsku floru Parka prirode “Blidinje” zabilježeno je 70 vrsta (11 % lišajske flore Bosne i Hercegovine). Sistematski pripadaju u 18 porodica i 42 roda lihenizirаnih gljiva. Vrstama su najbrojniji rodovi: *Cladonia* (7 vrsta); *Lecanora* i *Peltigera* sa po 4 vrste. Lišajevi istraživanog područja rastu na organskim i anorganskim podlogama, a najčešća stabla nositelji epifitskih lišajeva su: *Fagus sylvatica*, *Picea abies* i *Pinus heldreichii* var. *leucodermis*.

Lichen flora of the Una National Park and the Blidinje Nature Park (Bosnia and Herzegovina)

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Lichenological field surveys were carried out in the areas of the Una National Park (6-9 June 2012) and the Blidinje Nature Park (6-9 July 2012). Lichen specimens growing on trees and shrubs, mosses, rocks, in rock crevices and on soil were collected and identified at chosen sampling locations. Qualitative and quantitative composition of lichen flora has been determined. The Una National Park is located in the Una-Sana Canton, being proclaimed in 2008. It covers surface of 198 km^2, and comprises parts of the Una and the Unac river valleys, and slopes of Plješevica, Grmeč and Osječenica mountains. Lichen flora of the Una National Park contains 111 species, which makes 18 % of total of 624 species recorded for the lichen flora of Bosnia and Herzegovina. They are classified into 26 families and 56 genera of lichenized fungi. The most numerous genera are: *Lecanora* (10 species); *Cladonia* (8); *Pertusaria* (7) and *Caloplaca* (4 species). Lichens in the surveyed area grow on organic and inorganic substrates. The most frequent trees for epiphytic lichens are: *Acer pseudoplatanus*, *Alnus glutinosa*, *Carpinus orientalis*, *Cornus mas*, *Crataegus* sp., *Fagus sylvatica*, *Fraxinus excelsior*, *Quercus cerris*, *Quercus pubescens*, *Tilia* sp. and *Ulmus glabra.* In the forests of Veliki Ljutoč, rare and endangered lichens from the alliance *Lobarion pulmonariae* were discovered, indicating long ecological continuity of the forest habitats. The Blidinje Nature Park is located in the areas of three counties: Herzegovina-Neretva, West Herzegovina and Herzeg-Bosnia County, being proclaimed in 1995. It covers surface of 364 km^2, and comprises mountain massifs of Čvrsnica (2.228 m) and Vran (2.074 m), divided by 12 km long valley of Dugo polje, on which southern part Blidinje Lake is located. Lichen flora of the Blidinje Nature Park contains 70 species, which makes 11 % of total of Bosnia and Herzegovina. They are classified into 18 families and 42 genera of lichenized fungi. The most numerous genera are *Cladonia* (7 species) and *Lecanora* and *Peltigera* with 4 species each. Lichens in the surveyed area grow on organic and inorganic substrates. The most frequent trees which supports epiphytic lichens are: *Fagus sylvatica*, *Picea abies* and *Pinus heldreichii* var. *leucodermis*.

Lišajska flora općine Slatina

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Područje Slatine nalazi se u središnjem dijelu Virovitičko-podravske županije, između rijeke Drave na sjeveru te planine Papuk na jugu, pri prosječnoj nadmorskoj visini od 127 m. Ovakav položaj pozitivno se odrazio na razdiobu stanišnih tipova što predstavlja preduvjet za raznovrsnost lišajske flore. Flora lišajeva istraživana je na području grada Slatine i okolnih naselja tijekom 2011. i 2012. godine višekratnim terenskim obilascima. Obrađeno je 9 lokaliteta, međusobno različitih po svojem geografskom položaju, stanišnim tipovima i intenzitetu antropogenog utjecaja. Odabrani lokaliteti grubo prate glavnu cestovnu i željezničku prometnicu u smjeru sjeverozapad-jugoistok. Lišajski materijal uzorkovan je s tla, betona te drveća i grmova do 2 m visine od tla, na ukupno 28 drvenastih vrsta. Istraživanjem je zabilježeno 57 lišajskih svojti, od toga 56 vrsta i 1 podvrsta svrstanih u 36 rodova liheniziranih gljiva. Prema životnom obliku, najčešći su korasti lišajevi (56 %), zatim listasti (35 %) i grmasti (9 %). Najveća raznolikost lišajeva vezana je za koru poljskog jasena (*Fraxinus angustifolia*) i običnog graba (*Carpinus betulus*). Od lišajskih vrsta, najčešće se javlja *Physcia adscendens*, na 19 drvenastih vrsta, a potom *Xanthoria parietina* na 17 te *Parmelia sulcata* na 16 vrsta dendroflore. Analizom indikatorskih vrijednosti različitih ekoloških faktora za lišajsku floru Slatine, utvrđeno je da se većina lišajeva javlja na polusvjetlu; na umjereno toplim mjestima; kozmopolitske su vrste; uglavnom dolaze na suhim mjestima; vezani su za umjereno kisele podloge (pH 4,9–5,6); i rastu na kori stabala bogatoj mineralima ili umjereno impregniranoj prašinom. Deset lišajskih vrsta indikatori su vrlo slabog do slabog onečišćenja zraka. Iznimno je vrijedan pronalazak ugrožene vrste *Lobaria pulmonaria* na stablima hrasta lužnjaka, koja je indikator kontinuiteta šumskih ekosustava. Nizinski poplavni teren i gusti sklop krošanja formiraju pogodnu mikroklimu za opstanak ove vrste. Planirane su nove terenske aktivnosti s obzirom da većina slatinskog područja zasad nije podvrgnuta lihenološkim istraživanjima.

Lichen flora of the Slatina district

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The area of Slatina is located in the central part of Virovitica-Podravina County, between the Drava river to the north and mountain Papuk to the south, with average terrain elevation of 127 m. Such position has positively affected the distribution of habitat types which represents a precondition for diverse lichen flora. The lichen flora was researched in the area of Slatina and surrounding villages during 2011 and 2012 by numerous field visits. Nine localities were surveyed, distinctive in their geographic position, habitat types and intensity of anthropogenic impact. The selected localities roughly follow the main road and railway in the direction northwest to southeast. Lichen material was collected from the soil, concrete substrate, trees and shrubs up to 2 m above the ground on bark of 28 species of woody plants. The research has recorded a total of 57 lichen taxa, of which 56 species and 1 subspecies classified into 36 genera of lichenized fungi. The most common life form were crustose lichens (56 %), followed by foliose (35 %) and fruticose (9 %) forms. The largest lichen diversity is related to the bark of narrow-leaved ash (*Fraxinus angustifolia*) and common hornbeam (*Carpinus betulus*). The most frequent lichen species noted is *Physcia adscendens* on 19 species of woody plants, followed by *Xanthoria parietina* and *Parmelia sulcata* on 17 and 16 species of dendroflora, respectively. The analysis of various ecological indicator values has determined that most lichens occur in moderate insolation; moderately warm sites; are cosmopolitan species; mostly related to dry places; grow on moderately acidic substrate (pH 4,9–5,6); and on nutrient rich bark or bark moderately dust-impregnated. Ten lichen species are indicators of very low to low air pollution. An exceptionally important finding is that of the endangered species *Lobaria pulmonaria*, an indicator of forest ecosystem stability, on trunks of pedunculate oak. The flooded lowland terrain and dense forest canopy produce a favourable microclimate for the survival of the species. New research will follow considering that the most part of Slatina has not yet been subjected to lichenological research.

Brojnost, biomasa i fenologija roda *Suillus* u sastojinama crnog bora (*Pinus nigra*) u Istri – preliminarni rezultati

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Plodišta gljiva roda *Suillus* Gray istraživana su u kulturama crnog bora (*Pinus nigra* Arnold) u Istri. Uzorci su sakupljani na tri različite trajne istraživačke plohe površine 400 m^2 svaka, tijekom dvije uzastopne godine (2011./2012.) od 20. do 50. tjedna svakih 14 dana. Evidentirano je pet različitih vrsta iz roda *Suillus*: *S. collinitus* (Fr.) Kuntze, *S. granulatus* (L.) Roussel, *S. luteus* (L.) Roussel, *S. mediterraneensis* (Jacquet. & J. Blum) Redeuilh i *S. variegatus* (Sw.) Kuntze. Vrsta *S. granulatus* imala je najveću brojnost i biomasu tijekom obje godine dok su vrste *S. variegatus* i *S. mediterraneensis* imale najmanju brojnost i biomasu te su evidentirane na samo jednoj plohi. Vrsta *S. granulatus* jedina je evidentirana tijekom obje godine na svim plohama i imala je najduži period pojavljivanja (od 32. do 50. tjedna). Vrste *S. collinitus* i *S. luteus* evidentirane su tijekom obje godine dok su vrste *S. mediterraneensis* i *S. variegatus* evidentirane samo tijekom jedne godine istraživanja. Produktivnost je korelirana s količinom oborina u istraživanom razdoblju. Za bolje razumijevanje ekoloških obilježja mikoriznih gljiva potrebno je provoditi dugoročna istraživanja.

Abundance, biomass and phenology of genus *Suillus* in Austrian pine (*Pinus nigra*) stands in Istria, Croatia – preliminary results

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Fungi fruit bodies of the genus *Suillus* Gray were investigated in Austrian pine (*Pinus nigra* Arnold) stands in Istria. Samples were collected on three different permanent mycorrhizal fungi research plots of 400 m2 each, for two consecutive years (2011/2012) from week 20 to week 50 every fortnight. Five different *Suillus* species have been recorded: *S. collinitus* (Fr.) Kuntze, *S. granulatus* (L.) Roussel, *S. luteus* (L.) Roussel, *S. mediterraneensis* (Jacquet. & J. Blum) Redeuilh and *S. variegatus* (Sw.) Kuntze. *S. granulatus* was the species with highest abundance and biomass in both years while *S. variegatus* and *S. mediterraneensis* were the least abundant, had the lowest biomass and occurred on only one plot. *S. granulatus* was the only species that occurred in both years on all plots and had the longest fruiting period (weeks 32 to 50). *S. collinitus* and *S. luteus* occurred in both years while *S. mediterraneensis* and *S. variegatus* were present in only one year. Productivity was correlated with precipitation in the investigated period. Long term study is needed to better understand the ecology of mycorrhizal fungi.

Gljive i lišaji – posterska priopćenja
Fungi and lichenes – poster presentations

Antioxidant and genoprotective properties of *Trametes gibbosa* extracts

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Considering that fungi posses numerous medicinal properties, and that some of them are attributed to bioactive compounds with antioxidant activity, testing of antioxidant capacity and genoprotective effect are the topical study area. The aim of this study was to evaluate antioxidant capacity of T. gibbosa fruiting body ethanol extract and its potential to protect nuclear DNA in cells exposed to oxidative stress. Antioxidant potential was evaluated by measuring bleaching of the purple-coloured methanol solution of stable 1,1-diphenyl-2-picryl-hydrazil radical (DPPH·) at 517 nm. Commercial antioxidant, butylated hydroxyanisole (BHA) was used as a positive control. Total content of phenols and flavonoids in extracts were determined as gallic acid equivalent (GAE) and quercetin equivalent (QE), respectively. Protective effect of the extract against H2O2 induced oxidative DNA damage in human peripheral blood lymphocytes was studied by using the in vitro single cell gel electrophoresis (comet assay). After the initial exposure to H2O2 (0.25 μM) for 15 min on ice (repair mechanisms are inhibited at 0 °C), the cells were incubated at 37 °C for 30 min with seven different T. gibbosa extract concentrations (20.0, 10.0, 5.0, 2.5, 1.25, 0.625 and 0.312 mg/mL). After that, cells were pretreated with the extract (under the same conditions) and afterwards exposed to H2O2. Extract of T. gibbosa showed 61.4% of DPPH radical scavenging activity, in concentration of 20.0 mg/mL. The amount of total phenols and flavonoids was 19.43 μgGAE/mg and 4.13 μgQE/mg, respectively. The H2O2 treatment induced significantly increase of DNA strand breaks in lymphocytes, and afterwards the treatment with studied extract led to considerable decrease of the damage. In the second experiment, the extract pretreatment also resulted with the reduction of DNA damage level. T. gibbosa extract showed no cytotoxicity and genotoxicity to the lymphocytes at the all tested concentrations. Thus, no increase of DNA damage was found in comparison to the negative control, the cell viability was 90-95% after culturing and before starting the comet assay. The present study has shown that T. gibbosa possess significant antioxidant capacity which was directly correlated to phenol but not with flavonoid content in fruiting bodies. As for genoprotective activity: (i) all concentrations of T. gibbosa fruiting body extract may have beneficial protective and reparative effects on DNA; (ii) the extract promotes an increase of antioxidant capacity of lymphocytes; (iii) the extract concentration of 5 mg/ml was the most effective in prevention of H2O2 induced oxidative stress in human lymphocytes.

Diversity of cyanobacteria and fungi on stone monuments in Serbia

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Stone substrata are the extreme habitat, poor of nutrients, with enormous changes in humidity, mechanical erosions due to wind, rain and high doses of UV-radiation. However, stone is inhabited with various group of microorganisms organized into sub-aerial biofilms (SAB) which occur at the interface formed between the lithic substratum and atmosphere. All SAB forming microorganisms can cause biodeterioration and degrade the stone mechanically and chemically through the metabolic activity and cause chromatic variations of stone, changed texture of stone and biopitts. Aim of this research was identification of SAB forming microorganisms (emphasizing cyanobacteria and fungi) on stone surface from the monuments surface before planed conservation intervention. Using adhesive tape method and cultural analyses numerous genera of coccoid and filamentous cyanobacteria and filamentous fungi were documented on monument stone surfaces made from various type of stone (sandstone, limestone, granite, marble). The most prevailing genera of cyanobacteria documented in this research were *Gloecapsa, Nostoc*, *Oscilatoria*, *Scytonema* and *Tolypotrix.* The prevailing fungal taxa were dematiaceous hyphomycetes with melanized hyphae and reproductive structures (genera *Alternaria, Aureobasidium, Cladosporium, Drechlera, Epicoccum* and *Phoma*). The most common alteration of monument surface documented in this research was formation of colored biopatinas which is related to production of different pigments by SAB microorganisms.

Mahovine – usmena priopćenja
Bryophytes – oral presentations

Flora mahovina Hrvatske – povijesni pregled i sadašnja potreba za istraživanjem

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Hrvatska ima dugu tradiciju brioloških istraživanja započetu prvih desetljeća 19. stoljeća. Prva istraživanja bila su naravno povremena i sporadična sa svega nekoliko opsežnijih djela koja su iz njih proizišla. Nakon vrhunca na prijelomu 19. u 20. stoljeće, novi val brioloških istraživanja vrhunac je doživio 1950-ih i 1960-ih, no ta istraživanja mahom su bila fokusirana na krške rijeke, tako da za ostale stanišne tipove postoje vrlo malobrojni podaci. Gotovo svi objavljeni podaci o mahovinama i njihovim nalazištima sakupljeni su u djelu „Prodromus flore briofita Jugoslavije" objavljenom 1955. Nakon toga objavljeno je vrlo malo sporadičnih podataka, bez i jednog detaljnog popisa vrsta za neko od područja u Hrvatskoj. U nekoliko novih popisa vrsta koji se odnose na države jugoistočne Europe uključena je i Hrvatska te su pridodani neobjavljeni podaci iz herbarija Prirodoslovnog muzeja u Budimpešti, no i dalje bez novih terenskih podataka. Prema tim popisima mahovinska flora Hrvatske broji 474 vrsta pravih mahovina, 153 vrste jetrenjača i dvije vrste rožnjača. Međutim, u terenskim istraživanja započetim 2009. pronađeno je 30 novih vrsta za mahovinsku floru Hrvatske i to na vrlo malom području, što pokazuje nužnost daljnjih istraživanja kako bi se dobio uvid u stvarno stanje i bogatstvo flore mahovina Hrvatske.

Bryophyte flora of Croatia – historical overview present need for research

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Croatia has a long history of bryological research, started in the first decades of the 19th century. However, the researches activities were mostly sporadic and occasional, with only a few comprehensive works on the subject. After the peak at the end of the 19th and the beginning of the 20th century, a new wave of bryological works in the 1950's and 60's were mostly focusing on karst rivers and with only very scarce data for bryophytes of other habitats. Almost all published data about bryophyte species and their localities were summarised in "Prodromus flore briofita Jugolavije" published 1955. After that very few and sporadic records were published, without any comprehensive species list for any of regions or areas in Croatia. In some new species list dealing with bryophytes of countries in South-Eastern Europe, Croatia is also included and unpublished data from herbarium collection in Natural History Museum in Budapest are added, but still without any new field data. According to this lists Croatian bryoflora counts 474 species of mosses, 153 species of liverworts and two species of hornwotrs. However, renewed filed work started in 2009 and encompassing very limited areas resulted in 30 new species for Croatian bryophyte flora, showing urgent need of further research to assess the real status and richness of the bryophyte flora of Croatia.

Does anioxydative system increase salt stress survival in facultative halophytic moss *Entosthodon hungaricus*?

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The moss species *Entosthodon hungaricus* is inhabitant of the salty environment in central, eastern and southern Europe. It is European red-listed species since it is rare and rather threatened by the habitat changes. Here, we studied axenically farmed, *in vitro* developed gametophyte tolerances to NaCl stress. We compared *E. hungaricus* with its relative moss *Physcomitrella patens* (family Funariacerae, both with shuttle survival strategies). Survival, index of multiplications (i.e. new shots produced), total chlorophyll content of both species almost linearly decreased with increase of NaCl concentration added to the growth medium. In contarst, carotenoid content increased. The chlorophyll a/b ratio, decreased in both species. Catalases in *E. hungaricus* abruptly increase activity with low salt stress, and then slightly decrease by each further increase of salt stress. The activity of peroxydases, after slight decrease in small salt stress increased with the increase of salt concentration up to 300mM NaCl while in further salt increase of their activity significantly felled down. Catalase activity in *P. patens*. show no clear pattern while the activity of peroxidases abruptly decreased with salt stress increased. Superoxyddismutase had more activated izoformes in *E. hungaricus* than in *P. patens* during the stress, which implicate that enzyimes of anti-oxysative system react to salt stress and take part in biology of tolerance to NaCl in mosses, as a first level response. All these parameters showed *E. hungaricus* to be more stress tolerant moss than *P. patens*.

Mahovine – posterska priopćenja
Bryophytes – poster presentations

Distribution of mires in Serbia with special emphasis on *Sphagna* mires

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Mires persist on about 1250 ha or 0.014% of total Serbian territory, within 155 mires and mire complexes. Among these only 44 are known historically to bear *Sphagna* (at least one species). However, many sites cited in the literature are old, changed and/or destroyed. E.g. out of 12 species known for Kopaonik only 7 are reported recently, or out of 13 species previusly reported in Vlasina region only 8 species are still present there. According to the historical data, the most rich sites in *Sphagna* in Serbia are: Vlasina region (13), Kopaonik (12), Golija (8), Stara planina (8) and Tara (7). Six species are recorded only once in Serbia, namely *Sphagnum angustifolium, S. fuscum, S. magellanicum*, *S. russowii, S. subnitens* and *S. warnstorfii*. *Sphagnum palustre* is the most common species recorded in 12 sites. According to the present studies of the mire habitats in Serbia, only 10 areas bears *Sphagnum* species Accrodring to the EU Habitat directive all these species are protected. Further steps toward recent investigation, active and passive protection and cosnervation and recovery of mires in Serbia is urgently needed.

Is there a seasonal and spatial pattern in lead accumulation in the moss *Hypnum cupressiforme* in Europe

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The pleurocarpus moss *Hypnum cupressiforme* is widely used as bioindicating species in atmospheric deposition across the Europe. The accumulation pattern of lead from the atmospheric deposition in this moss has been studied in 34 accessions from accross the Europe. The accession were randomly sampled in different season and situations. The upper green part of the mosses were used for the ICP analyses. The values of the lead accumulated varies from 0.00-77.86 mg/g of dry weighted mosses. There were no clear pattern of lead accumulation but it can be inferred that lead accumulation increase with the wet climate conditions rather than wet (growth) seasons but these two overlapping in some accessions. Spatial pattern indicate that the samples collected closer to the lead emission centre or are rather heavily loaded by lead on the airways of predominate winds passing trough emission centres.

Floristička i ekološka analiza mahovina u šumskim zajednicama Medvednice

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Mahovine su bitna komponenta bioraznolikosti, a njihova jedinstvena biologija im omogućava zauzimanje specifičnih ekoloških niša. Raznolikost mahovina je zavisna o raznolikosti staništa, tj. biljnih zajednica te o raznolikosti mikrostaništa unutar njih. Medvednica se odlikuje dobro očuvanim šumama koje pripadaju različitim zajednicama uvjetovanim prije svega geološkom podlogom i nadmorskom visinom te je za očekivati da će tu raznolikost šumskih zajednica pratiti i raznolikost flore mahovina. Na 13 ploha u 6 šumskih zajednica Medvednice zabilježene su 63 vrste mahovina (51 vrsta Bryophyta te 12 vrsta Marchantiophyta). Dvostrukom klasterskom analizom pokazano je grupiranje vrsta i ploha, a korespondencijskom analizom s projiciranim vektorima srednjih vrijednosti ekoloških indeksa prema Landoltu i izmjerenih pH vrijednosti tla ustanovljena je jasna razlika u flori mahovina između termofilnih zajednica razvijenih na karbonatnoj podlozi (*Tilio-Taxetum* Glavač 1959, *Ostryo-Quercetum pubescentis* (Horvat 1950) Trinajstić 1979) i zajednica na kiseloj podlozi (*Hieracio racemosi-Quercetum petraeae* Vukelić 1991, *Festuco drymeiae-Abietetum* Vukelić et Baričević 2007, *Querco-Castanetum sativae* Horvat 1938 i *Luzulo luzuloidi-Quercetum* (Hillitzer 1932) Passarge 1953) te je objašnjena njihova ekološka uvjetovanost. Glavni ekološki čimbenici koji uvjetuju ustanovljenu razliku u sastavu vrsta istraživanih zajednica su reakcija supstrata te svjetlost i temperatura. Za zajednice na silikatnoj podlozi karakteristične su acidofilne vrste koje dolaze na tlu, dok zajednice na karbonatnoj podlozi karakteriziraju vrste neutralnih i bazičnih supstrata i vrste suhih staništa. Također, raznolikost mahovina je uvjetovana količinom i kvalitetom mikrostaništa koja su na raspolaganju, što objašnjava razlike u broju i sastavu vrsta na različitim lokalitetima unutar istih zajednica.

Floristic and ecological analysis of bryophytes in forest communities on Mt. Medvednica

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Mosses represent an important component of biodiversity, and their unique biology allows them to occupy specific ecological niche. The diversity of bryophytes is correlated with habitat heterogenity, diversity of present plant communities and available microhabitats within them. Mount Medvednica is characterised by well-preserved forests of different communities, which are primarily determined with the geological bedrock and altitude. Therefore, it can be expected that on Mt. Medvednica the diversity of moss flora follows the diversity of forest communities. In this research a total of 63 bryophyte species (51 species of Bryophyta and 12 species of Marchantiophyta) has been recorded on 13 plots in 6 forest communities. Double cluster analysis performed groups of species and plots, while correspondence analysis with passively projected vectors of mean values of Landolt' s ecological indices and measured soil pH showed clear distinction of bryoflora in thermophilous communities on calcareous bedrock (*Tilio-Taxetum* Glavač 1959 and *Ostryo-Quercetum pubescentis* (Horvat 1950) Trinajstić 1979) from bryophyte flora in forest communities developed on silicate bedrock (*Hieracio racemosi-Quercetum petraeae* Vukelić 1991, *Festuco drymeiae-Abietetum* Vukelić et Baričević 2007, *Querco-Castanetum sativae* Horvat 1938 i *Luzulo luzuloidi-Quercetum* (Hillitzer 1932) Passarge 1953) and their ecological dependence was explained. The main ecological factors that influence observed difference in the species composition among studied forest communities are substrate reaction, light and temperature. Communities developed on

silicate bedrock are characterised by acidophilous, terricolous species, while neutrophilous, basophilous and bryophyte species of dry substrata are characteristic of forest communities on calcareous bedrock. Furthermore, observed variations in species number and composition on different plots in the same forest communities is due to the fact that bryophyte assemblage is greatly influenced with quality and quantity of available microhabitats.

Urban bryophytes of the city of Ljubljana (Slovenia)

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Bryophytes is considered to be a significant part of urban ecosystems. In this work we present the first insight into the bryophyte flora of Ljubljana. In total 105 species are recorded in the area of the inner ring-road, 14 liverworts and 81 moss species. Among recorded species there are some considered as extinct or previously erroneously reported for Slovenia, like *Pohlia filum*, *Rhynchostegiella litorea* or *Grimmia trichophylla.* Some *Schistidium* species are reported for the first time for Slovenian bryo-flora. Within urban area just above the inner-city area in the green surface some European red-listed species were recorded like *Rhynchostegium rotundifolium, Fissidens fontanus* or some peat-mosses. It is expected that with further studies alpha diversity of the urban flora will increase.

The first report of apogamous *Entosthodon hungaricus* and the spores directly producing sporophytes in bryophytes

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A phenomenon of apogamy (formation of a sporophyte directly from gametophyte cell without intervention of gametes) is rare in living beings. The factors causing apogamy are unknown and speculative. The apogamy in bryophytes was reported only few times and it was reported just for mosses. In nature apogamy was reported only twice in *Phascum cuspidatum* and *Fissidens warnsorfii,* while in culture it was observed in 18 species. Here, an apogamous sporophyte of the moss *Entosthodon hungaricus* (Funariaceae) were reported for the first time. The plants under lower light condition and constant water accessibility and temperature produced apogamous sporophytes. These apogamous sporophytes have viable spores. The phenomenon of direct germination of spores into sporophytes was not previously observed in bryophytes.

Etnobotanika, edukacija, muzeologija i botanički vrtovi – usmena priopćenja

Ethnobotany, education, museology and botanical gardens – oral presentations

Biljke na slici „Gospa“ Mata Celestina Medovića

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Franjevac Mato Celestin Medović (Kuna, 17.11.1857. – Sarajevo, 20.1.1920.) pripada prvoj generaciji slikara hrvatske moderne. Iz njegove „Pelješke“ faze, gdje je ostavio neizbrisiv trag u pejzažnom slikarstvu, posebno se izdvajaju polja zasjenjeno crveno ljubičaste boje vrijesa i žuta polja smilja. Međutim, Medović nije slikao samo pejzaže s pelješkim biljkama. U samostanu Male braće u Dubrovniku ostalo je više Medovićevih djela među kojima se nalazi i slika „Gospe“ okružena biljkama, a u kojoj je spojio pobožnost prema Gospi s apotekarskim poslom prijatelja franjevca. Slika je nastala na temeljnom predlošku „Gospe“ autora „Sassoferrata“ punog imena Giovanni Battista Salvi (25.8.1609. - 8.8. 685.), rođenog u mjestu nedaleko Ancone (Italija) po kojem je kasnije i dobio nadimak. Sliku Sassoferratove „Gospe“, je nakon velikog potresa 1667.godine u Grad iz Madrida donio izaslanik Dubrovačke Republike fra Frano Cafarelli a po njoj je rađeno desetak slika raznih umjetnika, između ostalih i Medovića, koje su Dubrovčani nazvali „Dubrovačka Gospa“. Lik Gospe na slici okružuju sljedeće biljke: *Commiphora myrrha* (Nees) Engl. (Burseraceae), *Ferula gummosa* Boiss. (Apiaceae), *Myroxylon balsamum* (L.) Harms var. *pereiras* (Royle) Harms (Fabaceae), *Liquidambar orientalis* Mill. (Hamamelidaceae), *Cinnamomum camphora* (L.) Nees et Eberm. (Lauraceae), *Cedrus libani* A. Richard (Pinaceae), *Cupressus sempervirens* L. (Cupressaceae) i *Olea europaea* (Oleaceae). Izbor biljaka na slici vjerojatno je posljedica dobrog poznavanja njihove primjene u ljekarništvu, prema tome i u medicini toga vremena, ali imaju svoje mjesto i u Bilbijskim temama.

Plants on the painting „Our Lady“ by Croatian painter Mato Celestin Medović

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Franciscan, Mato Celestin Medović (Kuna, 17.11.1857 - Sarajevo, 20.1.1920) belongs to the first generation of the Croatian Moderna painters. From his „Pelješac“ phase, where he left indelible trace in colourful landscape paintings, we can particularly sort out fields with shadowed purple red coloured heath and yellow fields of immortelle.However, Medović hasn't painted only lanscapes with the Pelješac plants. In the monastery „Mala braća“ in Dubrovnik we can find few Medović's paintings among which is „Our Lady“ surrounded with the plants. In this work of art, he brought together devotion towards Our Lady with the work of his Franciscan friend, pharmacist. The painting was made upon the basic pattern „Our lady“ by „Sassoferrato“ fully named Giovanni Battista Salvi (25.8.1609. - 8.8.1685.), nick named after the place of his birth,, Sassoferrato, close to the Ancona (Italy). After the big earthquake (1667.), the painting of Sassoferrato's „Our Lady“ has been brought to the City from Madrid by Dubrovnik Republic's emissary franciscan Frano Cafarelli. After this original, ten paintings by different artists have been made. Medović being one of them. People from Dubrovnik named all this paintings „ Our Lady of Dubrovnik“. Image of the Our Lady on the paintings is surrounded by next plants: *Commiphora myrrha* (Nees) Engl. (Burseraceae), *Ferula gummosa* Boiss. (Apiaceae), *Myroxylon balsamum* (L.) Harms var. *pereiras* (Royle) Harms (Fabaceae), *Liquidambar orientalis* Mill. (Hamamelidaceae), *Cinnamomum camphora* (L.) Nees et Eberm. (Lauraceae), *Cedrus libani* A. Richard (Pinaceae), *Cupressus sempervirens* L. (Cupressaceae) and *Olea europaea* (Oleaceae). The choice of the plant species was probably the consenquence of their wide and well known use in pharmacy and medicine of that time, but these plants have their place in the Bible, too.

Tri godine „Tjedna botaničkih vrtova i arboretuma Hrvatske“

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Slijedom uspješnog Prvog "Tjedna botaničkih vrtova i arboretuma Hrvatske", koji je na 12 lokacija diljem zemlje održan početkom lipnja 2011., Sekcija botaničkih vrtova i arboretuma Hrvatske Hrvatskog botaničkog društva, u suradnji s mnogim institucijama i pojedincima, organizirala je u svibnju 2012. Drugi, te u svibnju ove godine i Treći edukativno-popularizacijski „Tjedan“. U ovogodišnjoj manifestaciji sudjelovala su 22 botanička vrta, arboretuma i manje botaničke zbirke u 12 hrvatskih županija, sa zajedničkim ciljem: slijedom raznovrsnih besplatnih događanja popularizirati vrijednost hrvatske flore, zaštitu biljaka i djelatnosti botaničkih vrtova uopće. Sudionicima „Tjedna“ predlažemo nekoliko značajnih datuma, uz koje mogu – ako to žele – vezati svoje aktivnosti, prije svega Međunarodni dan obitelji (15. svibnja), Međunarodni dan zaštite biljaka (18. svibnja) te Međunarodni dan biološke raznolikosti (22. svibnja). Svake se godine organizira svečano Otvaranje „Tjedna“ u drugom botaničkom vrtu ili arboretumu, kako bi se privukla pozornost medija, a time i javnosti: otvaranje Trećega „Tjedna“ organizirala je UŠP Našice u Arboretumu Lisičine. Glavni pokrovitelj i darovatelj ovogodišnjeg „Tjedna“ bio je Fond za zaštitu okoliša i energetsku učunkovitost, a supokrovitelji Ministarstvo zaštite okoliša i prirode, Ministarstvo znanosti, obrazovanja i sporta, Ministarstvo poljoprivrede te Državni zavod za zaštitu prirode. Svake godine raste broj raznovrsnih događanja kojima se nastoje privući posjetelji: od šetnji uz stručnu pratnju, preko tematskih predavanja i najrazličitijih radionica, edukativnih izložbi, predstavljanja projekata i učeničkih radova, do predstava, igrokaza i čitanja priča za mališane. Novouključeni vrtovi donose i nove sadržaje te se tako „Tjedan“ svake godine obogaćuje. Hrvatske botaničke vrtove i arboretuma tijekom tog samo jednog „Tjedna“ u svibnju posjeti više od 10.000 građana, a najviše – čemu smo se i nadali – djece. Osobito ohrabruje rastuće zanimanje za sudjelovanjem u „Tjednu“: za sudjelvoanje u dogodišnjem Četvrtom „Tjednu“ još prije početka Trećega „Tjedna“ bilo je zainteresirano šest novih vrtova.

Three years of the "Week of Croatian Botanical Gardens and Arboreta"

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Following a successful First *National Week of Croatian Botanical Gardens and Arboreta*, which took place in June 2011 at 12 locations across the country, *Section of Croatian Botanical Gardens and Arboreta* of the *Croatian Botanical Society*, in collaboration with many institutions and individuals, organized in May 2012 the Second, and in May 2013 the Third "*Week*". This year's event involved 22 botanical gardens, arboretums and smaller botanical collections across the country, with the common goals: to popularize a value of Croatian flora, importance of plant conservation in the modern world and botanical garden-activities in general through a variety of free events. Several important dates are suggest to the Participants, to which they can tie their activities: *International Day of Families* (May 15th) and *International Plant Conservation Day* (May 18th), following by the *International Day for Biological Diversity* (May 22nd). Every year a Grand opening of the "*Week*" is organized in one of the gardens/arboreta involved, in order to gain more media - and thus public – attention to the object: this year the ceremony was prepared in the Arboretum Lisičine (eastern Croatia). The main sponsor of the Third "*Week*" was the Environmental Protection and Energy Efficiency Fund, under the auspices of the Ministry of Environment and Nature Protection, Ministry of Science, Education and Sports, Ministry of Agriculture, and State Institute for Nature Protection. Croatian botanical gardens and arboreta, during this just

one "*Week*" in May, are visited by more than 10,000 people, and most of them – for what we hoped from the beginning – children.

Knjiga Pietra Andree Matthiolija (1500.-1577.) *I Discorsi di M. Pietro Andrea Matthioli Sanese, Medico Cesareo ... Di Pedacio Dioscuride Anacarbeo della materia Medicinale* iz Državnog arhiva u Dubrovniku

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Grad Dubrovnik svojim kulturnim značenjem od iznimne je važnosti u svjetskim razmjerima i njegova kulturna baština predstavlja iznimno bogatstvo. Prikazi biljaka, biljni ornamenti još od najranijih stoljeća imali su važnost u svom jeziku simbola. Djelovanjem benediktinskog reda koji je gajio iznimnu pažnju prema kultiviranju biljaka, njihovoj primjeni, kao i kasniji srednjovjekovni prosjački redovi: dominikanci i franjevci, zaslužni su djelovanjem svojih ljekarni za širenjem kulture bilinstva, odnosno nabave brojnih vrijednih rukopisa s prikazima biljaka. Posebno je vrijedan primjerak knjige iz Državnog arhiva u Dubrovniku: I DISCORSI/Di M. Pietro Andrea Matthioli Sanese, MEDICO CESAREO, ET/DEL SERENISSIMO PRINCIPE FERDINANDO ARCIDVCA D'AUSTRIA, & c./NE I SEI LIBRI/Di Pedacio Dioscoride Anazarbeo della materia medinicale,/DAL SVO ISTESSO AVTTORE INNANZI/su morte ricoretti, & in più/Con le figure tirate dalle naturali, & viue/Piante& Animali, in numero/molto maggiore, che le altre per auanti stampare./Con due/Tauole copiosissime: l'una à ciò, che in tutta l'Opera si contiene: & l'dura/alla cura a di/tutte le infermità del corpo umano./ALL M. ILL.re ET R.mo MONSIG. TOLDO/CONSTANTINI/Protonotario Apostolico, & Vicario Generale di Treusio./IN VENETIA Presso Marco Ginammi MDCXXXXV./Con licenza de' Superiori, & Priuilegio. U ovoj iznimno zanimljivoj knjizi nalaze se brojni grafički prikazi biljaka i njihovih plodova s višejezičnim nazivima. U Državnom arhivu u Dubrovniku se čuva izdanje iz 1645., ali je prvi je put Matthiolijevo djelo tiskano 1544., i to na talijanskom. Liječnik i botaničar Pietro Andrea Matthioli (1500.-1577.) je bio poznat po talijanskom prijevodu i komentaru "Di Pedacio Dioscoride Anazerbeo libri cinque ..." grčkog botaničara Pedanios Dioscuridesa. Matthioli je Dioscuridove studije nadopunio novim biljkama korisnim u liječenju. Knjiga je bila i u prvom izdanju opremljena iznimno vrijednim drvorezima, iako je tekst ponegdje bio nejasan. Prevedena je na latinski (Venecija, 1554), češki (Prag, 1562), njemački (Prag, 1563) i francuski (Lyon, 1572). U djelu se po prvi put dokumentira uzgoj rajčice u Europi. Osobita je vrijednost dubrovačke knjige jer potvrđuje nazočnost tog poznatog renesansnog autora i u Dubrovniku, makar u nešto mlađem izdanju.

Book of Pietro Andrea Matthioli (1500-1577) *I Discorsi di M. Pietro Andrea Matthioli Sanese, Medico Cesareo ... Di Pedacio Dioscuride Anacarbeo della materia Medicinale* from the National Archives in Dubrovnik

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Dubrovnik's cultural heritage is extremely rich and of great importance on a global scale. The illustrations of plants, floral ornaments and designs from the earliest centuries were important in their own language of symbols. The Benedictine monastic order of brothers had paid an incredible attention to the cultivation of plants and various ways of their uses. In addition, the major mendicant orders, the Franciscans and Dominicans, were largely responsible for using of plants and plant extracts for medicinal purposes. Collecting numerous valuable manuscripts, books and other material associated with wild plants used for medicine or food were also important. In the National Archives in Dubrovnik, we found a especially valuable original of book by I DISCORSI/Di M. Pietro Andrea Matthioli Sanese, MEDICO CESAREO, ET/DEL SERENISSIMO PRINCIPE FERDINANDO ARCIDVCA D'AUSTRIA, & c./NE I SEI LIBRI/Di Pedacio Dioscoride Anazarbeo della materia medinicale,/ DAL SVO ISTESSO AVTTORE INNANZI/su morte ricoretti, & in più/Con le figure tirate dalle naturali, & viue/Piante& Animali, in numero/molto maggiore, che le altre per auanti stampare./Con due/Tauole copiosissime: l'una à ciò, che in tutta l'Opera si contiene: & l'dura/alla cura a di/tutte le infermità del corpo umano./ALL M. ILL.re ET R.mo MONSIG. TOLDO/CONSTANTINI/Protonotario Apostolico, & Vicario Generale di Treusio./IN VENETIA Presso Marco Ginammi MDCXXXXV./Con licenza de' Superiori, & Priuilegio. In this very interesting book, there are numerous graphical representations of plants and their fruits with the multilingual names. The National Archives in Dubrovnik keeps edition from year of 1645, while the first edition of Mattioli's work appeared in Italian in 1544. There were several later editions in Italian and translations into Latin (Venice, 1554), Bohemian (Prague, 1562), German (Prague, 1563) and French (Lyon, 1572). Pietro Andrea Matthioli (1500-1577) described 100 new plants and coordinated the medical botany of his time in *Discorsi* ("Commentaries") on the *Materia Medica* of the Greek botanist Pedanios Dioscurides. In addition to identifying the plants originally described by Dioscorides, Mattioli added descriptions of some plants not in Dioscorides and not of any known medical use, thus marking a transition from to the study of plants as a field of medicine to a study of interest in its own right. However, the woodcuts in Mattioli's work were of a high standard, allowing recognition of the plant even when the text was obscure. A noteworthy inclusion is an early variety of tomato, the first documented example of the vegetable being grown and eaten in Europe. The particular value of book in Dubrovnik confirms the presence of this famous author in Renaissance Dubrovnik, though in a slightly younger version.

Etnobotanika, edukacija, muzeologija i botanički vrtovi – posterska priopćenja

Etnobotany, education, museology and botanical gardens – poster presentations

Tradicionalna upotreba bilja iz prirode stanovnika Biokovskog masiva i Livanjskog kraja

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Vrijedne informacije o tradicionalnoj upotrebi biljaka iz prirode, koje su se prenosile generacije na generaciju, još postoje kod malobrojnog ruralnog stanovništva. S promjenom načina života to znanje izumire. Cilj ovog rada bio je zabilježiti izvorno znanje upotrebe ljekovitih biljaka starosjedioca Biokovskog masiva i Livanjskog kraja. Prikupljeni su recepti za primjenu, među kojima su oni za *Urospermum picroides* (L.) Scop. ex F.W.Schmidt, *Salvia officinalis* L., *Thymus longicaulis* C. Presl, *Satureja montana* L., *Teucrium chamaedrys* L. *Papaver rhoeas* L., *Plantago major* L., *Crataegus monogyna* Jacq. etc.

Traditional use of plants from nature in Biokovo mountain range and Livno region

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Valuable information about traditional use of wild plants, which was transferred through generations, still exists within sparse rural inhabitants. With the change of life style that knowledge disappears. The aim of this research was to record the way of use of medicinal plants by indigenous inhabitants of Biokovo mountain range and Livno region. The recipes for use of plants were collected, among them for *Urospermum picroides* (L.) Scop. ex F.W.Schmidt, *Salvia officinalis* L., *Thymus longicaulis* C. Presl, *Satureja montana* L., *Teucrium chamaedrys* L. *Papaver rhoeas* L., *Plantago major* L., *Crataegus monogyna* Jacq. etc.

Herbarij u nastavi prirode u 6. razredu osnovne škole

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U OŠ Bogumila Tonija, Samobor i OŠ Ivane Brlić-Mažuranić, Virovitica kao izborni sadržaj u 6. razredu obrađuje se tema "Pravila sakupljanja i prešanja biljaka". Cilj obrade izbornih tema u nastavi prirode i biologije je unaprijeđivanje kvalitete nastavnog procesa, a obradom ovog nastavnog sadržaja učenici dobivaju smjernice za izradu klasičnog ili foto herbarija. Učenike je prije izrade herbarija potrebno upozoriti i na zakonom zaštićene biljne vrste koje mogu pronaći na staništima na kojima sakupljaju biljne vrste, te napomenuti kako takve biljne vrste mogu biti samo dio foto herbarija. Tijekom vrijednovanja herbarija provodi se, putem kratke pismene provjere zadacima konstrukcije i zadacima izbora, i provjera znanje učenika o biljnim vrstama kontinentalnih travnjaka. Tijekom provođenja projekta uspoređuju se i rezultati pismene provjere 50 učenika 6. razreda OŠ Bogumila Tonija Samobor sa rezultatima pismene provjere 50 učenika OŠ Ivane Brlić-Mažuranić Virovitica. Vrijednost izrade herbarija u nastavi prirode je u tome što učenici tijekom prikupljanja biljnih vrsta i izrade herbarija uče na temelju neposrednog iskustva kroz praktičan rad i primjenu teoretskog znanja. Na ovaj način učenici usvajaju i određene znanstvene metode, a dobiveni se podaci mogu koristiti u izradi istraživačkih radova koje učenici prezentiraju na natjecanjima iz biologije.

Herbarium in the nature history education in the 6th grade of elementary school

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«Rules for collecting and pressing plants» is an optional topic in the 6th grade of Bogumil Toni Elementary School in Samobor and Ivana Brlić-Mažuranić Elementary School in Virovitica. The purpose of optional topics in the natural history and biology education is to raise quality of the teaching process, and by working on this topic pupils are instructed on how to prepare classical, or photo herbarium. Before making the herbarium pupils need to be warned about protected plant species that can be found in habitats where they also collect plants, and it has to be emphasized that those species can be only a part of the photo herbarium. During herbarium evaluation there is also a short written test about plants of continental grasslands, containing construction and election assignments. In the course of the project we compare results of written tests of 50 pupils from the 6th grade of both Bogumil Toni Elementary School in Samobor and Ivana Brlić-Mažuranić Elementary School in Virovitica. The value of making herbaria in the nature history education lies in the very process of collecting plants and making herbarium, where pupils learn through personal experience and practical work, applying their theoretical knowledge. That way pupils also learn to use certain scientific methods, and obtained results can be used in research work which pupils then present in biology contests.

Botanika na tanjuru

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Tijekom travnja i svibnja 2013. godine, kao dio projekta „Botanika na tanjuru“ (a u sklopu višegodišnjeg programa Udruge „Cvjetkina škola o prirodi“), Udruga Populus je provela preliminarnu anketu o poznavanju biljnih svojti koje svakodnevno konzumiramo. U anketi je sudjelovao 61 ispitanik (46 žena i 15 muškaraca), prosječne dobi 35 godina, a anketa se sastojala od dva dijela: 1) kratkog upitnika te 2) slikovnog dijela u kojem su ispitanici trebali povezati fotografiju habitusa biljke s njenim hrvatskim imenom. Prilikom analize rezultata, uz deskriptivnu statistiku, su korišteni i t-testovi za nezavisne uzorke koji su pokazali nepostojanje statistički značajne razlike u prepoznavanju odabranih biljnih svojti s obzirom na dob, zanimanje i boravište. Osim provedene ankete, projekt „Botanika na tanjuru“ obuhvaća također: 1) niz radionica namijenjenih različitim dobnim skupinama, s naglaskom na djecu osnovnoškolske dobi, 2) niz slikovnica koje, s Cvjetkom u glavnoj ulozi, kratkim pjesmicama, ilustracijama, prikazom habitusa i radnim zadacima obrađuju po 15 voćnih, povrtnih i začinskih biljnih svojti te 3) niz Cvjetkinih kuharica. Rad detaljnije prikazuje metodologiju, rezultate i zaključak provedene preliminarne ankete te rezultate postignute provedbom ostalih dijelova projekta.

Botany on a plate

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During April and May 2013, as part of the project “Botany on a Plate” (within the Association’s multi-annual program “Cvjetka’s School of Nature”), the Association Populus conducted a preliminary survey of the knowledge of plant species we consume every day. The survey involved 61 subjects (46 women and 15 men) of average age 35 years, and consisted of two parts: 1) a short questionnaire and 2) the image section where the subjects had to connect photo of the plant habitus with the Croatian name of the taxa. When analysing the results, along with descriptive statistics, t-tests for independent samples were used that showed that there were no statistically significant differences in the recognition of selected plant taxa with respect to age, occupation and place of residence. Other than the survey, project “Botany on a Plate” also includes: 1) a series of workshops for different age groups, with an emphasis on primary school children, 2) a series of picture-books that, with Cvjetka as main character, present through rhymes, illustrations, habitus drawings and worksheets 15 fruits, vegetables and plant spices each and 3) a series of Cvjetka’s Cookbooks. This paper presents in more details the methodology, results and conclusion of the conducted survey, as well as results achieved through implementation of other parts of the project.

Ex situ zaštita svojti iz Crvene knjige u Botaničkom vrtu PMF-a Sveučilišta u Zagrebu

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Crvena knjiga vaskularne flore Hrvatske broji ukupno 234 svojte koje se smatraju izumrlima ili suočenima s rizikom izumiranja. Ta se brojka na svjetskoj razini penje do vrtoglavih 100.000 svojti ili gotovo jedne trećine svih poznatih vrsta vaskularne flore. Uloga botaničkih vrtova u *ex situ* zaštiti tih najugroženijih biljnih svojti je nezamjenjiva. Prema Globalnoj strategiji zaštite biljaka na Zemlji (*Global Strategy* for *Plant Conservation*, GSPC) do 2020. godine trebalo bi u *ex situ* zaštitu lokalnih botaničkih vrtova uključiti 75% ugroženih biljnih svojti svake zemlje. Detaljna analiza autohtone flore u zbirci Botaničkog vrta Prirodoslovno-matematičkog fakulteta Sveučilišta u Zagrebu provedena je početkom 2013. godine. Prema dobivenim podacima,u *ex situ* zaštiti Botaničkoga vrta nalazi se 13,2% svojti vaskularne flore Hrvatske sa statusom izumrle vrste ili s rizikom izumiranja, od kojih 97% ulazi u kategoriju strogo zaštićenih biljnih svojti. Jedna svojta (*Hippophaë rhamnoides*) u *ex situ* zaštiti smatra se regionalno izumrlom (RE); sedam svojti (7,8%) suočeno je s izuzetno visokim rizikom nestajanja (CR); šest svojti (9,7%) nalazi se u kategoriji veoma visokog rizika (EN), a 17 svojti (23,9%) u kategoriji visokog rizika nestajanja (VU). Četiri svojte s rizikom izumiranja također su i hrvatski endemi: *Geranium dalmaticum, Degenia velebitica, Dianthus integer* i *Iris croatica*.*Ex situ* zaštita najznačajnijih biljnih svojti hrvatske vaskularne flore u našoj je zemlji općenito nezadovoljavajuća i bit će potrebno uložiti znatne napore kako bismo se približili ciljevima Globalne strategije u zadanom roku.

Croatian *Red book*-listed species in *ex situ* conservation of the Botanical Garden, Faculty of Science, University of Zagreb

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The *Red book* of Croatian vascular flora counts 234 taxa that are considered extinct or facing the risk of extinction. The number of World's threatened plants is around one third of all known species, or 100,000 species that may be in danger of extinction. Botanic gardens are recognized as the institutions most concerned with the *ex situ* conservation of wild plant diversity. According to Target 8 of the*Global Strategy* for *Plant Conservation* (GSPC), until 2020 at least 75% of threatened plant species should be conserved in *ex situ* collections of the local botanical gardens. The list of Croatian *Red book*-taxa kept in the collections of our Botanical Garden (Faculty of Science, University of Zagreb)was completed in 2013.The collection of native Croatian protected and strictly protected (97%) taxa in the Botanical Garden currently includes 13.2% species from the *Red book of Croatian vascular flora*.One regionally extinct (RE) species still cultivated in the Botanical Gardenisis *Hippophaë rhamnoides*. There are further 7 taxa (7.8%) considered to be critically endangered (CR), 6 (9.7%) endangered taxa (EN) and 17 (23.9%) vulnerable taxa (VU). Four taxa that are facing the risk of extinction are also endemic in Croatia: *Geranium dalmaticum, Degenia velebitica, Dianthus integer* and *Iris croatica*. The *ex situ* conservation of Croatian most important plant species is today far from effective. Serious efforts should be made in order to achieve the*Target 8* ofGSPC untill 2020.

Josip Kalasancije Schlosser vitez Klekovski - botaničke crtice

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Povodom 205. godišnjice rođenja liječnika Josipa Kalasancija Schlossera željeli smo skrenuti pozornost na njegov doprinos hrvatskoj botanici.
Rođen je 25. siječnja 1808. godine u Jindrihovu u Moravskoj. Već za vrijeme školovanja pokazuje ljubav prema prirodoslovlju, osobito prema botanici. Došavši u Hrvatsku 1836. samo nekoliko godina po završetku studija medicine, Schlosser svaki slobodni trenutak posvećuje istraživanju flore i prikupljanju biljaka u svim krajevima u kojima je boravio. Tijekom brojnih floristićkih istraživanja sa svojim prijateljem i suradnikom Vukotinovićem prikupio je opsežan herbarijski materijal. Znatan dio toga materijala je nekad bio pohranjen u Narodnom muzeju u Zagrebu, a kasnije je predan današnjem Botaničkom zavodu Prirodoslovno-matematičkog fakulteta Sveučilišta u Zagrebu. Mnogi njihovi herbarijski primjerci iz nekadašnje zbirke Narodnog muzeja sačuvani su do današnjih dana u zbirci Herbarium Croaticum. Prva kraća priopćenja o flori Hrvatske počinje objavljivati 1851. godine u Österreishische Botanische Wochenblat, nakon čega slijedi cijeli niz članaka koje je u istom časopisu objavljivao gotovo do smrti. Mnoge je botaničke članke objavio i u drugim stranim, ali i domaćim časopisima, a ubrzo nakon osnutka Jugoslavenske akademije znanosti i umjetnosti 1866. godine, počeo je intenzivno pisati za Akademijin časopis Rad. Zajedno s Vukotinovićem je 1857. objavio Syllabus florae Croaticae koji će postati temelj za njihovo najpoznatije djelo Flora Croatica, objavljeno 12 godina kasnije. Budući da su ova djela pisana latinskim jezikom 1876. godine objavljuju priručnik za sabiranje i određivanje biljaka *Bilinar. Flora Excursoria*, koji je zapravo sažeti prikaz djela *Flora Croatica*, ali pisan na hrvatskom jeziku. Svojim neumornim i predanim radom na polju floristike Schlosser je itekako zadužio hrvatsku botaniku brojnim člancima i knjigama. U tom pogledu je svakako najzaslužnija *Flora Croatica*, djelo koje je uz sve nedostatke, u tadašnje vrijeme, hrvatsku botaniku stavilo u ravnopravni položaj s drugim razvijenijim zemljama.

Josip Kalasancije Schlosser (of Klek Mt) – Contributions to botany

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On the occasion of the 205th anniversary of birth of Dr. Josip Kalasancije Schlosser, we would like to draw attention to his contribution to Croatian botany. Schlosser was born on 25 January 1808 in Jindrichov, Moravia. Ever since his school days, he showed great interest in natural sciences, particularly botany. After moving to Croatia in 1836, only a few years upon completing his medical studies, Schlosser dedicated his entire spare time to exploring flora and collecting plants from all regions he would visit. During the numerous floristic investigations he embarked on together with his friend and associate Vukotinović he collected extensive herbarium material, a significant part of which was initially kept at the National Museum in Zagreb and was later handed over to today's Botany Department of the Faculty of Science, University of Zagreb. Many of their herbarium specimens from the past collection of the National Museum have been preserved to date within the collection *Herbarium Croaticum*. Schlosser began publishing his first short notes on Croatian flora in 1851 in *Österreichisches Botanisches Wochenblatt*, followed by a series of articles he continued publishing in the same journal almost until his final days. Many of his botany ar-

ticles were also published in other journals, both foreign and local, and shortly after the founding of the Yugoslav Academy of Sciences and Arts in 1866 he began writing extensively for its journal *Rad*. In 1857, together with Vukotinović he published *Syllabus Florae Croaticae* which became the basis for their most famous work *Flora Croatica*, published 12 years later. Since these works were written in Latin, in 1876 they published a plant collection and identification guide *Bilinar. Flora Excursoria*, a summarized overview of *Flora Croatica* in the Croatian language. Owing to his great dedication and efforts, as well as numerous articles and books in the field of floristics, Schlosser's contribution to Croatia's botany is extraordinary, with *Flora Croatica*, despite all of its deficiencies, being the work that put Croatia's botany, as early as the 70ies of the 19th century, on an equal footing with other more developed countries.

Novi način prepariranja biljaka epoksidnom smolom

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Na eksperimentiranje epoksidnom smolom u prepariranju herbariziranih biljaka bili smo potaknuti rezultatima postignutim u Prirodnjačkom muzeju Makedonije u Skopju. Botanički odjel Prirodnjačkog muzeja posjeduje zbirku biljaka u poliesterskim smolama, ali podaci o metodologiji prepariranja nisu dostupni i ne postoje u pisanom obliku. U namjeri da oformimo sličnu zbirku koja bi prvenstveno služila u prezentacijske svrhe 2008. godine smo nekoliko mjeseci prikupljali informacije, a zatim počeli s pokusima. Za rad s epoksidnom smolom smo se odlučili zbog njene manje otrovnosti, veće prozirnosti, veće čvrstoće i manje topline koju oslobađa prilikom stvrdnjavanja u odnosu na poliesterske smole. Prvenstvena zamisao je bila prepariranje svježeg biljnog materijala premazivanjem ili uranjanjem u smolu, ali svi pokusi sa svježim biljkama su bili neuspješni zbog kemijske reakcije izazvane biljnim sokovima. Iz tog razloga smo pokuse nastavili isključivo s osušenim, herbariziranim biljkama i biljnim dijelovima. Uz neke sitne tehničke probleme, koji su postupnim razvojem metodologije savladani, rezultati su bili odlični. Ova metoda prepariranja biljaka pruža sasvim nove mogućnosti naročito u prezentaciji, ali i čuvanju herbarijskog materijala, a također omogućuje vjernije i dugotrajnije zadržavanje prirodnog izgleda i boje biljaka.

A new plant preservation method using epoxy resin

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The results achieved at the Macedonian Museum of Natural History in Skopje encouraged us to experiment with epoxy resin in preserving herbarium specimens. The Botany Department of the above Museum owns a collection of plants in polyester resins, but the information on the preservation methodology are not available and do not exist in writing. With the aim of establishing a similar collection that would primarily serve for presentation purposes, we collected information for several months during 2008, after which we started with the experiments. We opted to work with epoxy resin as it is less toxic, more transparent and solid, and releases less heat when hardening compared to polyester resins. Our primary intention was to preserve fresh plant material by coating or immersing it in resin, but all of our experiments with fresh plants failed due to the chemical reactions caused by saps. For this reason, we continued doing experiments exclusively with well dried herbarium specimens and plant parts. Despite some negligible technical issues we dealt with as we gradually developed the methodology, the results were outstanding. This plant preservation method offers completely new possibilities, particularly for presentation purposes, but also for conserving herbarium material and keeping plants' natural appearance and colour as long as possible.

Palinologija – usmena priopćenja
Palinology – oral presentations

Određivanje botaničkog i geografskog podrijetla kontinentalnih medova Hrvatske

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U ljudskoj prehrani med i ostali pčelinji proizvodi dobivaju sve važniju ulogu. Kako bi se na tržište stavljali samo oni proizvodi koji su zdravstveno ispravni provode se različite analize. Analize se provode i u svrhu određivanja geografskog ili botaničkog podrijetla medova. Imajući to na umu analizirali smo 25 uzoraka medova iz kontinentalne Hrvatske s ciljem određivanja njihovog botaničkog i geografskog podrijetla. Određivan je sastav peludnih zrnaca te sadržaj 17 odabranih kemijskih elemenata. Sastav peludnih zrnaca određivan je determinacijom peludi ekstrahirane otapanjem 10 g meda u 20 ml destilirane vode nakon čega se dobivena otopina centrifugira, a dobiveni talog peludnih zrnaca nanosi na mikroskopsko stakalce. Peludna zrnca zatim su fiksirana i obojena pomoću gelvatola te je provedena determinacija pod svjetlosnim mikroskopom. Za potrebe kemijske analize mikrovalnom razgradnjom s koncentriranom dušičnom kiselinom i vodikovim peroksidom razgrađeno je po 5 g meda, nakon čega se dobije bistra otopina. Ta otopina zatim je korištena za određivanje udjela elemenata pomoću metode atomske emisijske spektroskopije uz induktivno spregnutu plazmu. Iz dobivenih rezultata proizlazi zaključak da prilikom utvrđivanja botaničkog i geografskog podrijetla medova nije dovoljno provesti samo palinološku ili samo kemijsku analizu nego je potrebno te dvije analize kombinirati. Ukoliko se provede samo analiza sadržaja kemijskih elemenata nije moguće odrediti ni botaničko ni geografsko podrijetlo uzorka, ali se pomoću te analize mogu uspješno eliminirati pogrešne interpretacije sastava peludnih zrnaca u uzorcima medova. Određivanje preciznog geografskog podrijetla nije moguće zbog sličnosti u sastavu flore, ali se podrijetlo može odrediti na razini regije. Važno je naglasiti da je prilikom interpretacije rezultata analiza potrebno na umu imati metode iz pčelarske prakse kako bi konačan zaključak o podrijetlu meda bio ispravan. Statistička analiza pokazala je grupiranje uzoraka medova u četiri kategorije, tj. cvjetne, bagremove i kestenove medove iz središnje Hrvatske te jedan izdvojeni, kontrolni uzorak iz mediteranske regije.

Determination of botanical and geographical origin of honeys from continental part of Croatia

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In the human diet, honey and other bee products are becoming more and more important. To ensure that products placed on the market are medically correct various analyses are conducted. Analyses are conducted in order to determine the geographical and botanical origin of honey, too. With this in mind, we analysed 25 samples of honey from the Croatian mainland with a view to determining their botanical and geographical origin. We determined the composition of the pollen grains and content of 17 selected chemical elements. The composition of pollen grains was determined by determination of pollen extracted by dissolving 10 g of honey

in 20 ml of distilled water, after which the resulting solution was centrifuged and the precipitated pollen grains were applied to a microscope slide. Pollen grains were then fixed and dyed with gelvatol and determination was performed under light microscopy. For chemical analysis samples of 5 g of honey were digested by microwave digestion with concentrated nitric acid and hydrogen peroxide. After digestion a clear solution was used for the determination of the elements by the method of atomic emission spectroscopy with inductively coupled plasma. From obtained results, we concluded that for determination of botanical and geographical origin of honey neither palynological nor chemical analysis is sufficient, but it is necessary to combine these two analyses. By analysing only the content of chemical elements either botanical or geographical origin of the samples cannot be determined, however using this analysis one can successfully eliminate misinterpretations of the composition of pollen in honey samples. Determining the precise geographical origin is not possible because of the similarity in the composition of the flora, but the origin can be determined at the regional level. It is important to emphasize that while interpretating the results one should keep in mind the methods of beekeeping practices to make a definitive conclusion about the origin of honey. Statistical analysis showed grouping samples of honey into four categories ie floral, acacia and chestnut honeys from the central Croatia and one single control sample from the Mediterranean region.

Morfologija polena i njena taksonomska primjena – primjeri primjene kod rodova *Iris* L. (Iridaceae) i *Hypericum* L. (Hypericaceae)

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Cilj ovog istraživanja bio je utvrditi taksonomski i evolucijski značaj morfoloških značajki peludnih zrnaca kod dva razuličita velika roda: *Iris* L. (Iridaceae) and *Hypericum* L. (Hypericaceae). U tu svrhu morfologija njihovih peludnih zrnaca istražena je pomoću "scanning" elektronske mikroksopije. Peludna zrnca svih svojti roda *Iris* su sulkatna, većinom s retikulatnom ornamentacijom eksine ili rjeđe semitektatne, s varijabilnom skulpturom – bakulama ili gemama. Unutar ovog roda uočeno je nekoliko peludnih tipova, taksonomski značajnih na nivou podrodova, sekcija i serija. Palinološke značajke koje mogu imati taksonomski značaj za različite kategorije unutar roda *Iris* su: oblik suhih peludnih zrnaca, oblik i prosječna veličina vlažnih peludnih zrnaca, prosječna veličina sulkusa (brazde), ornamentacija eksine i membrane brazde. Na temelju tih značajki na svim taksonomskim razinama roda *Iris* sugerirani su potencijalni taksonomski i evolucijski trendovi. Peludna zrnca svojti roda *Hypericum* su najčešće tri-zonokolporatna, s mikroretikulatnom do retikulatnom ornamentacijom eksine. Ipak, neke svojte pokazuju drugačije značajke peluda tj. stvaraju više od tri aperture i stoga gube svoju tipičnu polarnost. Iako ranija istraživanja unutar ovog roda razlikuju čak devet različitih peludnih tipova, opisanih na temelju oblika i tipova endoapertura te ornamentacije eksine, prema našim rezultatima morfologija peluda roda *Hypericum* je uglavnom uniformna i ujednačena unutar i između velikih skupina roda te time filogenetski neinformativna. Ovako različite taksonomske implikacije morfologije peluda kod dva velika roda svakako ukazuju na njihove dosadašnje evolucijske procese, koji će biti komentirani tijekom izlaganja.

Pollen morphology and its taxonomical implications – case studies on the genera *Iris* L. (Iridaceae) and *Hypericum* L. (Hypericaceae)

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The aim of this study was to investigate the taxonomical and evolutionary significance of pollen morphological features. Therefore pollen grains of two different large genera *Iris* L. (Iridaceae) and *Hypericum* L. (Hypericaceae) were studied by scanning electron microscopy. All pollen grains of the genus *Iris* are sulcate with mainly reticulate ornamentation or rarely with more or less partially semitectate exine, with a variable sculpturing – bacula or gemmae, baculae or gemmae. However, several different pollen types were recognized and taxonomically delimited to the specific subgenera, sections and series levels. Palynological features which could have taxonomical importance on different classification levels are: shape of dry pollen grains; shape, outline and approximate size of hydrated pollen grains, approximate size of the sulcus, ornamentation of the sulcus membrane and of the exine. Possible taxonomic and evolutionary implications of pollen morphology of the genus *Iris* were suggested on all classification levels. Pollen grains of the genus *Hypericum* were regularly three-zonocolporate with a microreticulate to reticulate ornamentation pattern. However, some taxa showed some irregularities, they may produce more than three apertures and hence loosed its polarity. Although earlier eleven distinct pollen types, described on the basis of shape, type of endoaperture and ornamentation of exine, according to our results, pollen morphology of the genus *Hypericum* is phylogenetically more or less uninformative. Such different taxonomical implications of pollen morphology within two large groups of plants (genera) would indicate type of their phylogeny and evolutionary processes and will be briefly discussed.

Aerobiološko istraživanje dinamike peludnih alergena na području grada Zadra (Sjeverna Dalmacija, Hrvatska): interakcija s onečišćivačima zraka

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Cilj ovog aerobiološkog istraživanja je analizairati spektar peludnih alergena, sezonsku dinamiku i glavne značajke polinacijskih sezona najzastupljenijih peludnih alergena te njihovu interakciju s onečišćivaćima zraka u atmosferi grada Zadra (sjeverna Dalmacija, Hrvatska). S obzirom na važnost meteoroloških pokazatelja, kao glavnih faktora koji određuju koncentraciju i otpuštanje peludnih zrnaca u zrak, utvrđena je njihova korelacija s koncentracijom peludnih zrnaca. Aerobiološko istraživanje provedeno je u razdoblju od 2006. do 2009. godine pomoću volumetrijskog sedmodnevnog uzorkivaća tipa Hirst. Zabilježena su poledna zrnca 62 svojte, s ukupnom koncentracijom od 179 928 peludnih zrnaca /m^3 zraka. Dominiraju peludna zrnca drveća s udjelom od 78,28%. Najzastupljenije svojte s udjelom većim od 1% su: Cupressaceae/Taxaceae, Urticaceae, *Olea* sp., *Pinus* sp., *Betula* sp., *Platanus* sp., Poaceae, *Ambrosia* sp., *Quercus* sp., *Salix* sp. i *Fraxinus* sp. Izrađen je peludni kalendar za područje grada Zadra. Korelacije između koncentracija peludnih zrnaca i meteoroloških pokazatelja su statistički značajne: uglavnom su pozitivne za tlak zraka, minimalnu, maksimalnu i srednju temperaturu, insolaciju i jačinu vjetra, dok je utjecaj oborina i relativne vlažnosti negativan, osim na peludna zrnca porodica Cupressaceae/Taxaceae. Analiza kakvoće zraka provedena je u razdoblju od 2006. do 2008. godine. Mjereni su SO_2 i dim. Kakvoće zraka grada Zadra pripada I kategoriji. Korelacija onečišćivaća zraka i koncentracije peludnih alergena je statistički značajna, pozitivna između onečišćivača zraka i peludnih alergena porodica Cupressaceae /Taxaceae te svojti *Pinus* sp. i *Platanus* sp., dok je utjecaj onečišćivača na peludne alergene porodice Poaceae negativan.

An aerobiological study of allergenic pollen dynamics in the city of Zadar (North Dalmatia, Croatia): interaction with air pollutants

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The aims of this aerobiological study were to analyze pollen spectrum, seasonal dynamics, characteristics of main pollen seasons (MPS) of the most abundant airborne pollen allergens and their interaction with air pollutants in the atmosphere of Zadar (North Dalmatia, Croatia). According to importance of meteorological parameters (weather conditions) as the main factors which determined concentration and dispersion of pollen grains in the air, the correlation between airborne pollen concentration and meteorological parameters was established as well. The investigation was carried out during the 2006-2009 period using a Hirst-type, seven-day volumetric sampler. Pollen grains of 62 different taxa were identified with total of 179 928 pollen grains. In pollen spectrum dominate tree pollen grains (72,28%). The most abundant taxa with portion of pollen grains higher than 1% were: Cupressaceae/Taxaceae, Urticaceae, *Olea* sp., *Pinus* sp., *Betula* sp., *Platanus* sp., Poaceae, *Ambrosia* sp., *Quercus* sp., *Salix* sp. *and Fraxinus* sp. Pollen calendar for Zadar area was made. Correlations between pollen concentration and meteorological parameters were statistically significant: influence of air pressure, minimal, maximal and mean temperature, insolation and wind were mostly positive and influence of precipitation and relative humidity were negative, except for Cupressaceae/Taxaceae family. Te monitoring of air quality was carried out during 2006-2008. Air pollutant such as SO_2 and black smoke were determinate. Air quality belongs to I category. Correlation between air pollutant and pollen concentration were statistically significant: influence on pollen grains of Cupressaceae/Taxaceae, *Pinus* sp. and *Platanus* sp. was positive, while on pollen grains of Poaceae family was negative.

Pelud masline u zraku grada Zadra, 2007-2009

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U mnogim zemljama Mediterana pelud masline se smatra jednim od jačih alergena koji mogu negativno utjecati na zdravlje lokalnog stanovništva. Budući da na području Zadra ne postoje podaci o koncentracijama peludnih zrnaca masline u zraku, ovaj rad će dati prve aerobiološke podatke za pelud masline za grad Zadar. Aerobiološko istraživanje je provedeno u razdoblju od 2007. do 2009. godine. Uzorci peludnih zrnaca prikupljeni su volumetrijskom metodom po Hirstu. Sezona cvjetanja masline započinje u svibnju, a ukupne godišnje koncentracije peludi masline pokazuju karakterističan dvogodišnji ciklus. Statističkom analizom dobivenih podataka utvrđeno je da postoji korelacija između ukupnih dnevnih i vršnih koncentracija (>50pz/m^3) s maksimalnom i prosječnom temperaturom. Korelacija između ukupnih dnevnih koncentracija i maksimalne i prosječne temperature je statistički značajna u 2007. i 2008. godini, dok 2009. godine korelacija nije utvrđena. Povezanost maksimalne i prosječne temperature i vršnih koncentracija je statistički značajna i pozitivna za 2008. i 2009. godinu, dok 2007. nije utvrđena povezanost što je karakteristično za mediteransko područje. Zbog važnosti masline kao jedne od alergološki najznačajnije svojte na području Mediterana te povećanja nasada maslina na zadarskom području, nužno je nastaviti sa sustavnim aerobiološkim ispitivanjima ovoga tipa.

Olea pollen in the atmosphere of Zadar (Croatia) 2007-2009

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In many Mediterranean countries olive tree pollen is considered to be one of the strongest allergen that can adversely affect the health of the local population. Since there are no data on the concentrations of olive pollen grains in Zadar area, this paper will provide first aerobiological data of olive pollen for the city of Zadar. Aerobiological survey was conducted in the period from 2007 to 2009. Samples of pollen were collected by volumetric method by Hirst. Olive tree flowering begins in May, and the total annual olive pollen concentrations show typical two-year cycle. Statistical data analysis showed that there is a correlation between the total daily and peak concentration (> 50pg/m^3) with maximum and average temperature. The correlation between the total daily concentration with maximum and average temperature is statistically significant in 2007. and 2008, while in 2009 correlation was not found. Connection between the maximum and average temperatures with peak concentrations was statistically significant and positive in 2008 and 2009, whereas in 2007 there was no association. These results are typical for the Mediterranean area. Because of the importance of olives as one of the most significant allergen species in the Mediterranean area and an increase in olive groves in Zadar area, it is necessary to continue with the systematic aerobiological studies of this type.

Palinologija – posterska priopćenja
Palinology – poster presentations

Koncentracija peluda trava (Poaceae) u zraku grada Dubrovnika, Hrvatska (2005-2009)

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Pelud trava (por. Poaceae) smatra se jednim od najvažnijih aeroalergena u Europi. Cilj ovog rada bio je analizirati dinamiku peludne sezone trava u zraku grada Dubrovnika u razdoblju od 2005. do 2009. Pelud je uzorkovana standardiziranom aerobiološkom volumetrijskom metodom, uzorkivačem tipa Hirst (Lanzoni VPSS 2000). Koncentracija peluda izražena je brojem peludnih zrnaca/m^3 zraka. Kako bi odredili međusobnu povezanost dnevnih koncentracija peluda i meteoroloških čimbenika korišten je Spearman-ov test korelacije. Duljina peludne sezone trava tijekom razdoblja istraživanja iznosila je 160 ± 35 dana. Pelud trava prisutna je u zraku grada Dubrovnika od kraja ožujka do početka listopada, iako se i tijekom preostalih mjeseci bilježe pojedinačna peludna zrnca. Polinacijska sezona trava započinje u razdoblju od 25. ožujka do 29. travnja, a završava u razdoblju od 12. kolovoza do 11. listopada. Najviše dnevne koncentracije peluda postignute su u razdoblju od kraja svibnja do kraja lipnja, a iznose između 25 (2009) i 91 (2006 i 2007) peludnih zrnaca/m^3. Godišnja koncentracija peluda trava varira u rasponu od 509 peludnih zrnaca (2009) do 1073 (2006). Prosječna godišnja koncentracija peluda tijekom razdoblja istraživanja iznosila je 791 peludnih zrnaca/m^3. Prosječan godišnji udio peluda trava u ukupnoj koncentraciji peluda iznosio je 4,4%. Najveći udio peluda trava u ukupnoj koncentraciji peluda zabilježen je 2005 (6,0%), a najmanji 2009 (2,1%). Statistički značajan i pozitivan stupanj korelacije s dnevnom koncentracijom peluda trava imala je temperatura, negativan oborina, dok vlaga i brzina vjetra nisu imale utjecaj na dnevne koncentracije peluda. Saznanja o sezonskoj dinamici peluda trava na području Dubrovnika dobivena ovim istraživanjem mogu biti izuzetno korisna u liječenju alergijskih bolesti.

Poaceae pollen concentration in the atmosphere of Dubrovnik, Croatia (2005-2009)

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Pollen from the grass family (Poaceae) is considered to be one of the most important aeroallergens in Europe. The objective of the present work was to analyze the dynamics of the grass pollen season in the atmosphere of the city of Dubrovnik, southern Croatia, in the years 2005-2009. The standardized aerobiological volumetric method of airborne pollen sampling was done by the Hirst sampler (Lanzoni VPSS 2000). The data were collected daily and expressed in grains/m^3 of air. In order to determine the relationship between the daily pollen counts and meteorological parameters Spearman correlation test was used. The length of grass pollen season during the study period was 160 ± 35 days. Grass pollen appears in the Dubrovnik atmosphere from the end of March until beginning of October. In the remaining months only single pollen grains could be detected in the air. The beginning of the main pollen season varied between March 25th and April 29th. End dates were noted

between August 12th and October 11th. The highest daily pollen concentrations were achieved from end of May until end of June, varying between 25 (in 2009) and 91 (in 2006 and 2007) pollen grains/m^3. The values recorded for total annual Poaceae pollen were extremely variable, ranging from 509 grains in 2009 to 1073 in 2006. The average annual pollen count obtained during the period studied was 791 pollen grains/m^3. Grass pollen grains represents only 4.4% of the annual pollen count, the highest proportion was recorded in 2005 (6.0%) and the lowest in 2009 (2.1%). Daily pollen concentrations present significantly positive correlation with temperature, negative with rainfall, and no significant correlation with humidity and wind speed. This study presents the first information about grass pollen season in the city of Dubrovnik which can be useful in the management of pollen related diseases.

Palinološka flora sela Razvor (Hrvatsko zagorje)

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U razdoblju od 2003. do 2004. godine istraživana je flora na području sela Razvor, u Hrvatskom zagorju. Sakupljeno je ukupno 137 svojti višeg bilja, od čega je 3.65 % golosjemenjača i 96.35 % kritosjemenjača. Obavljena je analiza svih sakupljenih svojti te izrađena palinološka zbirka. Od zabilježenih svojti, za njih 35 napravljena je analiza polena. Snimljene su fotografije najboljih preparata polenovih zrnaca te nacrtana polenova zrnca najčešćih svojti. Palinološkom analizom utvrđeno je da je polen 13 (37.14 %) uzoraka poratan, polen 6 (17.14 %) uzoraka kolpatan, polen 14 (40 %) uzoraka kolporatan, i polen 2 (5.71 %) uzorka je inaperturan. Dobiveni rezultati poslužit će kao dopuna podacima u okviru budućeg projekta „Palinološka flora Hrvatske".

Palynological flora of Razvor village (Hrvatsko zagorje)

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During the period from 2003 to 2004 flora of the village Razvor in the region of Hrvatsko zagorje has been explored and collected for the palynological analysis. 137 species of higher plants have been collected, 3.65 % of them are gymnosperms and 96.35 % are angiosperms. All specimens collected have been analysed and classified, and the palynological collection has also been made. Out of all recorded species, 35 of them have been selected for palynological analysis. The best samples of pollen grains have been photographed and drawings of the most common species have been made. The palynological analysis has shown that 13 (37.14 %) samples of pollen grains were porate, 6 (17.14 %) were colpate, 14 (40 %) were colporate and 2 (5.71 %) samples of pollen grains were aporate. Information found can be used as a supplement to the future project "Palynological flora of Croatia".

Pelud kao bioindikator klimatskih promjena. Potencijalna uloga aerobiologije.

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Rasprostranjenost peludi u zraku pod izravnim je utjecajima vremenskih uvjeta dnevnih promjena i općih klimatskih trendova. Promjene u prisutnosti i količini peludi, zbog razlika u klimi, također mogu utjecati na pojavu i ozbiljnost alergijskih bolesti. Istraživanja pokazuju da klimatske promjene utječu na količinu i učinak aeroalergena u peludnoj sezoni. Aerobiološko kontinuirano praćenje prisutnosti peludi u zraku daje precizne podatke o utjecaju klimatskih promjena.
Na Mediteranu, karakteristični klimatski i geografski uvjeti omogućuju razvoj biljaka slabo zastupljenih u srednjoj i sjevernoj Europi (Parietaria, Olea i Cupressus).
Cilj ovog istraživanja je ispitati utjecaj klimatskih čimbenika na rasprostranjenost peludi u zraku temeljem podataka prikupljenih u osmogodišnjem razdoblju na području Splita, uzimajući u obzir godišnje i mjesečne podatke.

Airborne pollen as bioindicator of climate change. Potential role of aerobiology.

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The presence of airborne pollen in the atmosphere is directly affected by weather conditions, not only by daily changes, but also by general climatic trends. Changes in pollination due to variations in climate may also affect the prevelance and severity of allergic diseases. There is evidence that climate change will influence aeroallergens by altering amounts, allergenicity and pollen season. Aerobiologically, continuous monitoring of the airborne pollen presence provides accurate indication of the climate change impact.
Climatic and geographic factors in the Mediterranean area are favorable for the development of the characteristic vegetation that release pollen allergens (Parietaria, Olea, Cupressus) that differ from the taxa of central and northern Europe.
The aim of this study is to evaluate the effects of climate factors on airborne pollen data over a 8-year period at a Mediterranean site, Split, Croatia, considering both, annual and monthly data.

Taksonomija i filogenija – usmena priopćenja

Taxonomy and phylogeny – oral presentations

The variability of morphological characters in populations of *Goniolimon tataricum* (L.) Boiss. (Plumbaginaceae) from the Balkan Peninsula

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Species *Goniolimon tataricum* (L.) Boiss. inhabits subarid area in SE Europe, SW Asia and N Africa. As a steppe relic in the Balkan Peninsula, it grows on relatively small number of scattered localities in Serbia, Macedonia and Bulgaria. It is doubtfully recorded for Greece. Populations of these species inhabit xerophilic serpentinite and limestone rocky grounds in the hilly areas and are characterized by a small number of individuals. The aim of this study was to determine the variability of morphological characters of 13 populations from the distribution area. Variability was determined based on 13 quantitative and 3 qualitative characters. Analysis of the principal components analysis (PCA) revealed a high variability of morphological characters, while no significant differences between populations was observed. Canonical discriminant analysis (CDA) confirmed significant separation of populations from Serbia and Macedonia along the first and second discriminant axes. The length of outer and inner bracts and long teeth bracts are characters that contribute most to the differentiation between the groups. The highest variability and discrimination have been observed in populations from Mt Vujan, which can be explained with the fact that it is the northernmost and westernmost point in the Balkan range of this species. Regardless of these interpopulation differences, it cannot be argued that these are different infraspecific taxa, but that is only present great variability among populations. Qualitative traits (hairiness of calyx, inner and outer bracts) display different frequences among analysed populations, but do not contribute to intraspecific morphological differentiation.

Phenotypic variability in *Silene* L. sect. *Saxifragoideae* Willk. populations from the Central Balkans and its taxonomic significance

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According to numerous literature sources *Silene* L. sect. *Saxifragoideae* Willk. is considered to be a taxonomically complex group, comprising from 15 up to 35 species. The diversity centre of the section lies on the Balkan Peninsula where c. 20 species occur. Unresolved taxonomic statuses are especially related to *S. saxifraga* group that can be divided into two subgroups centered on *S. saxifraga* L. and *S. parnassica* Boiss. & Spruner, respectively. The aim of this study was to examine the characters significant for taxa delimitation, based on quantitative and qualitative morphology. Morphometric analyses of vegetative and reproductive characters were performed on 25 populations from the 6 taxa (4 subspecies of *S. parnassica* Boiss & Sprun. and 2 varieties of *S. saxifraga* L.) from the Central Balkans (Serbia, Montenegro, Republic of Macedonia and Greece). We used Analysis of Variance (ANOVA), Principal Component Analysis (PCA) and Canonical Discriminant Analysis (DCA). Since the first three PCA axes account only for 49.12 % of total variability, the structural variability of analyzed populations appears to be quite complex. Characters proved to be the most useful in taxa delimitation are anthophore, calyx and capsule length.

A morphological study on the endemic species of the *Allium* L. (Sect. *Allium*) in Turkey

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Allium L. (Amaryllidaceae) is one of the large genera of Monocotyledons, it comprises of more than 800 species in the world and 180 of which grow in Turkey. *Allium* is an important genus due to the usages as food, spice, ornamental plants and also as medicinal plants. In the "Flora of Turkey" it has been investigated under 14 sections. Section *Allium* is the largest section of the genus, characterised by the tricuspidate inner filament. The subject of our study is the morphological investigations of 27 endemic species (29 taxa), which are endemic to Turkey. This study has been carried out between 2010-2012, using dried and fresh materials. Our research is mainly based on the specimens of AEF herbarium. A total of c. 300 specimens were examined during this study. Comprehensive descriptions, habitats, geographical maps and detailed illustrations were provided for each taxon.

Phylogenetic evidence for amphi-Adriatic connections in flowering plants

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Contemporary distributions of plants are result of different factors, such as historic geologic activities and climatic fluctuations, biology of the species (different dispersal modes) as well as recent influences, e.g. through human activities. In general, geographically closer areas share a more similar flora than more distant ones and larger water bodies (e.g. seas, oceans) often present barriers for dispersal. Such a barrier is also the Adriatic Sea, but it has been long acknowledged that several species managed to bridge this barrier, resulting in amphi-Adriatic distribution patterns. Traditionally it is assumed that many of these plants have bridged the Adriatic in the Tertiary (Miocene-Pliocene), when southern Italy was connected with the Balkans by a chain of islands across the Otranto Strait. The other, mostly Illyrian species, have more likely spread along the northern Adriatic coast. Some examples of the species (groups) with amphi-Adriatic distribution are the *Campanula garganica* complex, *Cardamine glauca*, *Drypis spinosa*, *Euphorbia barrelieri*, *Gentianella crispata* and *Potentilla apennina*. Some of them were recently studied phylogenetically and hypotheses of close relationships between populations/species from both areas were either confirmed (as in the case of *C. garganica*) or rejected (as in the case of *Androsace mathildae – A. komovensis*). Other phylogenetic studies indicated some additional connections, as in the case of *Knautia visianii* and *K. lucana*. The timing of the diversification events between the Italian and Balkan Peninsula is difficult to assess, but some studies indicate that the dispersal to Italy has likely taken place at different time horizons and is thus not limited to the Tertiary.

An insight into the morphological variability of the Balkan paleo-endemic species *Campanula secundiflora* Vis. & Pančić (Campanulaceae) inferred from traditional and geometric morphometrics

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The Balkan paleo-endemic species *C. secundiflora* Vis. & Pančić belongs to the *Campanula pyramidalis* complex which also includes closely related and morphologically similar species: *C. pyramidalis* L., *C. versicolor* Andrew. and *C. austroadriatica* D. Lakušić & Kovačić. Center of the distribution of this complex is on the Balkan Peninsula while some small disjunct parts of the range lie in the south Apennines. Broad molecular phylogenetic study of *Campanula pyramidalis* complex, showed that populations from continetal part of Montenegro (Morača canyon, Mt. Moračke planine, Mt. Sinjavina, Mt. Kučke Prokletije) which are traditionally considered as *C. pyramidalis*, are closer to *C. secundiflora*, found further inland, in Serbia. This molecular results are consistent with the concept of R. Lakušić who recognized 3 taxa within *Campanula secundiflora* s.l.: i) *C. secundiflora* s.str. from Panjica gorge in SW Serbia; ii) *C. secundiflora* subsp. limensis from canyons of the Lim and Mileševka river in SW Serbia and N Montenegro; iii) *C. secundiflora* subsp. montenegrina from continental part of Montenegro (Mt. Sinjavina and Morača canyon). The aim of this study is to get insight into the morphological variability of *C. secundiflora* by employing traditional and geometric morphometric techniques. Our study confirms that the taxa recognized by R. Lakušić are morphologically differentiated, and that their mophological characters vary with transitions, since the borders of their areas are not clear enough. *C. "montenegrina"* from continetal part of Montenegro is the most variable since it inhabits wider range of altitudes from canyons to high mountains, and presents intermediate form between C. austroadriatica on south-west, *C. secundiflora* on north-east and *C. versicolor* on south-east. Still, there is significant congruence between the results from traditional morphometrics, geometric morphometrics and molecular phylogenetic data.

Modern *Rubus* taxonomy and major tasks to explore the bramble flora of Croatia and Slovenia

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The representatives of the genus *Rubus* L. form a complex of few sexual diploid species and a plenty of polyploid apomicts. New morphotypes originated as result of occasional hybridization can be stabilized by renewed apomixis. The research of the genus was suffered from inaccuracies for a long time, the description of innumerable individual morphotypes caused serious difficulties throughout Europe. Due to a new species concept developed in the last 40 years ("Weberian reform") a scale of distribution extents was established for taxonomic classification: only uniform morphotypes with sufficiently large distribution areas have been classified as species. The authors give an overview on development of taxonomical concepts and special methods of modern *Rubus* research beside a summary of their actual batological activity both in Croatia and in Slovenia.

Genetic relationships within the endemic *Asperula* L. of the "Paleomediterraneae" group (Rubiaceae) from the Mediterranean area

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The representatives of *Asperula* L. sect. *Cynanchicae* (DC.) Boiss. (Rubiaceae) are herbaceous plants distributed across the Europe, northern Africa and southwestern Asia. Within this polymorphic section 17 Mediterranean taxa form informally called "Paleomediterraneae" group. The highest number of "Paleomediterraneae" taxa belongs to the *Asperula staliana* complex, located in the Adriatic Sea. The punctiform distribution of the taxa suggests the contraction of the species range, which probably originate from the late Tertiary. More recent dispersion was hypothesized for *Asperula staliana* complex (Pleistocene). The aim of this study was to re-analyze the present taxonomy of the taxa inside the group based on molecular markers, to explain some species-area biogeographic relationships and to assess the species genetic diversity. All together 25 samples from 15 taxa were analyzed. Various candidate markers was screened in chloroplast (*trnH-psbA*, *matK, trnT-trnL*, *trnL-trnL*, *trnL-trnF* and SG), and nuclear (ITS) DNA regions. Due to absent variability study finally focused on three chloroplast regions (*trnH-psbA*, *matK* and *trnL-trnF*). The total length of concatenated loci is 1723 bp, with 22 variable sites of which five are parsimony informative. Relationships between the samples were explored using classical phylogenetic approaches (Neighbor joining, Maximum likelihood and Bayesian inference) but also using phylogenetic network to evaluate conflicts in dataset. Trees topologies were concurrent and showed strong support mostly in the more distant species (*A. borbasiana* Korica*, A. woloszczakii* Korica*, A. paui* Font Quer*, A. peloritana* Brullo C., Brullo, Giusso & Scuderi*, A. naufraga* Ehrend & Guterm.*, A. deficiens* Viv. and *A. crassifolia* L.). Phylogenetic relationships inside the *Asperula staliana* complex stayed unresolved except from the *A. staliana* subsp. *diomedea* Korica, which is, geographically, the most distant taxa (potentially has been isolated for a longer period). The relationships among more recently isolated species could not be clearly resolved suggesting a very low rate of evolution in this taxonomic group. Network and haplotypes analyses did not show conflicts and highlight 13 haplotypes. However, complementary DNA regions are still required for deeper investigation of related species of "Paleomediterraneae".

Molecular study of *Sesleria autumnalis* species complex (Poaceae)

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The *Sesleria autumnalis* species complex belongs to *Sesleria* sect. *Argenteae* Deyl,"Turma" (=swarm) Argentea. According to Deyl, this Turma comprises the following species: *S. argentea* Savi, *S. autumnalis* (Scop.) F.W. Schultz, *S. latifolia* (Adam.) Degen, *S. pontica* Deyl, *S. alba* Sibth. & Sm. and *S. anatolica* Deyl. In the strict sense, *S.autumnalis* complex includes three closely related and morphologically similar species – *S. autumnalis*, *S. argentea* and *S. tuzsonii* Ujhelyi, which can be easily distinguished from other species of turma Argentea by very

elongated and thin spikes (sometime even ten or more times longer than wider). Although recent relevant floristic literature and check-lists accept the existence of this three species, some authors consider taxa *S. argentea* and *S. tuzonii* as synonyms of *S. autumnalis*. The main aim of this study was to investigate the relationships among populations of the *S. autumnalis* species complex based on Amplified Fragment Length Polymorphism (AFLP) analysis. Our results show a clear differentiation between the Balkan populations (*S. autumnalis* s.str.) and the central and western Mediterranean ones (*S. argentea*, *S. tuzsonii* and *S. autumnalis* s.l.), thus supporting the opinion of those authors who considered that the Balkan and the Apennine populations of *S. autumnalis* are differentiated into two geographically distinct groups. Morphological, taxonomical, and biogeographical implications of these relationships are also discussed.

Resolving a recalcitrant Northern Hemisphere radiation with plastid, mitochondrial, and nuclear data: A new spruce tree and its biogeographic implications

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Studies over the past ten years have shown that most conifer genera are young, with their most recent common ancestors having lived just 15–25 Ma ago. Spruces (*Picea*, Pinaceae), with around 35 species, appear to be no exception. Besides being young, conifers pose a particular phylogenetic problem because of widespread hybridization and introgression. Previous molecular studies of spruce relationships were based mostly on plastid sequences and suffered from poor statistical support. We sequenced carefully sourced material for chloroplast, mitochondrial and nuclear DNA regions, striking a balance between alignability across Pinaceae and phylogenetic signal content. Motif duplications in mitochondrial introns were treated as characters in a stochastic Dollo model. Strict and relaxed-clock models were calibrated with fossils, and ancestral ranges were inferred under maximum likelihood and models of past continental connectivity. *Picea* diverged from its sister clade 180 million years ago (Ma), and the most recent common ancestor of today's spruces dates to 28 Ma. There is a large Asian clade, an American clade, and a Eurasian one. There were two expansions from Asia to North America and several disjunctions between Asia and Europe. Chinese *P. brachytyla*, American *P. engelmannii*, and Norway spruce, *P. abies*, are not monophyletic, and North America has ten, not eight species. Divergence times imply that Pleistocene refugia are unlikely to be the full explanation for the relationships between the European species and their East Asian relatives. Thus, a clade comprising *P. omorika*, *P. orientalis* and Japanese species dates to 16.5 Ma, the time of the mid-Miocene thermal optimum, and northern Norway spruce is part of an Asian species complex that diverged from southern Norway spruce 6 Ma, explaining the genetic gap noted in phylogeographic studies of Norway spruce.

Inferring the origin and diversification of a recent polyploid complex (*Campanula rotundifolia*) using sequenced RAD markers - A project overview

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Polyploidization, the emergence of more than two genome copies per cell, is a major mechanism of speciation in the plant kingdom, and has occurred in around 50 to 70% of all angiosperm lineages. With the development of next-generation sequencing (NGS) technologies and whole-genome screening, important progress has been made in understanding the underlying mechanisms of polyploidization. However, NGS technology has so far not been used to resolve the phylogenetic relationships between recently formed polyploid species or to determine the impact of polyploidization on the evolution of these species. In this starting project, we intend to use RAD sequencing to study polyploidization and its possible effects on the recent diversification of *Campanula* in Eurasian mountains. The *Campanula rotundifolia* group (*Campanula* section *Heterophylla*, Campanulaceae) encompasses some 50-60 diploid to hexaploid taxa whose morphological delimitation has been proven problematic. Whereas most taxa have a restricted distribution in the respective European mountain ranges, some are more widespread, even circum-boreal, either at the diploid (*C. cochleariifolia*) or polyploid levels (*C. scheutzeri*, 4x; *C. rotundifolia*, 2x to 6x). Although these plants have long been used for ornamental purposes, little is known about their origin, their evolutionary relationships and their recent expansion. Recently, it was provided the first comprehensive phylogenetic taxa sampling of *Campanula* and it was reported a common and recent origin for the *Campanula rotundifolia* clade. However, the inferred phylogeny contained many unresolved nodes owing to the inherent deficiency of the included molecular characters. The *Campanula rotundifolia*-group thus constitutes a good model system for assessing the use of NGS-based methods in phylogenetic studies and for studying the evolutionary effects of polyploidization. Here we present an overview of the investigated group, along with the main research questions that will be specifically addressed in this project.

Genetska raznolikost i filogeografija ljekovite kadulje (*Salvia officinalis* L.)

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Salvia officinalis L. je grmolika trajnica prirodno rasprostranjena duž istočne obale Jadrana s izoliranim kontinentalnim populacijama u središnjem Balkanu. Iako je vrsta poznata i upotrebljavana još od vremena antičke Grčke, postoje značajna neslaganja vezano uz filogeniju i genetsku varijabilnost ljekovite kadulje. S ciljem utvrđivanja genetske raznolikosti, populacijske strukture i filogeografije ove vrste, analizirano je ukupno 35 prirodnih populacija primjenom osam SSR biljega i dvije kloropastne međugenske razmaknice (3'*rps*16-5'*trn*K i *rpl*32-*trn*L). Utvrđena je prisutnost 186 mikrosatelitnih alela i 10 kloroplastnih haplotipova. Većina populacija se grupira u skladu s njihovim geografskim smještajem. Populacije Južnog Jadrana pokazuju najvišu razinu genetske varijabilnosti i alelnog bogatstva. Za sve izolirane populacije središnjeg Balkana potvrđeno je njihovo reliktno i prirodno, a ne antropogeno podrijetlo.

Genetic diversity and phylogeography of common sage (*Salvia officinalis* L.)

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Salvia officinalis L. is a perennial shrub native to eastern Adriatic coast with continental disjunctions in the central Balkan. Although knowledge and use of common sage can be dated back to ancient Greece, there is significant confusion concerning its phylogeny and genetic diversity. To obtain evidence of genetic diversity, population structure and phylogeography of this species, 35 natural populations were analysed using eight SSR markers and two chloroplast intergenic spacers (3'*rps*16-5'*trn*K and *rpl*32-*trn*L). A total of 186 SSR alleles and 10 chloroplast haplotypes vere identified. The most of the populations grouped together in accordance with their geographical position. Populations from the South Adriatic showed highest levels of genetic variability and allelic richness. For all disjunct central Balkan populations, their relict and natural, rather than anthropogenic origin, is confirmed.

Rod *Knautia* (Dipsacaceae) – uvid u poliploidnu evoluciju, brzo širenje i opsežan protok gena

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Rod *Knautia* sadrži oko šezdesetak uglavnom europskih vrsta s najvećom raznolikosti u južnoj i jugoistočnoj Europi, pogotovo Alpama i Balkanskom poluotoku. Tradicionalno se smatra jednim od taksonomski najzahtjevnijih europskih rodova zbog česte pojave poliploidije, velikog opsega hibridizacije i pojave morfološki prijelaznih oblika. Cilj ovog rada je pružanje uvida u geografsku i vremensku diversifikaciju roda kao i ispitivanje prethodno postavljenih taksonomskih hipoteza unutar roda temeljenim na morfološkim i kariološkim osobinama. Upotrebom jezgrenih ribosomalnih ITS i kloroplastnih *pet*N(*ycf*6)-*psb*M regija kao i AFLP metode pružamo prvu filogeniju roda *Knautia* kao i njezinu klasifikaciju unutar samog roda. Naši molekularni podatci nedvojbeno podržavaju monofiliju roda, te prisutnost tri glavne razvoje linije. Diploidne jednogodišnje sekcije *Knautia* i *Tricheroides* sadrže samo po nekoliko vrsta, a sekcija *Knautia* nalazi se na bazalnom položaju unutar roda. Većina vrsta pripada višegodišnjoj sekciji *Trichera* gdje je poliploidizacija na tetraploidni i heksaploidni nivo prisutna u gotovo svim tradicionalno priznatim grupama. Opsežno istraživanje ploidnih nivoa otkrilo je da (1) postoje različiti citotipovi unutar nekih svojti koje su prethodno smatrane ploidno uniformne, kao i da je (2) prisutna sličnost veličine genoma u različitim svojtama, s izuzetkom nekih svojti s Iberskog poluotoka. Plastidni i jezgreni podatci pokazuju malu genetsku strukturu s niskom rezolucijom i samo djelomičnom podudarnošću, najvjerojatnije zbog recentne brze radijacije kao i još uvijek prisutne hibridizacije između različitih vrsta. Dobivene genetske grupe djelomično odgovaraju zemljopisnoj pripadnosti ili ekološkim uvjetima. Široka raširenost pojedinih haplotipskih grupa na velikim geografskim područjima ukazuje na recentno i brzo širenje. Također

naši rezultati ukazuju da infragenerička klasifikacija i obuhvat tradicionalno priznatih grupa nisu u podudarnosti s molekularnim podatcima.

The genus *Knautia* (Dipsacaceae) – insights into polyploid evolution, rapid radiation and extensive gene flow

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The genus *Knautia* comprises ca. 60, mostly European species, with highest diversity in southern and southeastern Europe, especially the Alps and the Balkan Peninsula. It is traditionally regarded as one of the taxonomically most challenging European genera due to the widespread occurrence of polyploidy, the high incidence of hybridization and the existence of morphologically intermediate forms. The aim of this study was to provide insights into spatiotemporal diversification of the genus and to test previous infrageneric taxonomic hypotheses based on morphological and karyological traits. Using the nuclear ribosomal internal transcribed spacer (ITS) and the plastid *pet*N(*ycf*6)-*psb*M region as well as amplified fragment length polymorphisms (AFLPs) we provide the first phylogeny of *Knautia* and its infrageneric classification. Our molecular data unambiguously support the monophyly of *Knautia* and the presence of three main lineages. The diploid annual sections *Knautia* and *Tricheroides* comprise only a few taxa; the former is resolved at a basal position. The majority of species belong to the mostly perennial section *Trichera*, where polyploidisation up to the tetra- and hexaploid levels occurred within almost all traditionally recognized groups. Large-scale ploidy-level screening revealed (1) multiple cytotypes within some taxa that were previously considered ploidy-uniform as well as (2) similarity of genome sizes across different taxa belonging to the same ploidy level, with the exception of some Iberian taxa with divergent genome size. The plastid and nuclear datasets inferred a shallow genetic structure with mostly low resolution and only partial congruence, possibly due to recent rapid diversification and still ongoing hybridisation among different taxa. The genetic groups correspond to some extent with geography or ecological requirements. The wide distribution of some haplotype groups spanning large geographical areas implies recent and fast range expansion. Moreover, our results show that infrageneric classification and circumscription of traditional groups are not congruent with molecular data.

Ecology, niche assembly and genetic/epigenetic structure of *Campanula tommasiniana* (Campanulaceae), a narrow endemic of Mt. Učka (NE Adriatic, Liburnian karst)

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Campanula tommasiniana is a typical chasmophyte occupying calcareous rock crevices and cracks along the wide range of various ecological gradients demonstrating high degree of ecological plasticity and stress tolerance with regards to abiotic factors. Generally, three ecologically and floristically distinct groups of stands were

recognized and typified according to sigmatistic approach: (a) *Seslerio juncifoliae-Campanuletum tommasinianae* ass. nov., with stands occupying higher elevated sites fully exposed to sun and strong winds; (b) *Seslerio autumnalis-Campanuletum tommasinianae* ass. nov., representing stands predominantly developed within the thermophytic beech stands, semi- to fully-shaded by the nearby tree canopy; (c) *Cystopteri fragilis-Campanuletum tommasinianae*, sciophytic, moist and cold adapted stands with high frequency and coverage of bryophytes. Results of DCA analyses using unimodal model suggest that *Campanula tommasiniana* is primarily a plant of open and exposed sites of higher elevation despite being most frequently found in rock crevices within the thermophytic and altimontane beech forests. With regard to distinct groups of stands, genetic (AFLP) and epigenetic (MSAP) diversities of the species were assessed, compared and discussed.

Mehanizmi hibridizacije srodnih vrsta: primjer poljskog (*Fraxinus angustifolia* Vahl) i običnog jasena (*Fraxinus excelsior* L.) u Europi

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Drvenaste vrste mogu formirati hibridne zone duž nekoliko stotina kilometara, što često ovisi o ekološkim čimbenicima. Poljski i obični jasen predstavljaju dvije široko rasprostranjene i visoko srodne vrste koje preferiraju različite ekološke uvjete. Međutim, potvrđeno je da ove dvije vrste hibridiziraju kako u laboratorijskim uvjetima, tako i u prirodi kada dolaze u simpatriji. Stoga su izvrstan model za istraživanje mehanizma hibridizacije. Cilj ovog rada bio je identificirati pomoću modela ekološke niše područja simpatrije između poljskog i običnog jasena, u takvim područjima analizirati razinu hibridizacije, te identificirati glavne ekološke čimbenike koji su odgovorni za formiranje hibridnih zona. Analiza genetske populacijske strukture temeljem SSR i EST-SSR biljega otkrila je dva odvojena genska skupa koja pripadaju roditeljskim vrstama, te niz hibridnih populacija u područjima gdje se modeli ekološke niše ove dvije vrste preklapaju. Utvrđeno je da su mraz u siječnju i temperature te padaline ljeti glavni okolišni čimbenici koji utječu na formiranje hibridnih zona. Međutim, rezultati ukazuju da se na kontinentalnoj razini ne može utvrditi jedinstveni obrazac hibridizacije. Ekološki uvjeti na istoku areala manje su pogodni za stvaranje hibrida, te se stoga čini da je hibridizacija asimetrična s tendencijom stvaranja križanaca u umjerenom pojasu u zapadnim i najsjevernijim dijelovima areala poljskog jasena.

Mechanisms of hybridization between closely related species: case study of the common ash (*Fraxinus excelsior* L.) and the narrow-leaved ash (*Fraxinus angustifolia* Vahl) in Europe

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Tree species can form hybrid zones over hundreds of kilometres which are often related to ecological conditions. The narrow-leaved ash and the common ash represent two widely distributed and closely related tree species with divergent ecological preferences. However, hybridization between the two species has been reported experimentally, as well as in nature in zones of sympatry. Therefore, they provide a valuable model for examining the possible mechanisms of hybridization between closely related species. The aims of this study were to identify geographical areas of sympatry between the two ash species predicted by ecological niche modelling at the continental scale, to examine the levels of molecular hybridization in such areas, and to determine the main ecological drivers responsible for the formation of hybrid zones. Population genetic structure analysis based on SSR and EST-SSR markers revealed two separate gene pools associated with the parental species, as well as a range of hybrid populations mostly found within the predicted niche overlap zones. Results suggest that the number of days of frost, summer precipitation and summer temperature are the main ecological factors potentially limiting the extent of the hybrid zones. However, at the continental scale, no clear pattern of hybridization can be assigned. Ecological conditions in southeastern Europe appear to be less favourable for the formation of the hybrids and the identified hybridization pattern seem to be asymmetrical with a bias towards the temperate areas of the western and northernmost distribution of *F. angustifolia*.

Taksonomija i filogenija – posterska priopćenja

Taxonomy and phylogeny – poster presentations

Interpopulation comparative analysis of leaves' morphological properties of black and gray alder (*Alnus glutinosa* L. and *A. incana* (L.) Moench)

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The presence and distinguishness of the native alder species *Alnus incana*, *A. glutinosa* and their hybrid *A.* x *pubescens* in six natural populations in Bosnia and Herzegovina was determined by comparative morphological methods. In this study, 13 quantitative morphological leaves' characters were analyzed. Interspecific significant differences were not determined just for the average length of leaf blades. Tukey's HSD test marked the interspecies hybrids as the statistically significant intermediate different subgroups according to eight significant leaf's characters: width of a leaf blade, distance from the base of a leaf blade to its widest part, distance from the leaf tip to the 3rd vein, number of pairs of lateral veins, upper angle of a leaf, leaf coefficient, ratio length of a leafstalk/ length of a leaf blade, and ratio distance from the leaf tip to the 3rd vein/ width of a leaf blade.

Nove spoznaje o filogeniji roda *Campanula* ser. *Garganicae* (Campanulaceae)

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Rod *Campanula* L. (Campanulaceae) obuhvaća oko 400 vrsta s najvećom raznolikošću u području Mediterana. Jedna od morfološki i filogenetski dobro utvrđenih grupa je amfi-Jadranska grupa s devet endemskih taksona koja pripada rodu *Campanula* sect. *Campanula* ser. *Garganicae* Trinajstić. Taksoni koji pripadaju grupi su: *C. reatina* Lucchese, *C. garganica* Ten., *C. fenestrellata* Feer subsp. *fenestrellata*, *C. fenestrellata* Feer subsp. *istriaca* (Feer) Damboldt, *C. portenschlagiana* Roem. & Schult., *C. poscharskyana* Degen, C. *cephallenica* Feer, *C. acarnanica* Damboldt, *C. debarensis* Rech. f., dok je takson srodan ovoj grupi *C. comosiformis* (Hayek & Janch.) Frajman & Schneew. S obzirom na to da svi proučeni taksoni nastanjuju jedinstvena krška staništa, ova vrsta istraživanja je važna za bolje razumijevanje kompleksne bioraznolikosti i endemizma u ovom području kao i za njihovu učinkovitiju zaštitu. Nedavno je nekoliko molekularno-filogenetskih istraživanja potvrdilo monofiliju grupe i istovremeno utvrdilo slabo razriješene odnose među taksonima kao i nejasne, sukobljene odnose između jezgrine ITS i kloroplastne DNA sekvence. Stoga su u ovoj studiji uključene dodatne populacije koje su analizirane usporedbom jezgrine ITS i kloroplastne *trnL-trnF* DNA sekvence. Dodatno, AFLP metodom provedena je preliminarna analiza na razini populacije kako bi se dobio daljnji uvid u filogenetske odnose unutar grupe. Plastidni i jezgrini setovi podataka se tek djelomično podudaraju, vjerojatno zbog linijskog sortiranja ili hibridizacije. AFLP podaci su jasno razdvojili sve ispitane taksone otkrivajući neke nove linije.

New insights into the phylogenetic relationships within *Campanula* ser. *Garganicae* (Campanulaceae)

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The genus *Campanula* L. (Campanulaceae) includes about 400 species with highest diversity in the Mediterranean area. One of the morphologically and phylogenetically well established is the amphi-Adriatic group of nine endemic taxa belonging to the *Campanula* sect. *Campanula* ser. *Garganicae* Trinajstić. The taxa belonging to this group are: *C. reatina* Lucchese, *C. garganica* Ten., *C. fenestrellata* Feer subsp. *fenestrellata*, *C. fenestrellata* Feer subsp. *istriaca* (Feer) Damboldt, *C. portenschlagiana* Roem. & Schult., *C. poscharskyana* Degen, C. *cephallenica* Feer, *C. acarnanica* Damboldt, *C. debarensis* Rech. f., while the sister taxa to the group is *C. comosiformis* (Hayek & Janch.) Frajman & Schneew. Since all studied taxa inhabit unique karstic habitats, this kind of research is important for better understanding of complex biodiversity and endemism in this area as well as its more efficient protection. Recently several molecular phylogenetic studies confirmed the monophyly of the group and at the same time revealed poorly resolved relationships between taxa as well as conflicting relations between the nuclear ITS and chloroplast DNA sequences. Therefore, in this study additional populations were included. They were analysed comparing their nuclear ITS and chloroplast *trnL-trnF* DNA sequences. In addition, preliminary analysis of AFLP fingerprinting was performed on the population level in order to gain further insight on phylogenetic relationships within this group. The plastid and nuclear datasets were only partly congruent, possibly due to lineage sorting or hybridization. The AFLP data clearly separated all investigated taxa revealing some new lineages.

Srodstveni odnosi i varijabilnost kompleksa *Anthyllis vulneraria* L. s.l. (Fabaceae) u Hrvatskoj i susjednim područjima

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Kako bi se utvrdili srodstveni odnosi svojti kompleksa *Anthyllis vulneraria*, na području Hrvatske i okolice, provedena je molekularna analiza na temelju mikrosatelitnih biljega te metoda komparativne morfometrije. Istraživanje je obuhvatilo ukupno 445 jedinki iz 58 populacija. Srodstveno stablo prema metodi sparivanja susjeda, kao i *Neighbor-Net* dijagram, pokazali su da je boja vjenčića važno determinacijsko svojstvo. Bayesovskom analizom populacijske strukture ustanovljeno je postojanje dvaju dominantnih genskih skupova koji pripadaju skupini populacija sa žutim odnosno crvenim cvijetom. Na temelju mikrosatelitnih biljega trenutna taksonomija svojti unutar kompleksa *A. vulneraria* nije opravdana. Najznačajnija razlikovna svojstva među populacijama su: boja cvijeta, boja i dlakavost čaške, dužina cvijeta, širina čaške, dužina brakteje, dužina terminalne liske lista rozete, stršeća dlakavost stabljike te omjer dužine najgornjeg internodija i dužine stabljike. Podvrsta *alpestris* dobro se razlikuje od ostalih svojti po dimasto sivoj čaški, dok se podvrste *carpatica*, *polyphylla* i *polyphylla 2* međusobno ne razdvajaju. Podvrsta *pulchella* na istraživanom području najvjerojatnije stvara hibridne populacije s podvrstom *alpestris*. Podvrsta *maura* dobro se razlikuje od ostalih crvenocvjetnih svojti po veličini cvijeta i rasporedu listova duž stabljike. Podvrsta *praepropera* na istraživanom području dijeli se na tri geografske skupine: (i) skupina istarskih i sjeverno i srednje dalmatinskih populacija, (ii) skupina južnodalmatinskih populacija, (iii) skupina populacija s pučinskih otoka.

Relationships and variation of the *Anthyllis vulneraria* L. (Fabaceae) species complex in Croatia and neighbouring countries

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Microsatellite markers and comparative morphometry were used to distinguish the subtaxa within the *Anthyllis vulneraria* species complex in Croatia and neighbouring countries. Analyses were carried out on 445 samples from 58 different populations. *Neighbour-Joining* method, based on Nei's distance, as well as the *Neighbor-Net* diagram, indicates that corolla colour is important distinguishing character. Existence of two dominant genetic units was found. Data showed that microsatellite markers do not discriminate the subtaxa within the *A. vulneraria* species complex. According to the morphometrical analysis, the most efficient characters to distinguish subtaxa of *A. vulneraria* were corolla colour, calyx colour and hairiness, flower length, calyx width, bract length, terminal leaflet length of rosette leaf, stem hairiness and uppermost internode length and stem height ratio. The subspecies *alpestris* was well distinguished from others by its smoke-grey calyx, while the subspecies *carpatica*, *polyphylla* and *polyphylla 2* were not separated among themselves. In the area of investigation, the subspecies *pulchella* most probably forms intermediates to subsp. *alpestris*. The subspecis *maura* is well distinguished from other red-flowered taxa by its longer corolla and the evenly distributed leaves along the stem. In Croatia the subspecies *praepropera* forms three different geographical groups: (i) Istrian and North and Central Dalmatian group, (ii) South Dalmatian group, (iii) remote Adriatic islands group.

Morphometric study on *Puccinellia convoluta* (Hornem.) Griseb. and *P. festucaeformis* (Host) Parl. in Italy

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Puccinellia is a genus of about 25-100 species mostly growing in salt, alkaline, brackish wetlands of coastal and inland areas of the northern hemisphere (arctic, temperate regions and Mediterranean). This genus is critical from the taxonomical point of view, showing a high phenotypic plasticity that is related to the particular preferential habitat. The *P. festucaeformis* group is represented by 5 closely related *taxa* with caespitose and glaucous habit, and plicate to convolute leaves. The taxonomic rank of these *taxa* was differently interpreted during the time. For Italy, 3 taxa are recognized: *P. festucaeformis* (Host) Parl., *P. convoluta* (Hornem.) Hayek and *P. gussonei* Parl. The aim of this research is to provide a taxonomic study of the *P. festucaeformis* group in Italy using biometric investigations.Herbarium (APP, FI, RO and PAD) and living specimens (Lazio and Toscana regions) of *P. convoluta* and *P. festucaeformis* from central and northern Italy were analyzed. Other specimens referred to the related *P. distans* (Jacq.) Parl. were measured for a comparison purpose.A morphological analysis, based on 34 characters was performed on 244 specimens for a total of about 8300 measurements. The data matrix so obtained was processed by means of the software NCSS 2007.The Cluster Analysis and PCA clearly separate *P. distans*, while no groups can be distinguished in the *P. festucaeformis* group from the statistical point of view. Further analysis using Box-Plot and Scatter Plot methods (3 main characters: length of the sheath, length of the first glume, and length of the palea of first flower) have confirmed the results of the clustering and the ordination. These results allow us to hypothize that the specimens studied belong to two taxa (*P. distans* and *P. festucaeformis*) reducing the group of the latter to a single taxon.Further investigations on other Italian and European specimens will be needed to confirm the morphometric suppositions. Tests of cultivation, karyological and molecular studies will be also carried out.

Disentangling the *Astragalus monspessulanus* knot (sect. *Incani*, Fabaceae) in Europe by means of morphology and molecules

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Section *Incani* DC. (= Sect. *Proselius* Bunge; Sect. *Myobromopsis* Boriss.; Sect. *Holophyllum* Boriss.) of the genus *Astragalus* L. (Fabaceae) comprises 135 – 150 species and represents species richest group of taxa among medifixed hairy *Astragalus* species (subgenus *Cercidothrix* Bunge), with the Armeno-Iranian floristic province of the Irano-Turanian phytogeographical region in the Middle and Greater Middle East being diversification centre. The species of this section are distributed in Asia, the Middle East, Caucasus, North Africa and Europe. Based on molecular evidence, taxa of the section *Incani* represent a monophyletic clade among medifixed hairy *Astragalus* taxa. Most recent monographic treatment of the European taxa listed only three species (*A. incanus* L., *A. monspessulanus* L. and *A. spruneri* Boiss.) and several other taxa ranked on subspecies level or bellow, distributed mostly in Circum-Mediterranean area. Despite being only a poor reflection of species diversity within the *Astragalus* section *Incani*, complex and ambiguous systematics and nomenclature of European species reflects recognition of different number of taxa, most probably based on diagnostic features of dubious taxonomic relevance. Our research aims at more accurate taxa circumscriptions and their distribution ranges as well as examination of taxonomic relevance of characters used in current systematic treatments. Here, the first results of morphometric and AFLP fingerprinting data based on comprehensive sampling across the whole distribution range of the *Astragalus* section *Incani* in Europe are presented.

Morphometric analysis of nectaries of *Jovibarba heuffelii* (Schott) A. Löve & D. Löve (Crassulaceae)

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The aim of this study was to describe the morphological details of nectaries in different populations of *Jovibarba heuffelii*. For purposes of analysis 14 populations were collected in the area of Serbia, Macedonia, Bulgaria and Romania, the populations were collected from different elevations and soils so that ecological effect on the characteristics of nectaries were taken into account. Morphometric analysis was performed in order to determine whether there is a differentiation between the population on the basis of shape, size and position and in order to point to the possible differences on a subspecies level (varieties or forms) within the species *J. heuffelii*. Quantitative characters of nectaries which were measured were their width, height and the angle under which the nectaries forms with carpel while the qualitative shape and spacing nectaries. The obtained results were analyzed using standard statistical methods such as descriptive statistics, analysis of variance (ANOVA), principal component analysis (PCA), canonical discriminant analysis (CDA) and the cluster method. The results indicate that the quantitative characteristics of nectaries do not lead to differentiation among population, meaning that the measuring of these characteristics is not enough in this kind of morphological analysis. If we also compare

the qualitative characteristics, then we can argue about some of the differences analyzed nectaries. Considering the fact that, so far, the types of nectaries in *J. heuffelii* were not analyzed in this manner, this research represents a huge step forward in their research.

Karyotype analyses of ten taxa of the genus *Jurinea* Cass. from Bulgaria

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One of the richest genera in the Asteraceae family, a part of the tribe Cardueae is the genus *Jurinea* Cass. It comprises about 200 species, widespread in Western and Central Asia, Europe and Northern Africa. The taxonomy of the genus is complicated and not well studied in the whole area of its distribution. This is the reason of the lack of an appropriate taxonomic scheme. In Bulgaria this group is still not investigated very well. A survey of the karyotype of ten taxa: *J. tzar-ferdinandii* Davidov, *J. stoechadifolia* (Bieb.) DC., *J. ledebourii* Bunge, *J. glycacantha* (Sibth. & Sm.) DC., *J. mollis* ssp. *anatolica* (Boiss) Stoj. & Stefanov, *J. consanguinea* ssp. *neicevii* Kozuharov, *J. consanguinea* ssp. *consanguinea*, *J. consanguinea* ssp. *arachnoidea* (Bunge) Kozuharov, *J. consanguinea* ssp. *bulgarica* (Velen.) Kozuharov and *J. albicauls* ssp. *kilaea* (Aznav) Kozuharov, collected from different localities in Bulgaria is conducted. The karyotype was studied on mitotic metaphase plates obtained from root tips of wild collected and transplanted ex-situ plants, and from root tips obtained from germinated seeds collected during 2012 vegetation season.

Varijabilnost krušvine (*Pyrus spinosa* Forssk.) u Hrvatskoj prema morfološkim svojstvima listova

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Istraživana je varijabilnost pet populacija krušvine (*Pyrus spinosa* Forssk.) u Hrvatskoj: Biokovo, Blato na Cetini, Istra, Muć i Vir. Unutarpopulacijska i međupopulacijska varijabilnost utvrđena je na osnovi devet morfoloških značajki listova i tri izvedena omjera, pri čemu su korištene deskriptivne i multivarijatne statističke metode. Provedenim istraživanjem utvrđena je visoka varijabilnost morfoloških značajki listova, a koeficijenti varijabilnosti na razini svih populacija zajedno kretali su se od 10,56% za odnos duljine lisne plojke mjerene od osnove do mjesta najveće širine plojke i duljine lisne plojke do 47,15 % za površinu lisne plojke. Unutarpopulacijska varijabilnost veća je od međupopulacijske za većinu istraživanih značajki. Primjenom multivarijatnih metoda utvrđeno je odvajanje najsjevernije populacije Istra od ostale četiri dalmatinske populacije, što je posebice izraženo u odnosu na najjužniju populaciju Biokovo.

Variation of the Almond Leaved Pear (*Pyrus spinosa* Forssk.) in Croatia according to the morphology of leaves

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The variation of 5 Almond Leaved Pear (*Pyrus spinosa* Forssk.) populations in Croatia (Biokovo, Blato na Cetini, Istria, Muć and Vir) was studied. The intra- and interpopulational variation was estimated according to 9 morphological traits of the leaves and 3 derived ratios. The descriptive and multivariate statistical methods were applied. High variation of the morphological traits of the leaves was found, and the variability coefficients in all populations were ranging between 10,56% for the ratio of leaf blade length measured from the base to the widest point of the blade and leaf blade length up to 47,15% for the leaf blade surface. The variation within populations was greater than among them for most of the examined traits. By applying the multivariate method a differentiation of the northernmost population in Istria from the other 4 Dalmatian populations was found, which is especially observable in relation to the southernmost population on Biokovo.

Ljutike – genetika, morfologija i nomenklatura

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Izraz 'ljutika' u Hrvatskoj označava tri morfološki i genetički različite forme srodne crvenom luku, *Allium cepa* L., koje se uglavnom tradicionalno uzgajaju za prehranu i kao začin: *A. cepa* Aggregatum grupa, (2n = 2x = 16), *A.* x *proliferum* (Moench) Schrad. (2n = 2x = 16) i *A.* x *cornutum* Clementi ex Vis. (2n = 3x = 24). Ovdje su usporedno prikazani rezultati istraživanja njihovih morfo-anatomskih obilježja i genetičke strukture. Iako su sve tri forme ljutike prethodno bile smatrane varijetetima crvenog luka, samo ljutika *A. cepa* Aggregatum skupina (syn. *A. ascalonicum* L.) pripada toj vrsti. Ljutika *A.* x *proliferum* predstavlja križanca između dviju srodnih vrsta, *A. cepa* i *A. fistulosum* L. Treći oblik ljutike, *A.* x *cornutum* je još uvijek nedovoljno razjašnjeni triploidni križanac između *A. cepa* i jedne ili dvije blisko srodne vrste iz roda Allium, sekcija Cepa, a čiji identitet nije u potpunosti razjašnjen. Za razliku od ljutike, *A. cepa* Aggregatum grupa, koja ima normalnu mejozu i stvara plodno sjeme, ljutike – križanci, *A.* x *proliferum* i *A.* x *cornutum* su sterilne, a razmnožavaju se isključivo vegetativno podzemnim lukovicama ili rasplodnim lukovicama iz cvata.

Shallots – genetics, morphology and nomenclature

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Term 'shallot' in Croatia denotes three genetically and morphologically different, vegetatively reproduced relatives of common onion, Allium cepa L., which are mainly traditionally cultivated for consumption and as a spice: *A. cepa* Aggregatum group, (2n=2x=16), *A.* x *proliferum* (Moench) Schrad. (2n=2x=16) and *A.* x *cornutum* Clementi ex Vis. (2n=3x=24). Here we show the results of studies of their morpho-anatomical characteristics and genetic structure. Although all three taxa were determined as varieties of common onion, only shallot *A. cepa* Aggregatum group (syn. A. ascalonicum L.) belongs to that species. The shallot *A.* x *proliferum* represents the hybrid between the two closely related species, *A. cepa* and *A. fistulosum* L. The third form of shallot, *A.* x *cornutum* is still incompletely understood triploid hybrid between *A. cepa* and one or two closely related Allium species, whose identity has not been fully elucidated. In contrast to shallot *A. cepa* Aggregatum group, which has normal meiosis and produces fertile seed, hybrid shallots *A.* x *proliferum* and *A.* x *cornutum* are sterile, and reproduce exclusively vegetatively by underground bulbs or bulbils from the inflorescence.

The variability of terpenes composition of *Juniperus deltoides* Adams populations in Croatia

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Juniperus oxycedrus L. is one of the 14 species of the section *Oxycedrus*. It grows in Mediterranean region, on dry hills or mountainous tracts up to 2,500 m usually not reaching more than 100 km inland, except in Iberian and Balkan peninsulas. Morphological studies have not yet shown significant differences between populations of *J. oxycedrus*, but recent studies of leaf terpenes and molecular markers show clear separation of eastern and western populations. According to Adams, eastern populations of *J. oxycedrus* L. subsp. *oxycedrus* represent in fact the hidden species *J. deltoides* Adams. In this study, essential oils of several Croatian populations of *J. deltoides* Adams were obtained by simultaneous distillation-extraction apparatus, and the composition was determined by GC/MS analysis. Two monoterpenes alpha-pinene and limonene were dominant components, constituting around 45% of the total essential oil. Only few reports exist on composition of essential oil of Croatian populations of *J. deltoides*. Preliminary results show some variation in composition of essential oil between populations, but also a clear separation of not only *J. deltoides* from *J. oxycedrus* but also of *J. oxycedrus* L. subsp. *macrocarpa* (Sibth. & Sm.) Ball. from both of *J. deltoides* and *J. oxycedrus*.

Vegetacija i ekologija – usmena priopćenja

Vegetation and ecology – oral presentations

Early spring ephemeral therophytic non-nitrophilous grasslands as a habitat of various species of *Romulea* in the southern Balkans

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The work deals with habitats of *Romulea bulbocodium* and *Romulea linaresii* ssp. *graeca* in the southern Balkans. Both species appear in early spring ephemeral therophytic non-nitrophilous grasslands in regions under the influence of the Mediterranean climate. These communities are classified within the *Romulion* alliance, which encompasses such communities from the eastern Mediterranean area. It was established that the main climatic factor causing the diversity of these communities is seasonality in precipitation and temperature. Two associations are presented, as *Lagopo-Poetum bulbosae* and *Romuleo graecae-Poetum bulbosae*.

Mediterranean coastal vegetation of woods and maquis in the Adriatic basin

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The research presented here deals with the forest vegetation and maquis occurring along the coasts of the Adriatic basin. Mainly have been considered the communities occurring on limestone rocky coastal areas. These kinds of coasts are common in the eastern side of the basin whereas they are scarce on the western one. The aim was to give a unique picture of vegetation, as exhaustive as possible, based on the current knowledge, but also considering the evolution of the phytosociological method that occurred during the 20th century. In these terms, the introduction of the concepts of vegetation series and landscape allowed to realize syndinamical models. These models allow to better understand the landscape complexity and to evaluate the role of human activities on the current environment status. Vegetation of some calcareous coastal areas of the Italian Adriatic shoreline (Conero, Gargano and Salento) will be compared with the vegetation of eastern side of the basin up to the level of plant association. Moreover, for some aspects of the western coasts, serial and catenal successions will be presented that contribute to create a plant landscape model which can be represented also in a cartographic form.

Kartiranje staništa Ornitološkog rezervata Krapje đol (Park prirode Lonjsko polje)

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Kartiranje staništa Ornitološkog rezervata Krapje đol s pašnjakom Orlinci i utjecajne zone na površini od 158,4 ha provedeno je tijekom 2010. i 2011. godine. Karta je izrađena u mjerilu 1:5000, obradom (delineacijom i vizualnom interpretacijom) ortofoto snimki, uz intenzivno terensko uzorkovanje. Cilj izrade karte bio je dati detaljan prikaz mozaičnosti i raznolikosti stanišnih tipova vodenih i močvarnih zajednica sa svrhom boljeg poznavanja zaštićenog područja i doprinosa budućem upravljanju. Terenskim uzorkovanjem prikupljeni su podaci o staništima i flori na više od 140 lokacija. Na istraživanom području kartirano je 48 stanišnih tipova prema Nacionalnoj klasifikaciji staništa Republike Hrvatske. Na kartiranom području najzastupljenije su, s izuzetkom poljoprivrednih površina, livade djeteline i puzave rosulje *(Trifolio-Agrostidetum stoloniferae* Marković 1973) na pašnjaku Orlinci. Hidrofitska staništa slatkih voda i močvarna staništa zauzimaju gotovo 30 ha. Na području ornitološkog rezervata najzastupljeniji su vrbici rakite (*Salicetum purpureae* Wendelberger-Zelinka 1952), tršćaci obične trske (*Phragmitetum australis* („*vulgaris*“) Soó 1927), poplavne šume vrba (*Salicion albae* Soó 1930) i rogozici uskolisnog rogoza (*Typhetum angustifoliae* Pignatti 1953). Velik broj biljnih svojti zabilježenih terenskim uzrokovanjem i u literaturi koje dolaze u sklopu staništa tršćaka, rogozika, visokih šiljeva i šaševa (21,68%), slobodno plivajućih flotantnih i submerznih hidrofita (6,64%) te zakorijenjene vodenjarske vegetacije (2,65%) ukazuje na dobro razvijene zajednice hidrofitskih i močvarnih staništa. Alohtona i invazivna čivitnjača (*Amorpha fruticosa* L.) prisutna je u značajnoj mjeri: sastojine u kojima dominira zauzimaju gotovo 3 ha, dok ostala staništa u kojima se pojavljuje zauzimaju više od 20 ha.

Habitat mapping of Ornithological reserve Krapje đol (Nature park Lonjsko polje)

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Habitat map of Ornithological reserve Krapje đol, pasture Orlinci and buffer zone (overall area of 158.4 ha) was created during period of 2010-2011. Map was produced at 1:5000 scale by processing digital orthophoto images (delineation and visual interpretation) in combination with intensive field sampling. The objective was to give a detailed presentation of habitat mosaic and habitat diversity related to hydrophytic and wetland communities in order to assure better understanding of protected area and to contribute to its future management. Data on habitats and flora were collected during field sampling at more than 140 locations. According to the National Classification of Habitats of Republic of Croatia, 48 habitat types were mapped on the study area. Meadows with *Trifolio-Agrostidetum stoloniferae* Marković 1973 community, which are present on Orlinci pasture, occupy the largest portion of the study area, with the exception of agricultural land. Hydrophytic freshwater habitats and wetland habitats cover nearly 30 ha. The area of Ornithological reserve Krapje đol is mostly covered with purple willow stands (*Salicetum purpureae* Wendelberger-Zelinka 1952), common reed growths (*Phragmitetum australis* („*vulgaris*“) Soó 1927), riparian willow forests (*Salicion albae* Soó 1930) and narrowleaf cattail growths (*Typhetum angustifoliae* Pignatti 1953). Many plant species sampled in field and recorded in literature for this area are related to habitat types formed by growths of reed, cattail and sedges (21.68%), free-floating and sub-

merged hydrophytic vegetation (6.64%) and rooted hydrophytic vegetation (2.65%), therefore indicating well-developed aquatic and wetland plant communities. Allochthonous and invasive false indigo (*Amorpha fruticosa* L.) is present on substantial area: stands dominated by this species occupy nearly 3 ha, while other habitats where it occurs cover more than 20 ha.

Leaf structure and photosynthetic properties to the intra canopy light gradient in the reserve "Siro Negri" (Italy): comparison among tree species

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The heterogeneous light environment within a tree crown due both to self-shading and to shading by neighboring trees determines leaf trait variations. However, the range of variation is species-specific reflecting the optimization of whole plant resource investment strategy. Most studies of plant response to light have been aimed at underlining ecological implications of the tolerance to the extreme (i.e. tolerance to sun and shade) but noticeably less effort has been invested in exploration of trends in the plastic response to light. The main objective of this research was to analyze leaf morphological and physiological trait variations among the species growing in the Natural Integral Reserve "Siro Negri" (Italy) in term of phenotypic plasticity *sensu* Valladares (2000). The considered forest which in the past largely covered the fluvial valleys along the Ticino river remained untouched for over two decades. The vertical light profile of the forest showed a significant decrease of the photosynthetic photon flux density from the upper tree crown (PPFD > 1500 μmol m^{-2} s^{-1}) to the lower tree crown (PPFD < 600 μmol m^{-2} s^{-1}). All the species had thicker sun leaves compared to shade ones (i.e. 73% higher leaf mass area, LMA, mean value). Leaf thickness could be used as a measure of energy investment per unit of leaf area in full sun conditions, while the larger and thinner shade leaves were more advantageous for light capture under low light. Sun leaves allocated more nitrogen than shade ones as attested by the photosynthetic nitrogen use efficiency (more than 100% higher in sun than in shade leaves) reflecting an increase in carboxylating enzymes (RUBISCO) and proteins, responsible for photosynthetic electron transport in full sun and justifying the significantly higher photosynthetic rates. The ratio respiration/photosynthesis was higher in shade than in sun leaves. The plasticity index (ranging from 0.34 to 0.55) shows significant differences in the response of the considered species to light variations underlining the larger plasticity of *Quercus robur* which might be advantageous in conditions of environmental change.

Utjecaj meteoroloških prilika na listanje i cvjetanje hrasta lužnjaka (*Quercus robur* L.)

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Općenito je poznato da šumsko drveće u rano proljeće zahtjeva određenu sumu topline da bi moglo započeti s otvaranjem pupova i razvojem listova i cvjetova. Prema tome, kašnjenje ili preuranjeno otvaranje pupova neke jedinke u odnosu na ustaljeno kalendarsko vrijeme kada ona obično započinje s listanjem i cvjetanjem ukazuje na to da su meteorološke prilike (prvenstveno temperatura zraka) prije ili u razdoblju otvaranja pupova bile drugačije nego što to obično biva. Prema tome, cilj ovoga istraživanja bio je utvrditi utječu li uz temperaturu zraka i ostali meteorološki čimbenici na početak i trajanje listanja i cvjetanja hrasta lužnjaka. Istraživanje je provedeno u proljeće 2010. i 2011. godine na 172 vegetativno razmnožene jedinke hrasta lužnjaka uzrasle na pokusnoj plohi. Tijekom istraživanja, meteorološke prilike (temperatura zraka, relativna vlažnost zraka, temperatura tla, volumetrijski sadržaj vlage u tlu i količina oborina) precizno su bilježene pomoću automatske meteorološke postaje instalirane na pokusnoj plohi. Na temelju fenoloških motrenja i preciznog bilježenja dnevne temperature zraka razvoj listova i cvjetova za svaku istraživanu biljku definiran je sumom toplinskih jedinica. Utjecaj meteoroloških prilika na početak i trajanje listanja, početak i trajanje razvoja cvjetova (muških i ženskih), početak i trajanje trušenja polena te receptivnosti ženskih cvjetova istražen je regresijskom analizom. S jedne strane, u analizu su uključene razlike u sumi toplinskih jedinica koje su utvrđene oduzimanjem njihovih vrijednosti u 2011. od vrijednosti u 2010. godini za svaku istraživanu biljku. S druge strane, u analizu su bile uključene razlike u ostalim meteorološkim parametrima bilježenim na pokusnoj plohi prije početka ili tijekom razvoja listova i cvjetova u 2010. i 2011. godini. Prilikom utvrđivanja utjecaja meteoroloških prilika na trajanje trušenja polena i receptivnosti ženskih cvjetova primijenjena je gore navedena metodologija uz napomenu da je trajanje trušenja i receptivnosti iskazano u danima, a ne u sumi toplinskih jedinica. Dobiveni rezultati ukazuju da meteorološke prilike utječu na trajanje razvoja listova i cvjetova kao i na trajanje trušenja polena te receptivnost ženskih cvjetova. Međutim, na početak otvaranja lisnih i cvjetnih pupova osim temperature zraka ostali meteorološki čimbenici nisu imali značajnijeg utjecaja. Prema tome, u uvjetima veće vlage tla i veće relativne vlažnosti zraka biljkama je bila potrebna manja suma toplinskih jedinica kako bi dovršile razvoj listova i cvjetova te započele s trušenjem polena i receptivnošću ženskih cvjetova. Biljke koje su bile izložene većoj relativnoj vlažnosti zraka u završnoj fazi razvoja muških cvjetova (pet dana prije početka trušenja) duže vremena su trusile polen. Veća količina oborina, veća vlaga u tlu i relativna vlažnost zraka u fazi receptivnosti ženskih cvjetova pozitivno su utjecale na trajanje receptivnosti.

Influence of meteorological conditions on flushing and flowering of pedunculate oak (*Quercus robur* L.)

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It is a generally known that in the early spring forest trees require a certain amount of heat in order to be able to start flushing and flowering. Thus, premature or delayed bud burst of a certain plant, as opposed to its regular calendar date of bud burst, indicates a divergence from the norm in the weather conditions before or during the bud burst. Therefore, the aim of this research was to determine whether the other weather conditions, aside the air temperature, affects the beginning and duration of the Pedunculate oak's flushing and flowering. The research was conducted in the spring of 2010 and 2011 on 172 vegetatively propagated plants of Pedunculate oak grown on a field trail. During the research, the weather conditions (air temperature, air humidity, soil tempera-

ture, soil water content and the amount of precipitation) were continuously recorded by an automatic weather station installed on the field trial. Based on the phenologic observations and the recording of the weather conditions, the development of leaves and flowers for each plant under study is defined by the sum of heat units. The impact of the weather conditions on the beginning and the duration of flushing and flowering (male and female ones), as well as the beginning and the duration of the pollen shedding and the receptivity of the female flowers was analyzed using the regression analysis. Analysis includes variations in the sum of heat units determined by subtracting their values in the year 2011 from the values in 2010, and it includes variations in weather conditions also recorded in aforementioned years before the onset or during the flushing and flowering. To estimate the influence of weather conditions on the duration of pollen shedding and female flower receptivity period, the aforementioned methodology was used, with a footnote that the period of shedding and the receptivity is given in days, and not in the sum of heat units. Obtained results indicate that the weather conditions affected duration of leaves and flowers development, pollen shedding and receptivity of female flowers, but did not affect the beginning of bud burst (except air temperature). Accordingly, in the conditions of higer soil and air humidity, plants required a smaller sum of heat units in order to finish the development of leaves and flowers and start with the pollen shedding and female flower receptivity. Plants which were exposed to the higher air humidity in the final stages of male flower development (five days before starting to shed pollen) shed pollen longer than the others. The increased amount of precipitation, higher soil water content as well as higher air humidity in the female flower receptivity phase had a positive effect on the length of receptivity.

Analiza vegetacijskih promjena u parkovima prirode Telašćica i Vransko jezero

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Uslijed prestanka antropogenog djelovanja, mnoge brdske i otočke travnjake počinje prerastati šikara i šuma. Dolazi do procesa sekundarne progresivne sukcesije te biljke prilagođene na otvorena staništa nestaju. NATURA 2000 propisuje razne mjere očuvanja takvih ugroženih staništa upravo s ciljem sačuvanja biološke raznolikosti vegetacijskih površina. Istraživanjem su određene kvalitativne i kvantitativne promjene tijekom posljednjih 40 godina u vegetacijskom pokrovu Parka prirode Telašćica i Parka prirode Vransko jezero. Analiza je napravljena usporedbom povijesnih vegetacijskih karata rađenih na razini asocijacija i recentnih karata staništa Parkova rađenih na različitim razinama. Usklađivanje tematskog razlučenja korištenih podloga je rađeno usklađivanjem klasa na najnižu zajedničku razinu. Cjelokupna analiza napravljena je korištenjem programa GIS SAGA i Excel. Na području Parka prirode Telašćica zabilježen je izraziti pad udjela travnjaka za 32,97 % ukupne površine Parka, pri čemu se površina travnjaka prepolovila (51,51 %) s obzirom na početnu, te povećanje prijelaznog tipa travnjaci/dračici za 27,88 % ukupne površine Parka (1620,76 % povećanje na razini tipa). Analiza smjera promjena potvrđuje da je 32,78 % travnjaka zaraslo u travnjake/dračike, 45,43 % je ostalo u travnjačkom tipu, dok je promjena u druge tipove zabilježena u manjim postotcima. Mediteranske šikare su se degradirale u prijelaz travnjaci/dračici za 27,03 %, 24,32 % je ostalo u tipu šikara, a 27,03 % je zaraslo u šume i makije. Na području Parka prirode Vransko jezero uočeno je smanjenje travnjaka za 16,31 % ukupne površine Parka, pri čemu se površina travnjaka izrazito smanjila (za 94,78 %) s obzirom na početnu, te povećanje šikara za 25,41 % ukupne površine Parka (3104,30 % povećanje na razini tipa). Analiza smjera promjena pokazuje da su svi travnjaci prešli u drugi vegetacijski tip, a najviše u šume i makije, 24,96 %, dok je čak 53,76 % kultiviranih površina prešlo u šikare. Ovim istraživanjem su nedvojbeno potvrđeni znatni procesi sekundarne progresivne sukcesije u Parku prirode Telašćica i Parku prirode Vransko jezero, koji ukazuju na nužnost bitnih provođenja mjera zaštite travnjačkih staništa.

Vegetation change analysis in Telašćica and Vransko jezero nature parks

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Due to the cessation of anthropogenic activities, many mountain and island grassland begins growing into scrubs and forests. It comes to the process of secondary progressive succession so plants adapted to open habitats disappear. NATURA 2000 prescribes various measures to conserve these endangered habitats precisely in order to preserve the biodiversity of vegetation areas. The study has determined the qualitative and quantitative changes in the last 40 years in the vegetation cover of the Telašćica and Vransko jezero Nature Parks. The analysis was made by comparing the historical vegetation maps made at the level of association and recent habitat maps of Parks mapped on different levels. Aligning thematic differentiation of used maps was done adjusting classes to the lowest common level. Overall analysis was done using the computer programs SAGA GIS and Excel. In the area of Telašćica Nature Park grasslands have decreased by 32.97 % of total Park area, with a grasslands significantly reduced (by 51.51 %) with respect to the initial area, and transitional grasslands/scrubs have increased by 27.88 % of total Park area (1620.76 % increase in the level type). The directional change analysis confirms that the 32.78 % of grasslands overgrown with transitional grassland/scrubs, 45.43% remained in grassland type, while changes to other types were recorded in smaller percentages. Mediterranean scrubs are degraded with transitional grasslands/scrubs by 27.03 %, 24.32 % remained in the type of scrubs, and 27.03% was overgrown with trees and underbrush. In the area of Vransko jezero Nature Park grasslands have decreased by 16.31 % of total Park area, with a grasslands markedly decreased (by 94.78 %) with respect to the initial area, and scrubs have increased by 25.41 % of total Park area (3104.30 % increase in the level type). The directional change analysis shows that all of the grasslands crossed to a different vegetation type, and most in the trees and underbrush, by 24.96%, and 53.76% of cultivated areas crossed into scrubs. This study clearly confirmed the significant processes of secondary progressive succession in the Telašćica and Vransko jezero Nature Parks, indicating the necessity of implementing essential measures to protect grassland habitats.

Physiological responses of five Holm oak (*Quercus ilex* L.) ecotypes to seasonal climatic factor variation

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In the Mediterranean ecosystems air temperature is a very important environmental driver for photosynthetic capacity due to the interaction with environmental stressors. Extreme temperature values may significantly affect Mediterranean plant productivity and distribution. *Quercus ilex* L. is a deep-rooted evergreen species, widely distributed in the Mediterranean Basin. It seems to be limited in its southern range by summer drought and in altitude by climatic factors associated with low temperatures. The physiological adaptability of *Q. ilex* to high temperature is very important for its future persistence in the distribution area, taking also into consideration the forecasted increase of climate change-based aridity in the Mediterranean Basin. The adaptive response to temperature depends also on the intra-specific variations due to the presence of ecotypes in the *Q. ilex* population (i.e. ecotypic variation). Nevertheless, few studies have been carried out to compare physiological traits of ecotypes coming from different climatic conditions and growing in the same environment. Our goal

was to analyse seasonal differences in the temperature response of five *Q. ilex* ecotypes from different Italian geographical areas (north to south gradient) in order to test if ecotypes maintained their specific physiological responses when grew all in the same environmental conditions and to evaluate which was the most adapted to global change among them. The study was carried out on 3-year-old saplings germinated from acorns collected in five sites from the north to the south of Italy and grown under the same climatic conditions. Measurements of gas exchange, biochemistry and chlorophyll fluorescence were carried out during wintertime, springtime and summertime to analyse the ecotypic responses to seasonal air temperature variations. Moreover, a net assimilation – stomatal conductance model was applied to ecotypes in order to analyse net assimilation rates in relation to their site of provenance. The results showed different ecotypic responses that reflected the climate of the native sites, particularly under sub-optimal temperature conditions. The ecotypes coming from the northernmost and the southernmost limits were the most sensitive to temperature variations. Our results give new insights regarding the shift of *Q. ilex* distribution throughout Italy with ecotypes more adapted to climate change defining new boundaries.

Fitocenološka istraživanja travnjaka Ćićarije: promjene floističkog sastava uslijed različitog načina korištenja

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Cilj istraživanja bio je utvrditi fitocenološki sastav travnjaka (livada košanica i pašnjaka) Ćićarije i istražiti utjecaj različitog načina korištenja travnjačkih zajednica na njihov floristički sastav. Da bi postigli ciljeve istraživanja napravljene su na 103 vegetacijske snimke sa pripadajućim okolišnim podacima (nadmorska visina te sjevernost, nagib i morfologija terena), kao i podacima o načinu (košnja/ispaša) i kontinuitetu (redovito se koristi/ne koristi se redovito) korištenja. Multivarijatnom analizom fitocenoloških snimaka utvrđene su četiri vegetacijske zajednice: *Danthonio-Scorzoneretum villosae*, *Carici humilis-Centaureetum rupestris* i njezina varijanta s vrstom *Brachypodium rupestre* (red *Scorzoneretalia villosae*, razred *Festuco-Brometea*) te *Anthoxantho-Brometum erecti* (red *Arrhenatheretalia*, razred *Molinio-Arrhenatheretea*). Ustanovljena varijabilnost floristićkih podataka bolje se može objasniti okolišnim parametrima nego načinom korištenja. Usvojen sustav gospodarenja je zapravo uvjetovan gradijentom vlažnosti tla/produktivnosti. Pojava invazivne vrste *Brachypodium rupestre* na napuštenim površinama istraživanih travnjaka posljedica je niskog intenziteta korištenja travnjaka (niski novo ispaše i povremena košnja). Unatoč činjenici da se travnjaci na Ćićariji uglavnom koriste ekstenzivno, oni pružaju krmu dobre kvalitete. U floristićkom sastavu istraživanih zajednica nalazi se velik broj proteinom bogatih vrsta iz porodice *Fabaceae* (*Anthyllis vulneraria, Hippocrepis comosa, Lotus corniculatus* ssp. *hirsutus*) i porodice *Asteraceae* (*Scorzonera villosa*). Iako je produktivnost travnjaka na Ćićariji relativno niska, njihova velika rasprostranjenost i dobra hranjivost čine ih značajnom krmom za ekološku prizvodnju ovčjeg mlijeka i mesa. Stoga se može zaključiti da poznavanje fitocenološkog i funkcionalnog sastava biljnih zajednica može doprinijeti optimizaciji planova gospodarenja travnjacima Ćićarije.

Coenological research on Ćićarija grasslands: change in floristic composition under different management regimes

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The research aims were to determine coenological composition of grassland communities, and to assess the effects of different management on grassland floristic composition. To achieve these aims, 103 phytosociological relevés were carried out; for each of them field data (altitude, aspect, slope, landform) and information on grassland management (mowing / grazing) and continuity of use (regularly used/not regularly used) were collected. Multivariate analysis of phytosociological relevés led to the identification of four vegetation types: ass. *Danthonio-Scorzoneretum villosae*, ass. *Carici humilis-Centaureetum rupestris* and its variant with *Brachypodium rupestre* (order *Scorzoneretalia villosae*, class *Festuco-Brometea*), and ass. *Anthoxantho-Brometum erecti* (order *Arrhenatheretalia*, class *Molinio-Arrhenatheretea*). The variability of floristic data set was better explained by environmental parameters than by management and continuity. The management system adopted appears in turn to be conditioned by the soil moisture/productivity gradient. The occurrence of the invasive species *Brachypodium rupestre* in Ćićarija unmanaged grassland communities could be explained because of the low intensity use of grassland (undergrazing and non-periodic mowing). Despite the fact that these grasslands are used extensively, they provide fodder of good quality. In its floristic composition there is a large spread of the protein-rich species from the *Fabaceae* family (*Anthyllis vulneraria*, *Hippocrepis comosa, Lotus corniculatus* ssp. *hirsutus*) and *Asteraceae* family (*Scorzonera villosa*). Although the relatively low productivity of grasslands, their wide distribution and good nutrition value makes it an interesting fodder for ecological production of sheep's milk and meat. We can conclude consequently the understanding of plant community coenological and functional composition can contribute to optimizing grassland management plans.

The reproductive success of three Orchid species in Hungary

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Orchids are frequently used models in plant autecology and evolutionary biology. The generally used method of quantifying their reproductive success is determinig fruit set. However, providing capsular and total seed numbers of specimens may give further information. Nevertheless, reproductive success of orchids has an undoubted conservational importance, because most of the species are rare and endangered. Previous studies proved pollination mode as the main predictor of reproductive success based on fruit set. We present the main results of our study on the reproductive success of the deceptive *Dactylorhiza majalis* (Rchb.) Hunt & Summerhayes and *D. sambucina* (L.) Soó and the nectar rewarding *Platanthera bifolia* (L.) L. C. Rich. Field studies were carried out in the Bükk Mountains, Hungary in 2010-2012. Individual fruit set, height and inflorescence length and population density were measured and population size was estimated. Capsular seed numbers were calculated, which provided the basis for estimation of the individual total seed number. Correlations with traits (height, inflorescence length, population density) were calculated. Although, our fruit set data followed the

European trend, as *P. bifolia* had the highest and *D. sambucina* the lowest value, we did not find significant differences between reproductive success of the three species. The above mentioned European fruit set data was significantly lower in case of the two deceptiv species than Hungarian values which may be explained by the minor rate of pollinator limitation in the Bükk . Only *D. majalis* had significant difference between the years in seed set, and significant correlations between all traits and fruit set. Concerning capsular and total seed number, the species were significantly different from each other. Fruit sets, capsular and total seed numbers of the species did not always show decline in dry years. Even where they did, differences were statistically non-significant. However, considering the number of flowering individuals as well, a substantial decline can be observed in total seed numbers of the populations.

Osvrt na invazivno ponašanje bagrema (*Robinia pseudoacacia* L.) u Hrvatskoj

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Bagrem potječe iz Sjeverne Amerike, a u Europu je unesen 1601. godine kao ukrasno drvo. Iz literaturnih podataka je vidljivo da je bagrem u Hrvatskoj flori prisutan dulje od 150 godina. Kao i u mnogim drugim zemljama, sadio se za kontrolu erozije, drvnu građu, kao ukrasno drvo i medonosna biljka, te se prilično uspješno naturalizirao. Trenutno je rasprostranjen po cijeloj Hrvatskoj te dolazi na različitim staništima. Analiza rasprostranjenosti pokazuje da je 45 % nalaza zabilježeno u mješovitim hrastovo-grabovim i čistim grabovim šumama, te se također velik broj nalaza (oko 35 %) bilježi na staništima usko vezanim uz ljudsku aktivnost. Iako visinski dolazi u rasponu od 0-900 m, najveći broj nalaza (80 %) bilježi se u rasponu od 90-400 m, što se podudara sa pojasom hrastovo-grabovih šuma. Visinska rasprostranjenost je u skladu s termofilnim karakterom bagrema, te najveći broj nalazišta pripada područjima sa srednjom godišnjom temperaturom 9-14 °C. Poznato je da je bagrem vrsta svjetla te da može rasti na vrlo različitim tlima, pa čak i na jako siromašnim. Stvara veliki broj sjemenki koje se akumuliraju u tlu u obliku trajne banke sjemena. Uzorci tla uzeti iz sastojina bagrema s grabom u Maksimiru (Zagreb) sadržavali su do 1400 sjemenki po 1 dm^3 uzorka, a sjemenke su pokazale jako veliku klijavost (nakon skarifikacije, 89-100 %). Vegetativni rasplod je također vrlo uspješan – poznato je da bagrem lako stvara izdanke iz debla i korijena koji vrlo brzo rastu. Također, sadrži nekoliko tvari koje pokazuju alelopatsku aktivnost, te je alelopatski potencijal uočen i u našim istraživanjima. Bagrem vrlo uspješno i u velikoj množini zaposjeda otvorene prostore, te se kao takav smatra invazivnom vrstom. Potencijalne posljedice dominacije bagrema su: povećanje količine dušika u ekosistemu što utječe na sastav flore te pogoduje nitrofilnim/invazivnim vrstama, smanjenje raznolikosti flore u odnosu na autohtone zajednice, progresivna sukcesija otvorenih ekosustava i posljedično smanjenje bioraznolikosti. U Hrvatskoj, bagrem najvjerojatnije dugoročno ne predstavlja prijetnju za šumske ekosustave, no mogao bi biti vrlo problematičan u kontekstu zaraštavanja otvorenih ekosustava. Mjere za njegovo suzbijanje morale bi uključivati ograničavanje uzgoja i sadnje, izbjegavanje čiste sječe, te aktivno poticanje tradicionalne poljoprivrede u svrhu sprječavanja zaraštavanja otvorenih prostora.

The overview of the invasive behaviour of black locust (*Robinia pseudoacacia* L.) in Croatia

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Black locust originates from Northern America and was introduced to Europe in 1601 as an ornamental tree. Literature data show presence of black locust in Croatia for more than 150 years. As in many other countries, the tree was planted for erosion control, as an ornamental tree, for lumber and honey production, and became very successfully naturalized. Nowadays black locust is distributed throughout the whole Croatia, growing in different habitats. Distribution analysis shows that 45 % of findings are located in mixed oak-hornbeam and pure hornbeam stands, while many findings (around 35 %) are located in areas closely associated with human activity. Although its altitudinal occurrence in Croatia is 0-900 m, the majority of findings (80 %) are located between 90-400 m, which corresponds with the oak-hornbeam forest belt. The altitudinal distribution is in accordance with its termophilous character, and majority of findings belong to areas with mean annual temperature of 9-14 °C. Black locust is heliophilous and succeeds on a variety of soil types, including poor soils. It produces a large amount of seeds, accumulated in the soil in a form of a persistent seed bank. Samples taken from locust-hornbeam stands in Maksimir (Zagreb) contained up to 1400 locust seeds per 1 dm^3 of soil, highly viable with a germination rate (after scarification) of 89-100 %. Vegetative reproduction is also highly successful, as locust readily forms fast growing sprouts from roots and trunk. Locust contains several compounds with known allelopatic activity, and alelopatic potential is also found in our studies. Black locust spreads over open areas with great success, for which it is considered invasive. Potential outcomes of locust domination are: addition of nitrogen in the ecosystem which influences floristic composition and favours nitrophilous/invasive species, loss of diversity compared to native communities, progressive succession of open areas and consequential loss of biodiversity. In Croatia, black locust is probably not a threat to forests, but could be a problem in the context of overgrowing open habitats. The measures for locust control should include limitation of cultivation and planting, avoidance of clear-cuts and active encouragement of traditional agriculture as a mechanism against succession.

Šumske zajednice crne johe (*Alnus glutinosa* (L.) Gaertner) u kolinskom pojasu srednje Hrvatske

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Šume crne johe uz vodotoke kolinskoga pojasa su u Hrvatskoj do sada opisivane kao makroasocijacija *Carici brizoidis-Alnetum glutinosae* ili pod općenitim imenom *Alnetum glutinosae* s.l. Novijim istraživanjima na području Zrinske gore ustanovljena je srednjoeuropska zajednica *Stellario nemorum-Alnetum glutinosae*. Crnojohove sastojine rasprostiru se na tlima zasićenim površinskom i visokom podzemnom vodom koja se slijeva s okolnih padina ili na povremeno plavljenim terasama uz potoke i manje rijeke. U takvim sastojinama uz vrste povremeno poplavnih i vlažnih staništa česte su vrste okolnih kitnjakovo-grabovih i bukovih šuma. Prema načelima standardne srednjoeuropske škole provedena su istraživanja sastojina crne johe uz vodotoke srednje i dijela sjeverozapadne Hrvatske kako bi se utvrdila njihova floristička građa i sinekološki uvjeti, a uz upotrebu statističkih metoda (Primer 6, JUICE 7.0, R, Statistica 8.0) njihova međusobna usporedba i sinsistermatska pripadnost odgovarajućim sintaksonima.

Forest communities of black alder (*Alnus glutinosa* (L.) Gaertner) in the colline belt of central Croatia

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Alder forests along the watercourses in the colline belt of Croatia have so far been described as the macroassociation *Carici brizoidis-Alnetum glutinosae* or under the general name *Alnetum glutinosae* s.l. The Central European association *Stellario nemorum-Alnetum glutinosae* was established by recent studies on Zrinska Gora Mt. Black alder stands are distributed both on soils saturated with surface and high ground water flowing from the surrounding slopes and on the occasionally flooded terraces along the streams and smaller rivers. In these types of stands with floodplain and wetland species, species from the surrounding sessile oak-hornbeam and beech forests are also common. According to the principles of the standard Central European School, alder stands along the streams in Central and parts of north-western Croatia were researched in order to determine their floristic structure and synecological conditions.Statistical methods (Primer 6, JUICE 7.0, R, Statistica 8.0) were used to make their mutual comparison and establish the synsystematic affiliation with the appropriate syntaxa.

Vegetacija i ekologija – posterska priopćenja

Vegetation and ecology – poster presentation

Syntaxonomy of the vegetation of the Italian Adriatic coast

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The research deals with the description of the saline vegetation of the Italian Adriatic coast. Adriatic coastal vegetation has notable affinities in all the basin because of common geological and floristic history, nevertheless there are also remarkable differences regarding the left and the right coasts. The research demonstrates that these differences are due both to biogeographic and bioclimatic reasons. In fact, on a biogeographical view, this part of the Mediterranean basin is divided in two regions: Eurosiberian and Mediterranean. The former one is limited to the northern part of the Adriatic basin with different biogeographic provinces whereas the latter is represented only by the Adriatic province with the two Apulian and Epiro-Dalmatian sub-provinces. Bioclimatic classification highlights a north-south gradient that ranges from a temperate oceanic macro-bioclimate occurring in the northernmost territories, through the submediterranean variant, to the south part that is interested by pluvial seasonal Mediterranean macrobioclimate. These different characteristics affect periadriatic areas that differentiate also on the basis of geomorphological features of the coast: in the eastern Adriatic shoreline high rocky coasts prevail whereas in the western one lower sedimentary coasts are more common. In the results, a syntaxonomical scheme of the coastal vegetation is presented according to the huge literature published by authors of several Adriatic countries. It will allow focusing on the state of knowledge achieved on the Adriatic coastal vegetation. In the conclusions, according to the syntaxonomical scheme presented, the variety of coastal habitats occurring in the Adriatic basin in accordance with the Directive 92/43/CEE will be discussed, in order to underline the high value in biodiversity terms.

New insights into the biogeography of the genus *Edraianthus* (*Campanulaceae*) using GIS and environmental modelling

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The genus *Edraianthus* (Campanulaceae) has the centre of its distribution in western Balkans with disjunctions in the Apennines, Sicily and Southern Carpathians. It has been extensively studied since the end of the 19th century. Initially, particular interests were raised totaxonomical and chorological problems, while recent research efforts have been focused on phylogenetic and phylogeographic relationships, both between the closely related genera, and within the genus. Furthermore, quaternary range shift patterns of some representatives were studied based on the molecular data. Consequently, accurate published data on *Edraianthus* species occurrences are today available along with existing herbarium specimen collections. The development of GIS software allows us to properly collect and process such data and when combined with environmental data and ecological niche modelling (ENM) we can predict species distribution in a geographic space according to a prediction of their environmental space. Models projected to past environmental conditions can help understanding late quaternary range shifts and to locate potential Pleistocene refugia. Here we present the results of our work on the

distribution of *Edraianthus tenuifolius* using GIS methodology with available environmental data. Combining GIS with standard statistic methods allows us to recognize distributional patterns or biogeographically distinct entities.

Sintaksonomska revizija i florističke značajke biljnih asocijacija termofilnih poplavnih šikara vegetacijske sveze *Viticion agni-casti* Lakušić 1975

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Šikare s konopljikom (*Vitex agnus-castus* L.) u primorskom dijelu jugoistočnih Dinarida objedininjene su u svezu *Viticion agni-casti* Lakušić 1975. Položaj sveze i njezinih asocijacija, od kojih neke nisu validno objavljene, do sada nije bio jasan. Razlog tomu, između ostaloga, jest eurivalentnost vrste *Vitexagnus-castus*, pa je sveza floristički i ekološki vrlo varijabilna. Najčešće je priključivana redovima *Salicetea purpureae* Moor 1958 ili *Populetalia albae* Braun-Blanquet 1931, dok su izvorno naglašavane značajke reda *Platanetalia orientalis* Knapp 1959 upitne. Na temelju literaturnih podataka i vlastitih istraživanja u Hrvatskoj, Bosni i Hercegovini, CrnojGori i Albaniji, u radu su analizirani floristički sastavi sljedećih asocijacija: i) *Vitici-Tamaricetum africanae* Horvatić 1960 (uključujući subasocijacije *Vitici-Tamaricetum africanae typicum*, *Vitici-Tamaricetum africanae holoschoenetosum*), ii) *Viticetum agni-casti* Lakušić 1972 (i subasocijacije *Viticetum agni-casti brachypodietum silvatici* i *Viticetum agni-casti chaerophylletosum hirsuti*), iii) *Periploco-Viticetum agni-casti* Lakušić 1980, iv) *Rubo-Viticetum agni-casti* Lakušić et al. 1980 te v) *Paliuro australis-Viticetum agni-casti* Jasprica et al. 2011. Floristički sastav asocijacija je uspoređen sa sastojinama vrste *Vitex agnus-castus* u Grčkoj, Italiji, Francuskoj i Španjolskoj. U radu su korištene metode numeričke analize: klasterska analiza i multidimenzionalno skaliranje. Temeljem dobivenih rezultata, istočno jadranska sveza *Viticion agni-casti* obuhvaća termofilne poplavne šikare unutar reda *Tamaricetalia africanae* Braun-Blanquetet O. Bolòs 1958 em. Izco et al. 1984 te se razlikuje od jugozapadno balkanske sveze *Tamaricion parviflorae* I. et V. Kárpáti 1961 i zapadno mediteranske sveze *Rubo ulmifolii-Nerion oleandri* O. Bolòs 1985.

Syntaxonomic revision and floristic characterization of the plant associations corresponding to the thermophilous scrub communitiesof the alliance *Viticion agni-casti* Lakušić 1975

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Stands with Chaste tree (*Vitexagnus-castus* L.) in the coastal region of southeastern Dinaric Alps have been included within the alliance *Viticion agni-casti* Lakušić 1975. Until now, the position of the alliance and its associations which some of them have never been validly published, was not clear. The alliance is floristic and ecological highly variable due to the wide range of environmental factors of species *Vitex agnus-castus*. It is usually attached to hygrophylic communities of the orders *Salicetea purpureae* Moor 1958 or *Populetalia albae* Braun-Blanquet1931. There was no reason for its subordination to the order *Platanetalia orientalis* Knapp1959. On the basis of the literature data and our own research from Croatia, Bosnia and Herzegovina, Montenegro and Albania, in this study was analyzed the floristic composition of the following associations: i) *Vitici-Tamaricetum afri-*

canae Horvatić 1960 (including subassociations *Vitici-Tamaricetum africanae typicum* and *Vitici-Tamaricetum africanae holoschoenetosum*), ii) *Viticetum agni-casti* Lakušić 1972 (and subassociations *Viticetum agni-casti brachypodietum silvatici* and *Viticetum agni-casti chaerophylletosum hirsuti*), iii) *Periploco-Viticetum agni-casti* Lakušić 1980, iv)*Rubo-Viticetum agni-casti* Lakušić et al. 1980, and v) *Paliuro australis-Viticetum agni-casti* Jasprica et al. 2011. Floristic composition is compared to stands with *Vitex agnus-castus* from Greece, Italy, France and Spain. Cluster analysis and multidimensional scaling are used to revise the syntaxonomy of the alliance. Based on the obtained results, thermophilic riparian thickets of the eastern Adriatic alliance *Viticion agni-casti* are included within the order *Tamaricetalia africanae* Braun-Blanquetet O. Bolòs 1958 em. Izco et al. 1984, and differs from the southwest Balkan alliance *Tamaricion parviflorae* I. et V. Kárpáti 1961 and West-Mediterranean alliance *Rubo ulmifolii-Nerion oleandri* O. Bolòs 1985.

Nectar production in *Galanthus reginae-olgae* subsp. *vernalis* Kamari from the Adriatic Sea coast

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There are six species of the genus *Galanthus* L. on the Balkan Peninsula. Among them, *G. reginae-olga*e Orph. occurs in Greece, Albania, Montenegro and Croatia. It commonly grows in beech forests, on calcareous soils, at altitudes from 300 to 600 m. The nectar production in *G. reginae-olgae* subsp. *vernalis* Kamari, originating from the Adriatic Sea coast, was examined, in order to determine its significance as nectariferous plant. Investigation included analysis of the total daily nectar amount per flower and dynamics of nectar secretion during the day and during the flower ontogeny. The intensity of nectar secretion was determined using a microcapillary method. Nectar was collected at three hour intervals during daytime (from 07.00 to 19.00). The results show that the total daily quantity of nectar is low (average 0.02 μl/flower), confirming the literature data that *Galanthus* species are poor nectar producers. Considering the dynamics of nectar secretion, the flowers produced nectar only once a day (in the morning). Also, nectar was detected only once during the flower ontogeny, which (in average) lasted 6.5 days. The low nectar production of *G. reginae-olgae* is attributable to flowering period, coinciding with inactivity period of the majority of insect pollinators. However, this plant is a valuable source of food for primary flower-visiting insects, feeding on its nectar during the late autumn, winter, and early spring period, when only small number of species is in flower.

Floristic differentiation of associations from wind edge siliceous open alpine grassland vegetation (*Juncetea trifidii* Hadač 1946) in the central part of the Balkan Peninsula

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The aim of this work is to present the floristic differentiation within the associations of siliceous alpine grasslands exposed to the wind (*Juncetea trifidii* Hadač 1946), described in the mountains of the central part of the Balkan peninsula (Mts Stara Planina, Šarplanina and Prokletije in Serbia, Mt Bjelasica in Montenegro and Mt Vranica in Bosnia and Herzegovina) in order to solve syntaxonomy and nomenclature of the communities in Serbia dominated by the local endemics *Cardamine pancicii*. Phytosociological characteristics of these stands, described in alpine belt of the Central-Balkan mountains were analyzed according to Braun-Blanquet methodology. In order to detect purely floristic differentiation of analyzed communities we applied Correspondence Analysis (CA). Relationship between vegetation and environment is assessed using the Canonical Correspondence Analysis (CCA), while the classification of sites was performed using UPGMA method and Chord distance as a heterogeneity measure. Finally, a new association from vegetation of wind exposed siliceous alpine grasslands was described from Serbia under the name *Minuartio recurvae-Cardaminetum pancicii*.

Močvarna vegetacija reda *Phragmitetalia* na obalama kopovskih jezera Tuzlanskog kantona, Bosna i Hercegovina

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U radu se navode rezultati fitocenološke analize močvarne vegetacije reda *Phragmitetalia* W. Koch 1926 na obalama četiri kopovska jezera Tuzlanskog kantona (jezera Suhodanj, Mušići, Ramići i Šićki Brod). Jezera Mušići i Šićki Brod su nastala u završnom krateru po prestanku površinske eksploatacije ugljena, dok su jezera Suhodanj i Ramići nastala pregrađivanjem površinskih tokova vode jalovinskim materijalom na djelomično-degradiranom terenu. Fitocenološke snimke močvarne vegetacije su prikupljene metodom Zurich-Montpellier škole škole od travnja do listopada 2008. godine. Močvarna vegetacija reda *Phragmitetalia* na obalama istraživanih jezera zastupljena je s dvije biljne zajednice. Na jezerima Suhodanj, Mušići i Šićki Brod prisutna je zajednica *Typhetum latifoliae* (Soó 1927) Now. 1930, unutar koje su zabilježene 33 biljne vrste. Na obalama jezera Ramići i Šićki Brod dominantna je zajednica *Phragmitetum australis* (Gams 1927) Schmale 1939 u okviru koje su pronađene 32 biljne vrste. U radu su analizirane životni oblici i bioindikatorske vrijednosti biljnih vrsta. Rezultati istraživanja upućuju na uspješan proces kolonizacije močvarnih biljnih vrsta na potpuno degradiranim staništima, kao što su kopovska jezera.

Marsh vegetation of the order *Phragmitetalia* on shores of mine pit lakes in Tuzla Canton, Bosnia and Herzegovina

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This paper presents the results of phytosociological analysis of the marsh vegetation of the order *Phragmitetalia* W. Koch 1926 on the shores of four mine pit lakes in Tuzla Canton (lakes Suhodanj, Mušići, Ramići and Šićki Brod). Lakes Mušići and Šićki Brod emerged in the final crater after the cessation of surface coal mining, while lakes Suhodanj and Ramići were created by damming surface streams with tailings material on a partially-degraded terrain. Phytocoenology records of marsh vegetation were carried out by Zurich-Montpellier school from April to October 2008. Marsh vegetation of the order *Phragmitetalia* on the shores of the studied lakes is represented with two plant communities. On the lakes Suhodanj, Mušići and Šićki Brod present is community *Typhetum latifoliae* (Soó 1927) Now. 1930, within which was noted 33 plant species. On the shores of lakes Ramići and Šićki Brod the dominant community was *Phragmitetum australis* (Gams 1927) Schmale 1939, within which were determined 32 plant species. This paper analyzes the life forms and bioindicator values of plant species. The research results indicate a successful process of colonization by wetland plant species on totaly degraded habitats such as mine pit lakes.

Floristic homogenization of roadsides in the case of Pécs

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Nowadays, more and more international articles deal with the problem of floristic richness, floristic homogenization of roadsides and the distribution pattern of plant species richness between urban and rural landscapes. Unfortunately, only a few of them were published in Hungary. According to the Flora Mapping Database of Pécs and the related literature, surveying the selected sections of roadsides of the city and its narrower surroundings, we tried to answer the following questions: 1) How rich are the 1 m wide sections of the surveyed roadsides from the floristic point of view? 2) How frequent are rare, red list and protected species within the flora of the investigated verges? 3) Can we demonstrate the taxonomic homogenization along the investigated linear landscape elements, and if so, does it correlate with the pattern of the urban-rural gradient, as well as the direction of traffic? These problems above were investigated at larger (~1000 m^2) and at smaller scales (4 m^2) as well. We pointed out the relative richness of the flora of verges in national and international relations. There were a lot of rare, red list and protected species along the roadsides. However, this narrow, 1 m wide zone of the verges can not serve as green corridor for the majority of these protected species, since these plants disappeared from this belt in a short-distance from their natural habitats. We detect relative environmental filtering effect of roadsides at larger and at smaller scales as well. In smaller scale the most frequent species were native and ruderal plants in the verges. In larger scale the rate of distance decay were lower in the case of verges than it was expected. We

can not support von der Lippe & Kowarik's expectations at the selected scale in the case of Pécs, since the effect of taxonomic homogenization was not stronger along the outbound lanes than along the lanes leading into the city.

Biljne asocijacije u rijekama Trebižatu i Lištici (Hercegovina, Bosna i Hercegovina)

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U razdoblju od 2007. do 2009. obavljena su istraživanja biljnih zajednica u oligotrofnim krškim rijekama Trebižatu i Lištici metodom Zürich-Montpellier fitocenološke škole. Na temelju 87 fitocenoloških snimaka, utvrđeno je 26 asocijacija svrstanih u 11 sveza, devet redova i šest razreda: *Adiantetea capilli-veneris* Br.–Bl. in Br.–Bl., Roussine et Nègre 1952, *Lemnetea* R. Tüxen ex O. Bolós et Masclans 1955, *Potametea pectinati* Klika in Klika et Novák 1941, *Phragmito australis-Magnocaricetea elatae* Klika in Klika et Novák 1941, *Molinio-Arrhenatheretea* R. Tüxen 1937 i *Salicetea purpureae* M. Moor 1958. U Trebižatu je utvrđeno 25, a u Lištici 10 asocijacija, dok je devet asocijacija prisutno u obje rijeke. Među asocijacijama, osam je novih za Bosnu i Hercegovinu: *Eucladio-Adiantetum capilli-veneris* Br.-Bl. ex Horvatić 1934, *Potametum perfoliati* W.Koch 1926, *Potametum graminei* W.Koch 1926, *Potametum lucentis* Hueck 1931, *Potametum pectinati* Cartensen 1955, *Myriophylletum spicati* Soó 1926, *Equiseto palustri-Iridetum pseudacori* Trinajstić 2008 and *Holoschoeno-Molinietum arundinaceae* Trinajstić (1965) 2008.

Plant associations in the Trebižat and Lištica rivers (Herzegovina, Bosnia and Herzegovina)

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Plant communities were studied along two oligotrophic karstic rivers - Trebižat and Lištica - in the period from 2007 to 2009. According to 87 relevés, a total of 26 plant associations,_using Braun-Blanquet methods, were found in the rivers and nearby surveyed area. These associations have been subordinated to 11 alliances, nine orders and six classes: *Adiantetea capilli-veneris* Br.–Bl. in Br.–Bl., Roussine et Nègre 1952, *Lemnetea* R. Tüxen ex O. Bolós et Masclans 1955, *Potametea pectinati* Klika in Klika et Novák 1941, *Phragmito australis-Magnocaricetea elatae* Klika in Klika et Novák 1941, *Molinio-Arrhenatheretea* R. Tüxen 1937 and *Salicetea purpureae* M. Moor 1958. In the Trebižat and Lištica rivers, 25 and 10 associations were found, respectively. Only nine associations were common to both rivers. Eight associations were recorded in Bosnia and Herzegovina for the first time: *Eucladio-Adiantetum capilli-veneris* Br.-Bl. ex Horvatić 1934, *Potametum perfoliati* W.Koch 1926, *Potametum graminei* W.Koch 1926, *Potametum lucentis* Hueck 1931, *Potametum pectinati* Cartensen 1955, *Myriophylletum spicati* Soó 1926, *Equiseto palustri-Iridetum pseudacori* Trinajstić 2008 and *Holoschoeno-Molinietum arundinaceae* Trinajstić (1965) 2008.

Knowledge contribution to the hilly and submontane garrigues in Central Apennines (Italy)

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The phytosociological studies carried out in the last years, on the hilly and submontane garrigues in Central-Southern Apennines, have increased significantly the knowledge of their phytocoenotic diversity, phytogeographic features and dynamical relationships. Here, the results of the study concerning some chamaephytic-nanophanerophytic vegetation types in Central Apennines are presented. The investigated plant communities are located in the upper hilly and lower montane belts of the Abruzzo region and are physiognomically characterized by: i) *Centaurea scannensis*, a species which lives only in Sagittario Gorges, in the province of L'Aquila. Those communities stand on limestone substrates in bioclimatic range between upper meso-temperate and upper supratemperate thermotypes, with upper subhumid to lower humid ombrotypes; ii) *Ephedra nebrodensis*, is a rare and relict species with a fragmented circum-mediterranean distribution. Such phytocoenoses can be found in several places in the Abruzzo region, on limestone lithotypes, from the upper mesotemperate to the lower supratemperate and the lower supramediterranean belts, from the lower subhumid ombrotype to upper humid one; iii) *Cytisus decumbens*, is a rare species distributed in southern Europe. This garrigues type have been analyzed in the Sirente-Velino natural park (Abruzzo), on limestones and in a bioclimatic range between lower supratemperate and upper supratemperate thermotypes with lower humid ombrotypes; iv) *Genista pulchella* subsp. *aquilana*, an endemic subspecies known only in some localities on the Gran Sasso massif. The phytocoenoses are characterized by their dominance on marly limestones in the lower supratemperate belt with upper subhumid and lower humid ombrotypes. The analysis of the biological spectra showed a clear dominance by chamaephytes, whilst the chorological spectra revealed the prevalence of eastern species, thus, confirming the strong floristic affinity with the Balcans, which has been already highlighted in a lot of syntaxonomical schemes, that have been proposed concerning the Apennines vegetation. On the basis of those considerations, the investigated communities are here referred to the class *Cisto cretici-Micromerietea julianae* Oberdorfer 1954 and to the order *Cisto cretici-Ericetalia manipuliflorae* Horvatić 1958. Four new plant associations, namely *Saturejo montanae-Centaureetum scannensis*, *Saturejo montanae-Ephedretum nebrodensis*, *Pimpinello tragi-Cytisetum decumbentis* and *Lomelosio graminifoliae-Genistetum aquilanae* are proposed within the alliance *Cytiso spinescentis-Satureiion montanae*. This research would be a further contribution in order to increase the knowledge of the garrigue vegetation framework of the Apennines, a well represented semi-natural habitat in which a lot of rare and endemic plants, considered to be preservation worthy, live.

Temporal patterns of vascular plant diversity in abandoned fields in S-Hungary

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Species richness and plant diversity are essential characteristics of successional communities and have great importance in ecological research. We investigated temporal patterns, changes in vegetation composition and species richness in old fields (abandoned croplands, orchards and vineyards) in S-Hungary. Abandoned fields in different stages of succession were sampled for 15 years (from spring 1999 to spring 2013) using either permanent or non-permanent plots.

The cover of vascular plant species (in %) was estimated in 2 m x 2 m and 20 m x 20 m plots. The age of abandoned fields ranged from 1 to 69 years. Stages of succession were defined on a physiognomic basis from initial open stages with domination of herbs and grasses to stages dominated by shrubs and trees. The climate of study area is subcontinental – submediterranean, with mean annual temperatures around 10°C. Annual precipitations range from ca. 600 to 700 mm. Stands are on loess bedrock, on elevations ranging from 90 to 280 m, with various expositions. Taking the whole successional sequence into account the herb species determined community diversity during succession, while the shrub and tree species together contributed less to diversity, despite the fact that the broadleaved forest is climax vegetation of the study area. The number of species depends on direction or stage of succession (grassland, scrub or forest). Abandonment of ploughed fields led to the rapid (10-15 years) overgrowing by shrubs (e.g. *Crathaegus monogyna, Rosa canina, Prunus spinosa*), and as a consequence, to the suppression and replacement of herbaceous plants (among them some rare grassland species, e.g. *Taraxacum serotinum*, *Adonis vernalis, Ajuga laxmanni*). The species richness increased when the succession proceeded to the direction of target grassland communities. Increase of cover in shrub layer was accompanied by a decrease in the number of the herb species. Ten native species were recorded as dominant (e.g. *Cirsium arvense, Calamagrostis epigeios, Bothryochloa ischaemum, Dorycnium pentaphylum, Chamaecytisus austriacus)* in at least one sample plot representing initial or mid-successional old fields. Monodominant populations of invasive plants, e.g. *Eleagnus angustifolia, Lycium halimifolium, Robinia pseudoacacia,* arrested succession and caused a decline of species richness.

The changes of the *Festuca* species in open sandy grasslands along climatic and geographical factors in the Carpathian Basin

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The examined area located in Carpathian Basin has semi-arid, extreme dry conditions where open grassland is the typical vegetation. The soil is dry and sandy with xerotherm vegetation types and with dominant endemic species such as *Festuca vaginata*. We examined also natural and anthropogenic environments. The urbanization caused growth of nitrate content in the degraded, shallow and sandy soils, while the physiognomy of the vegetation remained the same with some changes in the species composition: the amount of weeds and disturbance resistant species increased; *Cynodon dactylon* became dominant on grasslands. In this areas *Festuca pseudovaginata* was identified as a new taxon. The result suggested that this taxon is well adapted to the new environment which is changed because of human activity. Through climate change atlantic species apper in the western part, continental and pannonic species in the central region of the Carpathian basin and mediterranean species in the eastern part. The characteristic *Festuca* species are the *Festuca vaginata* (widespread), the *Festuca wagneri* (eastern region) and the *Festuca pseudovaginata* (central region). Soil characteristics were examined based on the average soil samples and their laboratory examinations. This project supported by a grant from Switzerland through the Swiss Contribution „Sustainable Nature conversation on Hungarian Natura 2000 sites".

Comparison of seminatural and anthropogenic grasslands in Zámoly region (Hungary)

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We studied the vegetation of a 260 ha grey cattle pasture near Páskom, in Zámoly basin. We carried out our surveys in May 2012. The pasture can be divided into five parts. One part, approximately the half of the area, is an old-field grassland, which was overseeded 20 years ago. The other half of the pasture was restored in four different ways (spontaneous regeneration, hay transfer, directly sown, alfalfa overseeding) in 2009 and then was mowed until 2011. Seven relevés were made in each part of the pasture (the occurrence of species and their cover values were recorded). The aim of our study was to compare the effects of the different restoration methods and mowing on the floristic composition of the pasture. For the analysis we used the Raunkiaer's life forms, conservation value categories and the social behaviour of the species. The analysis of life forms was performed according to the types of life form by Pignatti. The hay transfer and the old-field have the largest average numbers of species (more than 20). If we consider ten most abundant species of the sampling area, we found large values of the important species in grassland management. This is especially true for the directly sown area, where dominate some species of the seed mixture. Shannon diversity indices show that the hay transfer area and the old-field were the most diverse, followed by the alfalfa grassland, the spontaneously regenerated grassland and the directly sown area. Spectra of the Pignatti's life forms show that the perennial grassland species (H caesp) were the most abundant in each area. It is shown, that the grassland restored with hay transfer method was the most similar to the natural conditions. The greatest number of species was recorded in that part and the species of natural grasslands become dominant there. The parts of directly sown and the spontaneous grasslands were separated from the semi-natural 20 years old grassland.

How can rodents change the structure and diversity of a loess steppe in Hungary?

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Our aim was to investigate the species richness and diversity of the grassland influenced by the digging of the mole rat *(Nannospalax leucodon)* and study the effect of this disturbance to the diversity. We made the survey in Battonya-Tompapuszta which is a unique area in Hungary because of the excellent quality of soil and extension of the natural loess meadow. We recorded the presence/absence and the coverage of the species in 50x50 cm plots in 5x5 cm microquadrats, 12 plots were made on mounds and 12 plots in a control area with no mounds. The data analyses was made with using the Shannon- and Simpson diversity indices, the differences between the plot was tested by one-way ANOVA. There was no significant difference in the number of species (p=0,162), in the Shannon-diversity (p=0,373) and not either in the Simpson-diversity (p=0,505). On the basis of traits (life form, canopy height, vegetative propagation) the sites separated clearly: on the mounds there were mostly

hemiphanerophyte, dicotiledonous, and lower plant species with runners whilst in the control area the hemicryptophytes, graminoides and higher species were dominant. There were differences in the composition by the PCO ordination. On the strength of our survey we can conclude that the presence and disturbance of the mole rat influence the composition and the differentiation of the grassland significantly but not causes relevant variance in the species numbers, diversity and coverage. The grassland has adapted to these disturbances. These are preliminary results, we will plan to continue the survey and examine mounds with different state (new, inactive and old mounds) because the effects can depend on mound age.

An attempt to overview the Balkans` *Cynosurion* alliance

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All syntaxa ever related to *Cynosurion cristati* alliance on European level are studied. The information is collected from scientific journals and web sites. A total of 67 associations, 55 subassociations, 53 variants, 19 facies and 7 plant communities subjected to *Cynosurion* allianceare were found. The Balkans` *Cynosurion* syntaxonomical synopsis comprises respectively 24 associations, 39 subassociations, 5 variants, 19 facies and one plant community. A list of all theBalkans`*Cynosurion* associations and plant communities is presented. 24 associations and one plant community are listed chronologically. For every association the corresponding country is presented. The richest in *Cynosurion* syntaxa country is Romania encompassing 21 associations.

Pedološko vegetacijske karakteristike karakteristike park šume Marjan

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Park-šuma Marjan smještena je na marjanskom poluotoku, krajnje zapadnom dijelu splitskog poluotoka i zauzima 300,29 ha površine, od čega je 196,24 ha pokriveno vegetacijom. Greben marjanskog poluotoka proteže se u smjeru istok - zapad što je uzrok formiranju dviju padina, sjeverne i južne. Na južnoj padini Marjana prevladavaju lako trošivi lapor i fliš iznad kojih su antropogenim utjecajem nastale obradive površine s dubljim tlima. Vršni greben i sjeverna padina građeni su od alveolinskih i numulitnih vapnenaca gdje su pretežito razvijena plitka i stjenovita tla. Ukupno je utvrđeno sedam glavnih tipova tala: kamenjara (lithosol), sirozem (regosol), rendzina na flišu (rendzic leptosol), crnica na vapnencu (molic leptosol), smeđe tlo na vapnencu, (leptic cambisol) koluvij (eutric regosol) i eutrično smeđe tlo (eutric kambisol) te antropogena tla na flišnim površinama (anthrosols). Ovisno o prirodi pedogenetskih faktora i njima uvjetovanih procesa, na području park šume Marjan ustanovljeno je devet pedokartografskih jedinica od kojih su tri sastavljene od jednog tipa tla, a šest je sastavljeno od dva tipa tla. Na područjima s plitkim tlima razvijenim iznad vapnenačke podloge u prošlosti je uglavnom sađen alepski bor (*Pinus halepensis*), a često i čempres (*Cupressus sempervirens* var. *sempervirens* i var. *horizontalis*). Osim ovih biljnih vrsta još su u manjim grupama ili pojedinačno sađeni: pinija (*Pinus pinea*), primorski bor (*Pinus pinaster*), dalmatinski crni bor (*Pinus nigra* ssp. *dalmatica*), brucijski bor (*Pinus brutia*), himalajski cedar (*Cedrus deodara*) i libanonski cedar (*Cedrus libani*). Većina navedenih vrsta se zadržala do današnjih dana, ali se u sloju grmlja postupno pojavljuju elementi autohtone vegetacije s dominacijom crnike (*Quercus ilex*) i crnog jasena (*Fraxinus ornus*), čiji se razvoj potiče od strane Uprave parka.

Soil and vegetation characteristics of the Forest Park Marjan

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Forest Park Marjan is located on the Marjan Peninsula, the most western part of the Split peninsula and it occupies 300.29 hectares, of which 196.24 ha is covered with vegetation. Ridge of the Marjan peninsula stretches from east to west thus forming two slopes, northern and southern. On the southern slope of Marjan easily weathered marl and flysch dominate and above them cultivated land with deeper soils was created by anthropogenic influence. The ridge and the northern slope are built of alveoline and nummulite limestones above which there are mostly shallow and rocky soils. In total seven major soil types were registered: stony soils (lithosol), sirozem (regosol), rendzina on flysch (rendzic leptosol), calcomelanosol on limestone (molic leptosol), cambisol on limestone (leptic cambisol), colluvium (eutric regosol) and eutric cambisol (eutric cambisols) and anthropogenic soils on flysch (anthrosols). Depending on the nature of pedogenetic factors and processes caused by them, in the Park Forest Marjan 9 soil mapping units were found of which three are composed of one type of soil, and six is composed of two types of soil. In areas with shallow soils developed over limestone base in the past mainly Aleppo pine (*Pinus halepensis*) and often cypress (*Cupressus sempervirens* var. *sempervirens* i var. *horizontalis*) were planted. In addition to these species in small groups or individually planted were also: Stone pine (*Pinus pinea*), Scots pine (*Pinus sylvestris*), Dalmatian black pine (*Pinus nigra* ssp. *dalmatica*), Brutian pine (*Pinus brutia*), Himalayan cedar (*Cedrus deodara*) and Lebanese cedar (*Cedrus libani*). Most of these species still grows today, but in the shrub layer elements of autochthonous vegetation gradually appear, with domination of Evergreen oak (*Quercus ilex*) and Flowering ash (*Fraxinus ornus*), which is encouraged by the management of the Park.

Zaštita prirode, konzervacija i bioremediacija – usmena priopćenja

Nature protection, conservation and bioremediation – oral presentations

Kartiranje fizionomskih tipova vegetacije u određivanju stupnja korištenja prostora faune ptica i šišmiša pri procjeni utjecaja vjetroelektrana

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Suvremeni trendovi u energetici podrazumijevaju korištenje obnovljivih izvora energije, između ostalih i energije vjetra. Premda se vjetroelektrane često prezentiraju kao „zeleni" izvori energije, istovremeno mogu imati značajan negativan utjecaj na sastavnice prirode, u prvom redu na životinje koje lete i migriraju (ptice i šišmiše). Kako bi se u postupcima procjene utjecaja zahvata na okoliš i ocjene prihvatljivosti zahvata na ekološku mrežu zaštitile ugrožene svojte ptica i šišmiša, bitno je utvrditi kako navedene skupine koriste širi prostor planiranog zahvata. U tu svrhu razvijen je koncept procjene stupnja korištenja prostora (SKP) za ugrožene svojte. SKP, između ostalog, obuhvaća izradu karte staništa šireg područja zahvata (do 5 km oko vjetroelektrane), minimalne površine kartiranja od 1 ha, uz kartiranje stanišnih tipova na površinama manjim od 1 ha ukoliko su značajni za ptice ili šišmiše. Kartiranje prema Nacionalnoj klasifikaciji staništa Republike Hrvatske (NKS) pokazalo se kao neprikladno iz više razloga. Stoga se za opisanu svrhu koristi prilagođena karta staništa, u čijoj je izradi težište na fizionomskim tipovima vegetacije umjesto na biljnim zajednicama, što rezultira s: 1) povećanjem svrsishodnosti konačnog rezultata, 2) bržom izradom karti staništa prilagođenih potrebama ornitologa i hiropterologa, 3) smanjenjem terenskog napora botaničara aktivnim sudjelovanjem ornitologa i hiropterologa u kartiranju i 4) usklađenošću prostornih podataka prikupljenih tijekom terenskih izlazaka ornitologa, hiropterologa i botaničara. U prezentaciji će biti prikazana metodologija izrade prilagođene karte staništa te klasifikacija pojedinih fizionomskih tipova vegetacije.

Mapping the physiognomic types of vegetation in determining the space use degree of bird and bat fauna while assessing the impact of wind power plants

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Modern trends in the energy sector imply the use of renewable energy sources, including wind energy. Although wind power is often presented as a "green" energy source, it can at the same time pose a significant negative impact on nature, primarily on animals that fly and migrate (birds and bats). In order to protect endangered bird and bat species during the procedures of environmental impact assessment and nature impact assessment, it is important to determine how these groups use wider project area. Therefore, the space use degree (SUD) concept for endangered species was developed. SUD, among other things, includes development of the habitat map of the wider project area (up to 5 km around the wind power plant), with the minimum mapping area of 1 ha, but also mapping the areas of less than 1 ha if they are important for birds or bats. Habitat mapping according to the National Habitat Classification of Republic of Croatia (NHC) has proved to be inappropriate for several reasons. Therefore, for the described purpose modified habitat map is used, focused on physiognomic types of vegetation instead of plant communities and resulting in: 1) increasing the expediency of the final result, 2) faster development of habitat maps adjusted to the needs of ornithologists and chiropterologists, 3) reducing

the field effort of botanists by active participation of ornithologists and chiropterologists in mapping and 4) compatibility of spatial data collected during field works of ornithologists, chiropterologists and botanists. The presentation will show the methodology of development of the modified habitat map and classification of the physiognomic vegetation types.

Prvi koraci prema aktivnoj zaštiti i restauraciji ombrotrofnog creta na Trsteniku (liburnijski krš, Hrvatska)

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Ombrotrofni cretovi, uglavnom nastali u prilikama velike zračne vlage, godišnje ujednačene količine padalina i hladne ili umjereno hladne klime, danas su u jugoistočnoj Europi rijetka i ugrožena staništa. U Hrvatskoj je jedini ostatak takvog staništa poznat s Trstenika u Gorskom kotaru, gdje ombrotrofni cret, nastao za vrijeme posljednjeg glacijala, opstaje u neposrednoj blizini Jadranskog mora zahvaljujući specifičnim mikroklimatskim uvjetima. Uz nepovoljne uvjete klime i prirodno zaraštanje, ovaj cret kritično ugrožavaju i kanali prokopani nakon Drugog svjetskog rata radi odvodnje. U cilju revitalizacije cretnih staništa i povećanja brojnosti pokrovnosti ciljnih vrsta (*Sphagnum* spp., *Calypogeia sphagnicola*, *Eriophorum vaginatum*), na Trsteniku se od 2009. g. provode mjere aktivne zaštite i trajnog praćenja stanja: pregrađeni su melioracijski kanali, uklonjena stabla smreka zasađena po rubnom dijelu creta, a pokusno se obavlja košnja trave *Molinia coerulea* i presađivanje mahova tresetara. Utjecaj provedenih mjera prati se kvalitativnim i kvantitavnim analizama sastava vrsta na 29 kontrolnih i 29 pokusnih trajnih ploha, razina ukupne vode u tlu prati se na 56 pijezometera unutar 4 hidrološka profila, vertikalno kretanje vode prati se pomoću 5 pijezometarskih gnijezda, dok se kretanje mikroklimatskih uvjeta bilježi pomoću 8 datalogger uređaja. Izlaganjem će se dati rezultati praćenja stanja ombrotrofnog creta na Trsteniku u prvom petogodišnjem razdoblju (2009. – 2013.) provođenja aktivnih mjera zaštite te ocijeniti utjecaj pojedinih mjera na sastav i brojnost ciljnih vrsta.

First steps towards the active protection and restoration of an ombrotrophic mire in Trstenik (Liburnian karst, Croatia)

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Ombrotrophic mires of south-eastern Europe, that were mostly developed in cold or moderately cold climates, characterised with relatively high air moisture and precipitation distributed evenly throughout the year, nowadays are rare and endangered habitats. The only known remnant of an ombrotrophic mire in Croatia is found on Trstenik, Gorski kotar, in close proximity of the Adriatic Sea, where a peat bog dating from the last glacial still persists thanks to specific microclimatic conditions. Additionally to unfavourable climate and natural succession, this mire is critically endangered by drainage canals constructed after the Second World War. Since 2009, with the aims of revitalising mire habitats and achieving higher number and coverage of target species (*Sphagnum* spp., *Calypogeia sphagnicola*, *Eriophorum vaginatum*), active measures of renaturation and long-term monitoring have been undertaken: drainage canals have been blocked, spruce trees planted around

the mire margin have been removed, *Molinia coerulea* is being experimentally mowed, and *Sphagnum* mosses transplanted. The possible effect of measures applied is monitored by qualitative and quantitative analyses of species assembly on 29 control and 29 experimental permanent plots. The groundwater levels are monitored by 56 piezometers on 4 hydrological profiles, vertical movement of ground water is assessed by 5 piezometric nests, while microclimatic conditions are gathered by 8 data loggers. The presentation will give results of the first 5 years (2009 – 2013) evaluation period of the active renaturation of the Trstenik mire and evaluate the effect of different measures undertaken on changes in plant species composition.

Problematika provedbe mjera zaštite ugroženih biljnih svojti pri izvedbi građevinskih zahvata na primjeru vjetroelektrane Jelinak

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Kako bi se ublažio utjecaj izgradnje vjetroelektrane Jelinak, u tijeku postupka procjene utjecaja na okoliš propisane su mjere zaštite ugroženih i zaštićenih biljnih svojti, s naglaskom na nježnu kockavicu (*Fritillaria messanensis* ssp. *gracilis* (Ebel) Rix) i finobodljasti kaćun (*Orchis provincialis* Balb.). Obje svojte, ugrožene gubitkom i fragmentacijom staništa, zabilježene su na širem području vjetroelektrane, no mjerom je propisano ograđivanje na lokacijama vjetroagregata br. 1, 2, 3 i 4 oko kojih je utvrđena veća gustoća njihovih populacija. Provedba mjera uključivala je utvrđivanje staništa navedenih svojti pregledom terena na području četiri agregata, označavanje (ograđivanje) povoljnih staništa te savjetovanje izvođača građevinskih radova tijekom izvedbe radova radi zaštite označenih površina. U prezentaciji će biti prikazana metodologija određivanja površina za označavanje, njezine prednosti i nedostaci, ali i problematika provedbe mjera zaštite ugroženih biljnih svojti pri izvedbi građevinskih zahvata.

Implementation problems of mitigation measures for the protection of plant species during construction projects

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As a part of the environmental impact assessment, mitigation measures for protection of endangered and protected plant species were appointed in order to alleviate the impact of the construction of the wind farm Jelinak. The emphasis of the measures was on the protection of Snake's Head Fritillary (*Fritillaria messanensis* ssp. *gracilis* (Ebel) Rix) and Provance Orchid (*Orchis provincialis* Balb.) as both species are endangered by habitat loss and fragmentation. They were recorded for the wider project area, but only the sites of wind turbines no 1, 2, 3 and 4 were designated for fencing as these had the densest population of the two species. The implementation of the mitigation measures consisted of fieldwork to determine the habitat of the species around the four wind

turbines, marking (fencing) of the favorable habitats, and counseling the constructors about the conservation of these areas during the construction works. The methodology used for designation of conservation areas will be presented along with its advantages and disadvantages, as well as the implementation problems of mitigation measures for protection of plant species for construction project.

Izazovi upravljanja zaštićenim prirodnim područjima delte Neretve (Hrvatska)

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Dolina donjeg toka rijeke Neretve sadrži najveće i najvrjednije ostatke sredozemnih močvara na istočnojadranskoj obali te je jedno od malobrojnih područja preostalih u Europi. Vodne regulacije, izgradnja akumulacija u uzvodnom dijelu te isušivanje i pretvaranje močvarnog u poljoprivredno zemljište, nepovratno su izmijenili izgled tog prostora. Nekadašnji prostrani tršćaci i lagune, vrijedni za zimovanje i selidbu izuzetno raznolikog ptičjeg svijeta, kao i za hranidbu i mrijest riba, danas su svedeni na ostatke te i dalje ugroženi različitim ljudskim djelatnostima. U delti Neretve koji pripada Republici Hrvatskoj nalazi se pet zaštićenih lokaliteta, u ukupnoj površini od 1620 ha. To su u kategoriji ornitološkog rezervata Pod Gredom, Prud i Orepak, ornitološko-ihtiološki rezervat ušće Neretve te zaštićeni krajolik Modro oko i jezero Desne. Čitava delta je predviđena za zaštitu u kategoriji parka prirode. Antropogeni utjecaj je snažan (poljoprivreda, turizam i dr.) što usložnjava upravljanje zaštićenim područjima.

The challenges of management of protected areas in the Neretva River delta (South Croatia)

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The Lower Neretva valley contains the largest and the most valuable remnants of the Mediterranean wetlands on the eastern Adriatic cost and one of the few areas of this kind remaining in Europe. Regulation of streams, construction of storage reservoirs of the valley, drainage and turning the wetlands into the arable land changed the appearance of this area irreversibly. The once vast reed-patches and lagoons important for wintering and migration of a wide variety of birds, as well as for fish feeding and spawning, presently are reduced to small fragments, which continue to be threatened by all types of human activities. In the Republic of Croatia, five sites with the total surface area of 1620 ha are protected. These are as follows: i) in the category of ornithological reserve Pod Gredom, Prud and Orepak, ii) ornithological and ichtyological reserve of the Neretva River mouth, and iii) protected landscapes of Modro oko and Lake Desne. The entire delta is proposed to be protected as a nature park. Anthropogenic influences are strong (agriculture, tourism, etc.), which complicates the management of the protected areas.

Zaštita prirode, konzervacija i bioremediacija – posterska priopćenja

Nature protection, conservation and bioremediation – poster presentations

Bioremediation of reactive textile dyes using free and immobilized *Trametes trogii*

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Among the many different groups of synthetic dyes, reactive textile dyes with amine groups are mostly used for dying fabric in textile industry. These dyes are generally resistant to degradation and remain persistent for long time due to its aromatic structure (1-4). Due to their versatility, adaptability and low cost, bioremediation using microorganisms has been demonstrated for soil and water remediation. In this regard, many published studies have indicated that microorganisms could be used for the degradation of various classes of organic molecules. In this study, a white rot fungus *Trametes trogii* was studied to assess its potential for enhanced de-colorization and detoxification of two different dyes such as Reactive Green-19 (RG-19) and Reactive Blue-4 (RB-4). *T. trogii* biomass was immobilized in Ca-alginate gel beads. The free and immobilized forms were used for the biodegradation of RG-19 and RB-4 dyes. The decolorization of dyes, were studied with different initial dye concentration, pH, and temperatures. The activities of laccase, manganese peroxidase, and lignin peroxidase enzymes were estimated to the roles of enzymes in the dye decolorization. The effect of pH was investigated and the maximum degradation of dyes by free and immobilized *T. trogii* preparations was observed for pH 6.0. The free *T. trogii* showed 78% and 83% de-colorization of RG-19 and RB-4 dyes (initial concentration: 0.5 mmol/L) in batch system. Whereas, under same experimental conditions, the immobilized *T. trogii* biomasses was decolorized 65% and 74% in 48 h operations, respectively. The degraded dye metabolites were assessed for cytotoxicity using *Saccharomyces cerevisiae*, which demonstrated the formed metabolites were found to nontoxic nature after degradation of dye. The live and immobilized biomasses were reused in five de-colorization cycles without any considerable loss in their finial de-colorization rate.

In situ and *ex situ* conservation of *Centaurea wagenitziana* Bancheva & Kit Tan (Asteraceae) in Bulgaria

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A preliminary analysis of the current state of Bulgarian threatened and rare plants showed that the populations of 299 species fall outside any protected area and their survival is under serious threat. Centaurea wagenitziana Bancheva & Kit Tan is one of them. It is a tall composite with conspicuous large pinnatisect leaves and capitula with pale pinkish-mauve florets. The species is Balkan Endemic, distributed in Bulgaria and Turkey. In the last country the species is probably extinct, whereas in Bulgaria the unique population is situated in Tundzha Hilly Country floristic region, Municipality of Elhovo, north of the village of Golyam Dervent. It is growing at an altitude of c. 350 m alt, at the edge of shady meadows in xerophilous forests dominated mainly by Q. cerris (Turkey oak) and Quercus frainetto (Hungarian oak). C. wagenitziana is included in the Bulgarian Biodiversity Act and in the Red data Book of Bulgaria as 'Critically Endangered'. The population comprises c. 450 individuals distributed in several small groups occupying an area of c. 2 square km. The following threats have been identified to directly affect the population of the target species: forest felling, construction and infrastructure, successional changes, low germination rate, insect-larvae attack on the capitula etc. In order to improve the population state in situ and ex situ conservation measures are undertaken and a protected area is designated under the framework of the project 'A pilot network of small protected sites for plant species in Bulgaria using the Plant Microreserve model' supported by the EU's financial instrument for environmental and nature conservation LIFE.

Bioremediation of reactive textile dyes using free and immobilized *Trametes trogii*: Batch and continuous flow system studies

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Color is the first contaminant to be recognized, and environmental regulation in most European countries has made it mandatory to decolorize the dye wastewater prior to discharge. Textile dyes are heavily used in factories for coloring different cloth materials. The reactive triazine dyes or their metabolites (e.g. aromatic amines) may be highly toxic and potentially carcinogenic, mutagenic and allergenic on exposed organisms. Biological processes have received more attention as they are cost-effective and environmentally friendly. Microorganisms are capable of removing textile dyes, either by biodegradation or by biosorption. The immobilization of microorganisms can also provide several advantages such as facility to reuse and separation of solid biomass from the solutions. The process will become cost effective by reusing the biomass after regeneration (1-3)The potential use of the immobilized T. trogii to remove a textile dye (i.e., Reactive Blue-4 (RB-4)) dye from aqueous solutions was evaluated using Ca-alginate bead as a control system. Ca-alginate beads containing immobilized T. trogii were incubated for the uniform growth at 22 °C for 5 days. Effects of pH, temperature, initial concentration of dye and biosorbent dosages on the biosorption of RB-4 dye were studied. Biosorption of RB-4 dye on the immobilized fungal biomass increased as the initial concentration of dye increased in the medium. In the batch system, the biosorption equilibrium time was about 60 min and the maximum dye uptake on the tested free and immobilized fungal biomass preparations was observed at pH 3.0. The temperature change in the range of 10-40 °C did not affect the removal capacities of the immobilized fungal biomass. Biosorption of the dye from aqueous solution was also investigated in a continuous flow system. The maximum adsorption capacity of the immobilized T. trogii was 96.3 mg/g dry biomass at an initial dye concentration of 100 mg/L and at a flow rate of 20 ml/h.. 102 (2011) 9833.

Utilisation of microalgae *Scenedesmus quadricauda* for biosorption of Chromium ions from aqueous solution

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Heavy metals are toxic contaminants that are accumulated by the living organisms and, there are no widely accepted methods to have them removed. Chromium is a toxic metal ion entering surface waters from the effluent of textile, tannery, electroplating, mining and metal cleaning industries. The removal of heavy metal ions using biosorbents has been widely studied in the last decade due to thier potential, particularly in wastewater treatment. Compared to some biomass such as fungi, bacteria and yeast, heavy metal uptake capacity of algae proved to be the highest because of the algal cell wall, which is composed of a fiber-like polysaccharides structure.. Among them, *Scenedesmus quadricauda* has been applied, for more than 75 years, in a sense excluding its original type, to an important taxon of microscopic green algae (*Chlorophyta, Chlorococcales*), easy to grow in culture, therefore widely used in a variety of studies in different fields of science. *S. quadricauda* has rarely been utilized for removal of metal from aqueous solutions. In this study, a wild type of *S. quadricauda,* isolated from a polluted site of Kızılırmak River was cultured to achieve the most probable removal efficiency because the species grown in polluted areas were known to be more resistant, and thus having more capability of accumulating heavy metals. The hexavalent chromium biosorption onto native *S. quadricauda* was studied from aqueous solutions. Biosorption equilibrium was established in about 90 min. The surface property of the algal

preparations was varied with pH, and the maximum biosorption of chromium ions on the algal preparations was obtained between pH 2.0-3.0. The biosorption increased as the initial concentration of chromium ions increased in the medium.

Conservation of threatened plants in Bulgaria using the micro-reserve model

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The Bulgarian flora comprises *ca*. 3900 species that is a relatively high number for a territory of over 110 000 km^2. In 2003-2005, the national threat status of 898 species of vascular plants and 251 species of bryophytes has been evaluated using the IUCN Red List Categories and Criteria. In the resulting Red Lists 208 vascular species and 28 bryophytes were assessed to be Critically Endangered (CR).In 2010, a team of botanists started the implementation of a project named "BulPlantNet – A Pilot Network of Small Protected Sites for Plant Species in Bulgaria Using the Plant Micro-reserve Model". This project is financed by the LIFE+ Programme of the European Commission and by the Bulgarian Ministry of Environment and Waters. The concept of plant micro-reserves for protection and monitoring of rare and endangered plants has been developed in the 1990-ties in Valencia Province of Spain and is adopted now in Bulgaria. The strategic objective of the project BulPlantNet is to conserve the plant biodiversity in Bulgaria focusing on species that are unique or have strongly fragmented populations on the territory of the country, whose populations fall outside existing protected areas and whose survival is under serious threat. The target species are 47. They are of European and/or national conservation importance; have small populations and need urgent conservation actions to be undertaken.Seven species of vascular plants and three species of bryophytes are object of the present work – *Genista germanica*, *Lycopodiella inundata*, *Potentilla fruticosa*, the Balkan endemic *Merendera attica*, the Bulgarian endemics *Anthemis argyrophylla*, *Ranunculus stojanovii* and *Tulipa pirinica*, as well as the liverworts *Mannia androgyna*, *Riccia crustata* and *Trichocolea tomentella*. Of these, 7 species are legally protected by the Bulgarian Biodiversity Law, namely all vascular plants. Critically endangered species are 8; 1 is endangered (*T. tomentella*); 1 is vulnerable (*P. fruticosa*). Here we present the national distribution, habitat requirements, population state, main threats, *in situ* and *ex situ* actions aiming at conservation of their populations and habitats, etc. Permanent plots for a long-term monitoring are installed. Several protected sites are already officially declared; others are in process of designation. Elaboration of Action plans for the conservation of each species, based on carried out studies, is now in progress.

Utilization of Ni-hyperaccumulator plant *Thlaspi jaubertii* Hedge for removal of heavy metals from wastewaters

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Heavy metals are toxic contaminants that are accumulated by the living organisms and there are no widely accepted methods for effective removal of these pollutants from wastewater. In recent years, there has been considerable interest in the use of plant biomass as adsorbents to remove toxic metals from aqueous solution by biosorption since they are cheap and have high efficiency biosorbents for biosorption of metal ions. *Thlaspi jaubertii* is a Ni-hyper-accumulator plant, and it can endure high concentrations of Ni(II) ions due to the hyper-accumulation ability of its host. This research aimed to evaluate the capability of *T. jaubertii* plant material to adsorb Ni(II), Cd(II) and Pb(II) ions from single and binary metals solutions to determine the metal ions binding capacities of the plant biomass. The biosorption capacities of the *T. jaubertii* biomass for metal ions were investigated under different conditions. The single component and binary biosorption equilibrium of Ni(II), Cd(II) and Pb(II) ions were experimentally studied using biomass of *T. jaubertii* plant at 25 °C and at pH 5.0. It was found that the maximum biosorption capacities calculated from Langmuir isotherm were 1.65, 1.14 and 0.4 mmol/g plant biomass for Ni(II), Cd(II) and Pb(II) ions, respectively. The kinetics of the biosorption was better described by pseudo-second order kinetic model. Desorption efficiency of biosorbents was investigated at various pH values. Based on the above studies, the plant biomass appears to be a more efficient biosorbent for the removal of Ni(II) and Cd(II) ions from aqueous solution.

Setting conservation priorities in the Mediterranean region: vascular plants and habitats of Cilento National Park (Southern Italy)

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As for national, regional and policy lists of conservation priorities at species or habitat level frequently lack of objectivity and of a standard method, we argue that there is an urgent need for a method to define species and habitat listing for conservation actions at different scales. Due to limitedness of resources for conservation policies, setting priorities is crucial to improve management actions and to evaluate conservation effectiveness. In this framework, we select as case of study, in the Mediterranean region, the Cilento and Vallo di Diano National Park (Southern Italy), one of the largest national Park in Italy (approx. 1800 km^2). We compare different methods, recently proposed in the literature, to achieve species and habitat listing for conservation purposes. We argue that a combination of expert based assessment, and explicit criteria regarding rarity, habitat vulnerability and regional responsibility could provide a flexible and efficient framework to rank species for conservation purposes. We highlight the differences with the related Red list assessment sensu IUCN, and, considering that information on extinction risk, in particular on population trends, are frequently lacking, we retain that setting priorities could address conservation efforts also regarding this topic.

Internationally important species in flora of Serbia

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Although the territory of Serbia covers only 1.9% of the European continent, it comprises 18% of its vascular flora. Of about 4000 vascular plants (species and subspecies) that have been recorded in Serbia, 1129 are protected under national legislation (Rulebook on proclamation and protection of strictly protected and protected wild species of plants, animals and fungi ,"Official Gazette of RS", no 5/2010, 47/2011). In total, 116 plant taxa are listed under European or global policy instruments. Among them Habitats Directive includes 36 species, Bern Convention 48, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the EU Wildlife Trade Regulation involves 60 species. Based on the revised Resolution 6 of the Bern Convention and Annex II of the Habitats Directive (which refers to the list of flora and fauna), 32 Emerald plant species have been identified in Serbia as well. Basic information about distribution and population status of some internationally important plant species in Serbia, as well as threatening factors and conservation measures undertaken in order to preserve and improve their numbers, will be presented in this paper.

Conservation of rare plants in the Bulgarian flora using the plant micro-reserve model

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There are about 300 species of endangered vascular plants in Bulgaria whose populations are located outside protected areas and for which any protection measures have not been taken yet. In order to preserve these species threatened with extinction, the Institute of Biodiversity and Ecosystem Research with the Bulgarian Academy of Sciences and the Ministry of Environment and Water developed a project entitled "*A pilot network of small protected sites for plant species in Bulgaria using the plant micro-reserve model*" (2010–2014) under the EU Life+ Program. The project focuses on 47 plant species of high conservation concern, located in 61 sites throughout the country. For conservation of these species and their habitats a number of conservation activities have been taken: designation of small protected sites, elaboration of a long-term monitoring plan for each species and regular monitoring of its populations, development of action plans, *in situ* and *ex situ* conservation activities, information campaigns to raise public awareness on plant conservation issues. Significant progress in the protection of the target species in their natural habitats and in *ex-situ* collections has already been achieved. As a result of the project a network of 61 small legally declared protected sites (micro-reserves) will be established. Other major results include development of action plans for all target species, on-line database with information on the species and their monitoring, and a strategy for sustainable development of the network of small protected sites for plant conservation in Bulgaria.

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Occurrence and conservation of *Tragopogon floccosus* (Asteraceae) in Bulgaria

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Tragopogon floccosus Waldst. et Kit. (*Asteraceae*) was recorded for the first time in Bulgaria in 2003 in a few neigbouring localities in the Danubian Plain floristic region. The species occurs on sandy habitats in the middle and lower stretches of River Danube. The Bulgarian population comprises several hundreds specimens and grows in a habitat listed under the EU Habitats Directive – 2340 *Pannonic inland dunes. The species was evaluated as Critically Endangered at national level and needs urgent protection measures. It is one of the target species in an ongoing Life+ project "*A pilot network of small protected sites for plant species in Bulgaria using the plant micro-reserve model*" aiming at establishment of a national network of small protected sites for conservation of endangered plants. The poster presents the results of the studies carried out on the species during the past three years – population characteristics, seed germination rate, accompanying species. An Action plan for conservation of the species is under preparation, containing the major threats and measures for conservation of the species, which are presented and discussed.

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