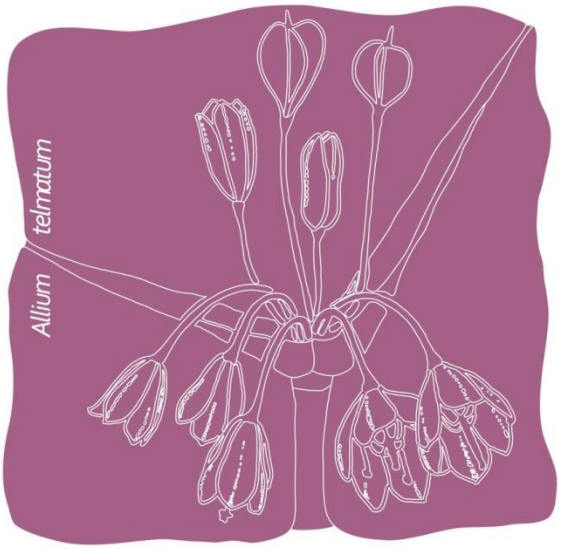
5. Hrvatski botanički simpozij s međunarodnim sudjelovanjem

5th Croatian Botanical Symposium with international participation



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Zadovoljstvo nam je pozdraviti vas sve, sudionike 5. Hrvatskog botaničkog simpozija s međunarodnim sudjelovanjem. Svima želimo srdačnu dobrodošlicu, ugodan boravak u Primoštenu i uspješna izlaganja.

Simpozij se kontinuirano održava svake tri godine i okuplja hrvatske botaničare kao i botaničare središnje i jugoistočne Europe. Od Prvog hrvatskog botaničkog simpozija održanog u Zagrebu 2004. godine, navedeni skup postao je središnji događaj na kojem se predstavljaju sva važnija botanička istraživanja u Hrvatskoj i izmjenjuju nova saznanja. Stoga je i cilj ovogodišnjeg Simpozija promicanje suradnje i razmjene znanstvenih i stručnih informacija s područja botanike između botaničara i stručnjaka srodnih struka te potencijalnih korisnika botaničkih podataka, kako iz Hrvatske tako i iz susjednih europskih zemalja, ali i šire. Ponosni smo što uz kolege iz Hrvatske na simpoziju sudjeluju i kolege iz Austrije, Bosne i Hercegovine, Bugarske, Italije, Mađarske, Makedonije, Slovenije, Srbije i Turske. Zadovoljstvo nam je što očekujemo više od 120 kolega koji će sudjelovati u radu simpozija i predstaviti rezultate svojih istraživanja.

Osobito nam je zadovoljstvo što se u sklopu ovogodišnjeg Simpozija održava i zasebna Nastavnička sekcija „Botanika u nastavi biologije u osnovnim i srednjim školama" na kojoj očekujemo veći broj nastavnika biologije. Nadamo se da će pripremljena predavanja i konstruktivna rasprava doprinijeti kvalitetnijem prijenosu znanja s područja botanike na buduće generacije. Također nam je zadovoljstvo što ćemo imati priliku poslušati dva predavanja koja ukazuju na neraskidivu povezanost botanike kao znanosti i našeg svakodnevnog života, te su osim za sudionike simpozija, otvorena i za širu zainteresiranu publiku. Predavanje „Zašto brojni prostorni planovi devastiraju nacionalnu baštinu i slabe razvoj kvalitetnog turizma?" organizirano je u suradnji sa Znanstvenim vijećem za prirodoznanstvena istraživanja Jadrana i Znanstvenim vijećem za zaštitu prirode HAZU.

Na kraju veselimo se i stručnoj ekskurziji u prekrasan Nacionalni park Krka gdje ćemo zajedno uživati u flori ovoga kraja.

Najljepše zahvaljujemo svim pokroviteljima i sponzorima koji su svojim prilozima uvelike olakšali održavanje ovog simpozija. Također zahvaljujemo svima koji su se na bilo koji način uključili i podržali ovaj skup i njegovo održavanje.

U ime Organizacijskog i Znanstvenog odbora 5. Hrvatskog botaničkog simpozija,

Preface

It is a great pleasure to welcome you, the participants of 5th Croatian Botanical Symposium with international participation. We wish you a warm welcome, pleasant stay in Primošten, and successful presentations.

The Symposium has been continuously held every three years and gathers botanists from Croatia and neighbouring central and south eastern European countries. Since the First Croatian Botanical Symposium, held in Zagreb in 2004, it has become the main meeting where all significant botanical research is presented and new ideas are discussed. Therefore, this Symposium aims to share scientific and research knowledge among botanists and related experts, highlighting the importance of expertise sharing with colleagues from different countries. We are pleased that beside Croatian colleagues, we are joined by colleagues from Austria, Bosnia and Herzegovina, Bulgaria, Italy, Hungary, Macedonia, Slovenia, Serbia and Turkey. Altogether we are expecting more than 120 participants who will present the results of their research.

We are especially honoured to host the Education section "Botany in biology classes in primary and secondary schools" where we are expecting the participation of a large number of biology teachers. We hope that the prepared lectures and fruitful discussion will contribute to constructive transfer of botanical knowledge to future generations.

We are pleased that we will have the opportunity to attend two interesting lectures which prove the strong connection of botany as a science to our everyday lives, which will be in Croatian and open to public. The lecture "Why does spatial planning more often than not devastate heritage and weaken the development of high-quality tourism?" is co-organized with Scientific Council for Environmental Protection and Scientific Council for Adriatic Research of the Croatian Academy of Science and Arts.

Finally, we are looking forward to the excursion to beautiful Krka National Park where we will have the opportunity to enjoy local flora.

Many thanks to all the sponsors and donors who greatly facilitated and supported this symposium. We would also like to thank all of our colleagues who made this symposium possible by providing their help and devoted work.

On behalf of the Organizing and Scientific Committees of the 5th Croatian Botanical Symposium,

Ivana Rešetnik & Zrinka Ljubešić

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Program 5. Hrvatskog botaničkog simpozija s međunarodnim sudjelovanjem
Program of the 5th Croatian Botanical Symposium with international participation

Četvrtak / Thursday 22.9.2016

17:00	20:00	Registracija / Registration
20:00	22:00	Koktel dobrodošlice / Welcome cocktail

Petak / Friday 23.9.2016

8:00	9:00	Registracija / Registration
9:00	9:30	Svečano otvorenje / Opening ceremony
9:30	**11:00**	**Evolucija, taksonomija i filogenija / Evolution, taxonomy and phylogeny**
		Plenarno predavanje / Plenary lecture
9:30	10:00	Levkov Z.: ANTO JURILJ'S EVOLUTIONARY HYPOTHESIS AND ITS IMPLICATION FOR DIATOM RESEARCH ON LAKE OHRID
10:00	10:20	Mejdandžić M., Bosak S., Gligora Udovič M., Peharec Štefanić P., Kružić P., Špoljarić I., Mršić G., Orlić S., Ljubešić Z.: *ENTOMONEIS* SPECIES IN THE ADRIATIC SEA
10:20	10:40	Bošnjak I., Bosak S., Petrić I., Mihanović H., Ljubešić Z.: DISTRIBUTION OF *PROCHLOROCOCCUS* AND *SYNECHOCOCCUS* ECOTYPES IN THE SOUTHERN ADRIATIC SEA
10:40	11:00	Vugrin M., Mejdandžić M., Bosak S., Mihanović H., Dupčić- Radić I., Godrijan J., Orlić S., Ljubešić Z.: TAXONOMY AND SPATIAL DISTRIBUTION OF COCCOLITHOPHORS IN THE SOUTH ADRIATIC: WINTER ASPECT
11:00	11:20	Pauza za kavu / Coffee break
11:20	13:00	**Flora, ekologija, vegetacija i biogeografija / Flora, ecology, vegetation and biogeography**
		Fiziologija, anatomija i morfologija / Physiology, anatomy and morphology
11:20	11:40	Purger D., Házi J., Bartha S.: EFFECTS OF LAND USE CHANGES ON FLORISTIC RICHNESS AT LANDSCAPE SCALE: TRADITIONAL LAND USE - VS. LAND ABANDONMENT AND SPONTANEOUS SUCCESSION OF VEGETATION
11:40	12:00	Šegota V.: SPRING FLORA OF THE SOUTHERN SLOPES OF SVILAJA MT (SOUTHERN CROATIA)
12:00	12:20	Škrtić D.: PHYTOGEOGRAPHICAL CHARACTERISTICS OF ORCHIDS (ORCHIDACEAE) IN CROATIA
12:20	12:40	Zebec M., Idžojtić M., Mihaldinec I., Trogrlić N.: MORPHOLOGICAL VARIABILITY OF WHITE ELM (*ULMUS LAEVIS* PALL.) IN CROATIA
12:40	13:00	Mamić M., Puljak T., Mitić, B.: AEROBIOLOGICAL DYNAMICS OF THE *PARIETARIA* POLLEN TYPE IN THE AIR OF THE CITY OF SPLIT, 2005-2013.
13:00	14:30	Ručak / Lunch

14:30	16:40	**Fiziologija, anatomija i morfologija / Physiology, anatomy and morphology** **Primijenjena botanika / Applied botany** Plenarno predavanje / Plenary lecture
14:30	15:00	Salopek Sondi B.: FLORAL PHOTOSYNTHESIS: WHAT CAN WE LEARN FROM THE CHRISTMAS ROSE (*HELLEBORUS NIGER* L.)?
15:00	15:20	Rottensteiner W. K.: DIFFICULTIES IN THE MORPHOLOGICAL DIFFERENTIATION OF *HELLEBORUS* SPECIES IN ISTRIA
15:20	15:40	Sabovljević A., Vujičić M., Ćosić M., Sabovljević M.: WHAT DO WE KNOW ON SALT RESISTANCE IN BRYOPHYTES? CASE STUDIES ON SELECTED MOSSES
15:40	16:00	Dajić Stevanović Z., Stankovic J.: SURVEY OF BALKAN HALOPHYTIC FLORA: FROM BIODIVERSITY TO BIOACTIVITY
16:00	16:20	Vitasović Kosić I., Juračak J.: ETHNOBOTANY RESEARCH ON ĆIĆARIJA MT. (ISTRIA, CROATIA): THE USE OF WILD PLANTS AND MUSHROOMS
16:20	16:40	Yaman B.: ANATOMY OF ARCHAEOLOGICAL WOOD CHARCOALS AT URARTIAN SITE OF AYANIS IN VAN PROVINCE, EASTERN TURKEY
16:40	17:00	Pauza za kavu / Coffee break
17:00	19:30	Posterska sekcija / Poster session **Evolucija, taksonomija i filogenija / Evolution, taxonomy and phylogeny** **Fiziologija, anatomija i morfologija / Physiology, anatomy and morphology** **Konzervacijska biologija, zaštita prirode i okoliša / Conservation biology, environmental and nature protection** **Primijenjena botanika / Applied botany**
18:00	19:30	Pozvana predavanja / Invited lectures **Konzervacijska biologija, zaštita prirode i okoliša / Conservation biology, environmental and nature protection** **(samo na hrvatskom, otvoreno za javnost / in Croatian only, open to public)**
18:00	18:30	Viličić D.: ZAŠTO BROJNI PROSTORNI PLANOVI DEVASTIRAJU NACIONALNU BAŠTINU I SLABE RAZVOJ KVALITETNOG TURIZMA?
18:30	19:30	Bakić J.: PRIKAZ NUTRIONISTIČKO-ANTROPOLOŠKO-ETNOGRAFSKIH ISTRAŽIVANJA NEKONVENCIONALNIH HRANIDBENIH IZVORA U PRIMORJU HRVATSKE S POSEBNIM OSVRTOM NA ETNOBOTANIKU (1962. - 1986.)
20:30	0:00	After work party

Subota / Saturday 24.9.2016

8:00	9:00	Registracija / Registration
9:00	10:50	**Flora, ekologija, vegetacija i biogeografija / Flora, ecology, vegetation and biogeography** **Konzervacijska biologija, zaštita prirode i okoliša / Conservation biology, environmental and nature protection** Plenarno predavanje / Plenary lecture
9:00	9:30	Alegro A.: MACROPHYTE VEGETATION OF RIVERS IN CROATIA – DIVERSITY AND ECOLOGICAL INDICATION POTENTIAL

9:30	9:50	Papp B., Alegro A., Šegota V., Szurdoki E.: CONTRIBUTION TO THE EXPLORATION OF THE BRYOPHYTE FLORA OF CROATIA IN LAST FIVE YEARS WITH A SPECIAL ATTENTION TO THE SPECIES OF CONSERVATION INTEREST
9:50	10:10	Kaya Z., Yaman B.: FLORA OF BARTIN IN THE WESTERN BLACK SEA REGION OF TURKEY
10:10	10:30	Prlić D.: FINAL RESEARCH OF THE VASCULAR FLORA AND HABITAT MAPPING IN THE CITY OF SLATINA, CROATIA
10:30	10:50	Ozimec S., Prlić D.: ACTUAL STATE OF DIVERSITY OF THE LICHEN MYCOTA IN CROATIA
10:50	11:10	Pauza za kavu / Coffee break
11:10	13:30	**Konzervacijska biologija, zaštita prirode i okoliša / Conservation biology, environmental and nature protection** **Edukacija, promocija i strukovno djelovanje / Education, promotion and progress in botany**
11:10	11:30	Sirotić G., Šehić S.: DIGITALIZATION OF OLDER ISSUES OF THE JOURNAL ACTA BOTANICA CROATICA (1925-2001)
11:30	11:50	Bavcon J., Ravnjak B.: IN-SITU CONSERVATION OF MEADOW PLANT SPECIES
11:50	12:10	Srečec S., Kremer D., Dujmović Purgar D., Karlović K., Bezić N., Dunkić V., Erhatić R.: BOTANICAL APPROACH IN PROBLEM SOLVING IN GROWING AND PROCESSING OF CAROB TREE (*CERATONIA SILIQUA* L.)
12:10	12:30	Vuković N., Šegota V., Alegro A., Koletić N.: „FLYING UNDER THE RADAR“ – INVASIVE *REYNOUTRIA* × *BOHEMICA* CHRTEK ET CHRTKOVÁ (POLYGONACEAE) IN CROATIA
12:30	12:50	Škegro M., Bićanić Marković E. , Lončar G. , Tomašević I., Vranješ D.: INVASIVE SPECIES – MITTIGATION MEASURES TO REDUCE ENVIRONMENTAL IMPACTS
12:50	13:10	Škunca M., Šteko V., Berta A., Mesić Z.: EVALUATION OF THE ISLAND OF VELI BRIJUN FROM THE ASPECT OF BIODIVERSITY
13:10	13:30	Škunca L., Škunca M., Peternel H.: APPLICATION OF RISK ASSESSMENT FOR PLANT INVASIVENESS IN CROATIA – A PRELIMINARY COMPARISON
13:30	14:30	Ručak / Lunch
14:30	19:30	Paralelne sekcije / Parallel sessions A/B
		A
14:30	16:40	**Evolucija, taksonomija i filogenija / Evolution, taxonomy and phylogeny** **Konzervacijska biologija, zaštita prirode i okoliša / Conservation biology, environmental and nature protection**
		Plenarno predavanje / Plenary lecture
14:30	15:00	Peruzzi L.: SPECIES, EASY TO CREATE, DIFFICULT TO DESTROY
15:00	15:20	Rešetnik I., Frajman B., Schönswetter P.: DIVERSIFICATION AND TAXONOMY OF HETEROPLOID *KNAUTIA DRYMEIA* HEUFF.
15:20	15:40	Jogan N., Nikolić T.: IS THE STATE BORDER ALSO A BIOGEOGRAPHICAL ONE?
15:40	16:00	Fišer Pečnikar Ž., Fujs N., Brus R., Ballian D., Bužan E.: CONSERVATION GENETICS OF *DAPHNE BLAGAYANA* FREYER (THYMELAEACEAE)
16:00	16:20	Ravnjak B., Bavcon J.: PLANT COLONIZATION INTO NATURAL GAP OPPENINGS IN FOREST
16:20	16:40	Žuljević A., Antolić B.: *PNEOPHYLLUM CETINAENSIS* – FROM MARINE TO FRESHWATER HABITAT

16:40	17:00	Pauza za kavu / Coffee break
17:00	19:30	Posterska sekcija / Poster session **Flora, ekologija, vegetacija i biogeografija / Flora, ecology, vegetation and biogeography** **Edukacija, promocija i strukovno djelovanje / Education, promotion and progress in botany**
14:30	19:30	**B** **Nastavnička sekcija: Botanika u nastavi biologije u osnovnim i srednjim školama** **(samo na hrvatskom jeziku) / Education section (in Croatian only)**
14:30	16:40	Škrtić D.: PRIMJENA HERBARA U NASTAVI BIOLOGIJE Rinčić D.: ODGOJNE MOGUĆNOSTI ŠKOLSKIH VRTOVA I MOGUĆNOST REALIZACIJE DIJELA NASTAVE U ŠKOLSKOM VRTU Alegro A.: KLJUČNI KORACI U EVOLUCIJI KOPNENIH BILJAKA Gligora Udovič M.: CIJANOBAKTERIJE I NJIHOVA ULOGA U EVOLUCIJI FOTOSINTETSKIH ORGANIZAMA Ježić M.: INTERSPECIJSKE ASOCIJACIJE GLJIVA
16:40	17:00	Pauza za kavu / Coffee break
17:00	17:45	Tkalec M.: ŠTO RADIMO KRIVO: POGREŠNE PREDODŽBE O PROCESU FOTOSINTEZE
17:45	19:30	Okrugli stol
19:30	19:45	Papp B.: Collections Self-Assessment Tool (SYNTHESYS 3)
19:45	20:00	Završna riječ / Closing remarks

Nedjelja / Sunday 25.9.2016

9:00	17:00	Stručna ekskurzija u NP Krka / Excursion NP Krka

Petak / Friday 23. 9. 2016

17:00 19:30 Posterska sekcija / Poster session

Evolucija, taksonomija i filogenija / Evolution, taxonomy and phylogeny

- Arapov J., Skejić S., Bužančić M., Bakrač A., Ujević I., Ninčević Gladan Ž.: DIVERSITY OF *PSEUDO-NITZSCHIA* SPECIES DURING OCCURRENCE OF DOMOIC ACID IN SHELLFISH FROM KAŠTELA BAY, CENTRAL ADRIATIC SEA
- Berković B., Žutinić P., Ogresta L., Ćukurin A., Plenković-Moraj A., Levkov Z.: DIVERSITY OF DIATOMS IN THE PLITVICE LAKES
- Car A., Hafner A., Jasprica N., Ljubimir S., Dupčić Radić I.: BENTHIC DIATOMS OF THE DEATH SEA (ISLAND OF LOKRUM, ADRIATIC SEA COAST)
- Hafner D., Arapović B., Dedić A.: DIATOMS OF RIVERS NERETVA, CETINA AND TREBINJŠCICA IN BOSNIA AND HERZEGOVINA
- Levkov Z., Hinz F., Gligora Udovič M., Plenković-Moraj A.: TYPIFICATION OF DIATOMS DESCRIBED BY ANTO JURILJ (1910—1981) IN 1948 AND 1954 FROM LAKE OHRID
- Mitić B., Hazler Pilepić K., Hruševar D., Halbritter H.: POLLEN AND SEED MORPHOLOGY OF THE GENUS *HYPERICUM* L. (HYPERICACEAE) - TAXONOMICAL IMPLICATIONS
- Novaković J., Rajčević N., Boršić I., Marin P., Janaćković P.: ESSENTIAL OIL COMPOSITION OF *CENTAUREA ATROPURPUREA* WALDST. & KIT. FROM LIKA (CROATIA)
- Raos P., Bosak S., Mejdandžić M., Ljubešić Z.: MICROPHYTOPLANKTON WINTER DIVERSITY IN THE SOUTH ADRIATIC SEA
- Skejić S., Arapov J., Bakrač A., Bužančić M., Ninčević Gladan Ž.: VARIABILITY OF COCCOLITHOPHORIDS IN OPEN WATERS OF THE CENTRAL ADRIATIC SEA
- Tofilovska S., Reed J.M., Cvetkoska A., Francke A., Wagner B., Levkov Z.: DIATOMS FROM ANCIENT LAKE OHRID AS PALAEOECOLOGICAL INDICATORS OF CLIMATE CHANGE DURING MARINE ISOTOPE STAGES 11-10. PRELIMINARY RESULTS

Fiziologija, anatomija i morfologija / Physiology, anatomy and morphology

- Dahija S., Karalija E., Parić A., Muratović E., Đug S.: EFFECTS OF HEAVY METAL CONTAMINATED WATER ON PHENOLICS CONTENT IN *MENTHA AQUATICA*
- Erhatić R., Pešec Ž., Židovec V.: CERTAIN MORPHOMETRIC AND CHEMICAL PROPERTIES OF SWEET VIOLET (*VIOLA ODORATA* L) DEPENDING OF THE GROWING MEDIA
- Fišer Pečnikar Ž., Jeklar M.: EFFECTS OF SALINITY AND TEMPERATURE ON GERMINATION OF THE INVASIVE *AMORPHA FRUTICOS*A L. (FABACEAE)
- Friščić M., Štibrić M., Milović M., Hazler Pilepić K.: PHYTOCHEMICAL SCREENING AND ANTIOXIDANT POTENTIAL OF EIGHT MEMBERS FROM THE GENUS *GALIUM* L.
- Klisura T., Parić A., Tukulija A., Karalija E.: AIR POLLUTION TOLERANCE INDEX (APTI) OF *PLANTAGO MAJOR* L. IN THE IRONWORK AREA ZENICA (BOSNIA & HERZEGOVINA)
- Kukuljac B., Tukulija A., Parić A., Muratović E., Pustahija F., Karalija E.: INFLUENCE OF SALICYLIC ACID PRE-TREATMENT ON GERMINATION, VIGOUR AND GROWTH PARAMETERS OF *SILENE SENDTNERI* BOISS.
- Subašić M., Berilo A., Handžić E., Bašić N., Pustahija F.: PRELIMINARY PHYTOCHEMICAL SCREENING OF SECONDARY METABOLITES IN LEAVES AND BARK IN 25 DENDRO SPECIES
- Subašić M., Konjo S., Duraković R., Pustahija F.: TOTAL PHENOLICS, ANTIOXIDATIVE POTENTIAL AND ANTIMICROBIAL ACTIVITY OF METHANOL EXTRACTS OF *SILENE SENDTNERI* BOISS.
- Tukulija A., Kukuljac B., Parić A., Muratović E., Pustahija F, Karalija E.: CUMULATIVE EFFECT OF SALICYLIC ACID ON SEED GERMINATION OF *SILENE SENDTNERI* BOISS.

- Zebec M., Drvodelić D., Moro M.: QUANTIFICATION OF *ULMUS MINOR* MILL. SENSU LATISSIMO FRUIT SHAPE VARIABILITY IN CROATIAN MEDITERRANEAN VIA ELLIPTIC FOURIER DESCRIPTORS

Konzervacijska biologija, zaštita prirode i okoliša / Conservation biology, environmental and nature protection

- Boršić I., Smolec R.: NEW LOCALITIES OF *ALYSSUM MONTANUM* L. SSP. *PLUSCANESCENS* (RAIM. EX BAUMGARTNER) TRPIN (BRASSICACEAE) OUTSIDE OF SPECIAL RESERVE BREŽULJAK KOD SMEROVIŠĆA AND NEW THREAT CATEGORY PROPOSED
- Hazler Pilepić K., Antolić G., Bakotić Ž., Balent M., Čaleta M., Friščić M., Hrs D., Sakoman D., Rivić B., Vidić V.: SEED GERMINATION OF EIGHT *HYPERICUM* L. TAXA
- Ježić M., Mlinarec J., Nuskern L., Tkalec M., Katanić Z., Vuković R., Krstin Lj., Poljak I., Idžojtić M., Ćurković-Perica M.: CHANGES IN POPULATIONS OF *CRYPHONECTRIA PARASITICA* IN CROATIA OVER THE LAST TEN YEARS
- Lasić L., Ahatović A., Radosavljević G., Čakar J., Bogunić F., Bajrović K.: OPTIMIZATION OF DNA ISOLATION FROM FIVE ENDEMIC B&H LAMIACEAE SPECIES
- Likić S., Maslać M., Jukić M., Tkalec M.: THE EFFECT OF THE OIL REFINERY POLLUTION ON HEAVY METAL CONTENT AND SECONDARY METABOLITES IN LICHENS *FLAVOPARMELIA CAPERATA* AND *PARMELIA SULCATA*
- Mihelj D., Sandev D.: LIST OF POTENTIALLY INVASIVE SPECIES (IAS) THAT ARE GROWN OUTDOORS IN THE BOTANICAL GARDEN, FACULTY OF SCIENCE, UNIVERSITY OF ZAGREB
- Petković A., Šegota V., Alegro A.: POPULATION SIZE, CONSERVATION STATUS AND MORPHOLOGICAL CHARACTERIZATION OF CRITICALLY ENDANGERED DOWNY BIRCH (*BETULA PUBESCENS* EHRH.) AND HYBRID BIRCH (*B. x BLATUSAE* PEVALEK) IN CROATIA
- Poljak I., Idžojtić M., Šatović Z., Ježić M., Ćurković-Perica M., Liber Z.: GENETIC DIVERSITY OF THE SWEET CHESTNUT (*CASTANEA SATIVA* MILL.) IN CENTRAL EUROPE AND WESTERN PART OF BALKAN PENINSULA
- Sandev D., Kovačić S.: SEED GERMINATION ECOLOGY OF CROATIAN STATUTORILY STRICTLY PROTECTED SPECIES
- Stević F., Špoljarić Maronić D., Žuna Pfeiffer T., Zahirović V., Mihaljević M.: THE ECOLOGY OF CYANOBACTERIA IN THE TEMPERATE FLOODPLAIN LAKE

Primijenjena botanika/ Applied botany

- Car A.: PLANTS IN THE TREATMENT OF TUBERCULOSIS
- Hadžić M., Lasić L., Haverić A., Lojo-Kadrić N., Čakar J., Haverić S.: CYTOTOXICITY EVALUATION OF *THYMUS BRACTEOSUS* VIS. EX BENTHAM (LAMIACEAE) AQUEOUS EXTRACT IN HUMAN PERIPHERAL BLOOD LYMPHOCYTES *IN VITRO*
- Jug-Dujaković M., Ninčević T.: THE USE OF WILD PLANTS IN AREA OF KLIS (CROATIA)
- Maleš Ž., Antolić A., Suban Jakuš V., Miličević I., Tomičić M., Bojić M.: HPLC ANALYSIS AND ANTIAGGREGATORY ACTIVITY OF LEMON BALM – *MELISSA OFFICINALIS* L. LEAVES ETHANOLIC EXTRACTS
- Šišić S., Randić M., Jurić I., Rogić I., Kremer D.: ENDEMIC FLORA OF RIJEKA AND THE "RIJEKA RING", CROATIA – SOME ASPECTS OF PRACTICAL USE OF KNOWLEDGE OF ENDEMIC PLANTS
- Vujčić V., Radić Brkanac S., Radić Stojković M., Žilić I., Tolić S., Krivohlavek A., Ivanković S., Hrenović J., Ruščić M., Grienke U., Rollinger J.: BIOLOGICAL ACTIVITY OF ETHANOLIC EXTRACT AND FRACTIONS FROM *CENTAUREA RAGUSINA* L.
- Vujičić M., Ristivojević P., Saboljević A., Rajčić M., Šegan S., Sabovljević M.: PHENOLIC PROFILES OF THE MOSSES *POLYTRICHUM FORMOSUM* AND *PHYSCOMITRELLA CALIFORNICA*

Subota / Saturday 24.9.2016

17:00 19:30 Posterska sekcija / Poster session

Edukacija, promocija i strukovno djelovanje / Education, promotion and progress in botany

- Barbarić – Gaćina J., Perić M.: THE GREEN STREETS OF OUR TOWN (PHOTOHERBARIUM)
- Bogut I., Popović Ž., Ljubojević B., Vuković K.: YOUNGER SCHOOLCHLIDREN'S KNOWLEDGE ABOUT FOREST PROTECTION AND CULTIVATION
- Broz J., Čičak M., Škegro M.: INTERNATIONAL YEAR OF PULSES – EDUCATION OF PRIMARY SCHOOL PUPILS
- Kletečki N., Mitić B., Razlog-Grlica J.: STUDENT PROJECT "SPRING FLOWERS OF MY HOMETOWN"
- Kostović-Vranješ V., Bulić M.: THE IMPACT OF EXPERIMENTAL WORK IN REDUCING STUDENTS' MISCONCEPTIONS IN TEACHING SCIENCE
- Vlahović D., Mitić B.: PUPILS' MINI PROJECT: INVASIVE PLANTS IN THE SURROUNDING AREA OF OUR SCHOOL

Flora, ekologija, vegetacija i biogeografija / Flora, ecology, vegetation and biogeography

- Asenov A.: THE TERTIARY RELICT SPECIES *OSTRYA CARPINIFOLIA* SCOP. AND *PINUS NIGRA* ARNOLD ON MT FALAKRON, NORTH-EASTERN GREECE
- Barudanović S., Mašić E.: FLOODED FORESTS AS A TOOL FOR RESTORATION OF COASTAL AREA OF MINE PIT LAKES IN BOSNIA AND HERZEGOVINA
- Barudanović S., Mašić E.: EFFECT OF HEAVY METALS ON PHYTOBENTHOS IN MINE PIT LAKES OF BOSNIA AND HERZEGOVINA
- Bogdanović S., Britvec M., Dujmović Purgar D., Ljubičić I., Vitasović Kosić I.: AN OVERVIEW OF ZAGR HERBARIUM OF THE FACULTY OF AGRICULTURE IN ZAGREB (CROATIA)
- Borak Martan V., Šoštarić R.: URBAN FLORA OF VARAŽDIN
- Budisavljević A., Mihelić P., Papković D., Špadina B., Terlević A., Šegota V.: VASCULAR FLORA INVENTARISATION AND MAPPING IN DOTRŠČINA MEMORIAL PARK
- Dolina K., Jasprica N., Milović M., Pandža M.: THE FLORISTIC COMPOSITION OF THE *SPARTIUM JUNCEUM*-STANDS ON THE FLYSCH (SOUTH CROATIA)
- Hruševar D., Bakrač K., Miko S., Ilijanić N., Hasan O., Mitić B.: WHAT CAN POLLEN AND SPORES TELL US ABOUT THE FLORA DIVERSITY – THE PRELIMINARY RESULTS FROM THE BLATUŠA AREA
- Husnjak Malovec K., Vitko S., Kranjčević D., Geušić I.: INVASIVE FLORA IN THE EASTERN PART OF THE NATURE PARK ŽUMBERAK – SAMOBORSKO GORJE
- Husnjak Malovec K., Mitić B., Alegro A., Łuczaj Ł.: TRADITIONAL USE OF WILD PLANTS IN SAMOBOR AND ŽUMBERAK AREA
- Jasprica N., Milović M., Dolina K., Pandža M.: VEGETATION ANALYSIS OF THE ŽUPA DUBROVAČKA REGION (SOUTH CROATIA): A PLANT LANDSCAPE CHARACTERISED BY ANTHROPOGENIC INFLUENCE
- Jeričević M., Jeričević N.: DISTRIBUTION OF THE *SERAPIAS* SPECIES ON THE ISLAND OF KORČULA
- Krstonošić D., Temunović M., Sever K., Katičić Bogdan I., Čarni A., Škvorc Ž., Franjić J., Bogdan S.: FLORISTIC AND ECOLOGICAL CHARACTERISTICS OF PEDUNCULATE OAK (*QUERCUS ROBUR* L.) FORESTS IN EUROPE
- Ljubičić I., Vugrinčić F., Dujmović Purgar D.: WILD MEDICINAL AND AROMATIC PLANTS OF THE SOUTHEASTERN SAMOBORSKO GORJE MEADOWS
- Lučić P., Žuljević A.: *UMBRAULVA DANGEARDII* - RARELY REPORTED SPECIES IN THE ADRIATIC SEA

- Paušič I., Kaligarič M., Bakan B.: LATE SEASONAL MOWING ENHANCES CENTRAL-EUROPEAN *SPIRANTHES SPIRALIS* (L.) CHEVALL. (ORHIDACEAE) POPULATION VIABILITY
- Prlić D.: DISTRIBUTION AND HABITATS OF THE ENDEMIC *CARDAMINE WALDSTEINII* DYER IN THE SLATINA AREA, CROATIA
- Randić M., Kremer D.: MORPHOLOGICAL AND ECOLOGICAL CHARACTERIZATION OF THE NEWLY FOUND *CROCUS* × *VELEBITICUS* RANDIĆ ET KREMER (*C. MALYI* × *C. VERNUS*)
- Rat M., Bogdanović S.: *ORNITHOGALUM SIBTHORPII* GREUTER (ASPARAGACEAE) IN CROATIA
- Ruščić M., Raos G.: THE FLORA OF WALLS OF THE SPLIT AREA
- Ruščić M., Zubčić I.M.Z.: THE EPIPHYTE FLORA ON THE PALMS SPECIES *PHOENIX CANARIENSIS* CHABAUD
- Šegota V., Šapić I., Alegro A., Vukelić J.: *GLYCERIA STRIATA* (LAM.) HITCHC. (POACEAE) – A NEWCOMMER IN CROATIA
- Tekebaş S., Kaya Z.: FLORA OF ZONI PLATEAU (BARTIN)
- Temunović M., Krstonošić D., Sever K., Katičić Bogdan I., Bogdan I., Škvorc Ž., Franjić J.: NICHE CHARACTERISTICS OF PEDUNCULATE OAK (*QUERCUS ROBUR*) ALONG THE SPECIES DISTRIBUTION RANGE IN EUROPE
- Vilović T., Buzjak S., Buzjak N.: GEOECOLOGICAL AND FLORISTIC FEATURES OF THE SOVLJAK DOLINE (MT. VELIKA KAPELA, CROATIA)
- Vladović D, Ževrnja N., Hruševar D., Mekinić S., Piasevoli G., Damjanović T., Boban J., Cvitanić R., Barbarić S.: FLORA ALONG THE KARST SPRINGS RUMIN VELIKI AND RUMIN MALI (DALMATIA, CROATIA)
- Vladović D., Mitić B., Ževrnja N.: ANALYSIS OF THE FAMILY COMPOSITAE FROM CARL STUDNICZKA'S HERBARIUM
- Vučetić V., Britvec M.: PHENOLOGICAL CHANGES IN APPLE TREES IN NORTHERN CROATIA
- Vucić A., Hrga I., Stjepanović B., Večenaj A., Mitić B., Peroš- Pucar D., Puca, B.: SPATIAL AND TEMPORAL DISTRIBUTION OF RAGWEED POLLEN IN THE EXAMPLE OF ZADAR AND ZAGREB
- Vukojević M., Vitasović Kosić I., Bogdanović S.: PLANT AND HABITAT DIVERSITY OF MATOKIT MT. (VRGORAC) – NEW FINDINGS OF ENDEMIC TAXA
- Zima D.: RESEARCH OF BOTANICAL VALUABLE SPECIES IN THE AREA PLIŠ-MALIŠĆAK-TURJAK-LAPJAK
- Žutinić P., Gligora Udovič M., Berković B., Ogresta L., Plenković-Moraj A.: BENTHIC DIATOMS – INDICATORS OF ECOLOGICAL STATUS OF KARSTIC LAKES

USMENA PRIOPĆENJA

Plenarna predavanja

ORAL PRESENTATIONS

Plenary lectures

ANTO JURILJ'S EVOLUTIONARY HYPOTHESIS AND ITS IMPLICATION FOR DIATOM RESEARCH ON LAKE OHRID

Levkov, Z.*

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The diatom flora of Lake Ohrid has been under investigation for more than a century and has resulted in the recognition of around 900 different taxonomic entities. Although several floristic studies have been published, one of the more important studies was undertaken by Anto Jurilj (1910-1981), a Croatian diatomist, who published his observations in four publications (Jurilj 1948, 1954, 1956, 1957). In these, Jurilj provided several important results on the taxonomy, biogeography, phylogeny and evolution of Lake Ohrid diatoms. According to his studies the diatom flora of Lake Ohrid is characterized by its high diversity, endemism and abundance of relict taxa. However, besides just describing many new diatom taxa (genera and species), Jurilj proposed some important ideas concerned the phylogeny and evolution of the Surirelloid diatoms. Jurilj proposed that species in the genera *Surirella* and *Campylodiscus* were the ultimate members of a phylogenetic lineage that had several transitional forms. The Lake Ohrid Surirelloids represent a complete series of those transitional taxa and provide evidence that the evolutionary process of speciation is a result of cladogenesis. Thus, for example, *Campylodiscus* is not the result of a direct line of descent, but only a branch. It is important to point out that this evolutionary process began in the Miocene, but not in Lake Ohrid, while the transitional forms still exist in the lake. These finding suggest several important questions concerning the age, origin, phylogeny, evolution and speciation of diatoms in Lake Ohrid. Answers to these questions might be obtained by examination of the fossil record and molecular/genetic analyses of extant populations.

Recently, the deep-drilling project SCOPSCO (Scientific Collaboration On Past Speciation Conditions in Lake Ohrid) was initiated to investigate the influence of past geological and environmental events on the biological evolution of the lake biota. According to geochemical analyses and extrapolation of average sedimentation rates, the age of the lake is estimated at ca. 2 million year (Myrs). The data from the core sequence also implies that Lake Ohrid did not experience any major catastrophic events, such as extreme lake level low stands or desiccation events. Lake Ohrid, however, did experience a number of environmental disturbances during its ca. 2.0 Myrs history. These comprised of disturbances that lasted over longer periods of time (“press events”), such as glacial–interglacial cycles and Heinrich events, as well as sudden and short disturbances (“pulse events”), like the deposition of landslides, earthquakes and volcanic ash depositions. Depending on the magnitude of the disturbance and the resilience of the ecosystem, the lake biota may react with extinction events and/or changes in community structures and function. Data from core sequences suggest that the communities in Lake Ohrid probably did not experience regime shifts and the lake show a high

resilience to environmental disturbances. This might accord with the constant diversification rate of species, but also with the lack of an abundance of extinction events. Examples of anagensis and cladogenesis in the genera *Cyclotella* (planktonic) and *Surirella* (benthic) might be observed in the core sequence. It is supposed that evolution of planktonic species is anagenetic (phyletic transformation), while the evolution of benthic species is cladogenetic.

Molecular analyses (multilocus phylogeny) of selected diatom genera has shown that intralacustrine speciation very likely occurred in Lake Ohrid. Molecular data on the Surirelloids show that the genus *Spirodiscus* is sister to a *Scoliodiscus*/*Campylodiscus hibernicus* clade, and also the genera *Iconella* and *Helissella*, which have species with apical torsion to their valves, were found to be sister to one another. Such data provide support for hypothesising the evolutionary steps leading to *Campylodiscus* by both morphological and molecular data.

Few endemic species from Lake Ohrid related to *Diploneis elliptica* form a monophyletic clade, supporting the hypothesis of intralacustrine speciation. However, data show that *Diploneis* taxa (lineages) from Lake Ohrid form a paraphyletic assemblage that might be the result of multiple colonization events or the colonization of different evolutionary lineages. The age estimates obtained from molecular-clock analysis reveals that the species flocks from Lake Ohrid potentially started to diversify before the extant lake came into existence. The species were present in a pre-lake/paleo-lake phase or in other waterbodies of the Ohrid Graben system, such as rivers or springs, and continued to exist in the extant lake. The evidence for such hypothesis might be found in the core sequences, where the deepest (oldest) parts of the core are dominated by the benthic species with almost the same morphology as contemporary species.

Finally, the high diversity and endemism of diatoms in Lake Ohrid is very likely not the result of a single process, but of multiple factors including several colonizations, the presence of relicts and speciation, all of which can contribute to the high diversity. Alternatively, the presence of relict species in the lake may have been caused by two factors: (i) a lack of catastrophic environmental events in Lake Ohrid; and/or (ii) high ecosystem resilience, buffering any environmental changes. The occurrence of Surirelloid species observed and described by Jurilj from Lake Ohrid provides support of these hypotheses.

Anto Jurilj, in his extraordinary work on Lake Ohrid, noticed events that are now gaining support from fossil (core sequences) and molecular data.

FLORAL PHOTOSYNTHESIS: WHAT CAN WE LEARN FROM THE CHRISTMAS ROSE (*HELLEBORUS NIGER* L.)?

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Although leaves have been traditionally considered as the main source of photo-assimilates, the reproductive structures of many plant species may also perform photosynthesis and be significant source of assimilates. Non-foliar organs, such as green petals, spathe and receptacle, developing fruits, and stem tissues, have thus been reported as potential source of photo-assimilates. Question arises: what is the role of non-foliar tissues greening and photosynthesis, and how is this process regulated? Floral greening of Christmas rose (*Helleborus niger* L.) has been examined in details and represents a good example for functionality of non-foliar photosynthesis.The sepals of the Christmas rose, which are white at anthesis, persist until the seeds are ripe and become intensely green during that period. Unpollinated or depistillated flowers survive almost as long as their fruit-bearing neighbours, but do not pass through the complete greening process. Removal of the gynoecium also affects the shape of the flower and the length of the flower scape. Fertilization and fruit development are triggers that modulate foliar photosynthesis in the Christmas rose. The correlative signals which maintain these morphogenetic processes appear to include plant hormones (cytokinins, gibberellins, auxins) synthesized in the developing fruit. The life-cycle of the flowers is almost complementary to that of the leaves. Leaves survive normal winters, but are often pressed to the ground by snow and covered with debris, and thus no longer fully operative during anthesis. They will then die back around the time when fruit development is initiated. The new generation of leaves starts appearing a few weeks later and is not always fully expanded, at seed maturity. Since leaves are only moderately functional when the fructification occurs, the green sepals of Christmas rose are thus responsible to carry out the bulk of photosynthesis and provide assimilates for the developing fruit. This flexibility should be a competitive advantage for a species exposed, during fruit set, to the stressful, ever changing, weather conditions of a South-European winter and early spring.

MACROPHYTE VEGETATION OF RIVERS IN CROATIA – DIVERSITY AND ECOLOGICAL INDICATION POTENTIAL

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The aim of this study was to gain insight in diversity and distribution of river macrophytes in Croatia, to develop typology of macrophyte vegetation and to apply these data in establishing of macrophyte based index for the ecological quality assessment of rivers.
In the period 2009-2015 almost 500 sampling spots on rivers randomly scattered through all biogeographical regions of Croatia were surveyed. This included almost all Croatian rivers and replicates along the watercourses including repeated sampling on the same locality in three year periods. Abundances of macrophytes (flowering plants, bryophytes and charophytes) were assessed using ordinal scales (extended Braun-Blanquet and Kohler scales). The chemical and physical parameters of water, as well as geomorphology and bank vegetation were also surveyed following standard protocol. Different correlation and ordination procedures were employed to identify main ecological gradients and to define vegetation units. Several general types of macrophyte vegetation were recognized: (i) moss communities (*Platyhypnidium-Fontinalis* type) with two main subtypes depending on water regime; (ii) communities with *Berula erecta* and other herbids with several variants; (iii) communities with submerged and floating macrophytes (*Scirpus-Sparganium-Nuphar* type), which are the species richest and very often heavily changed in Panonnian ecoregion; (iv) communities with narrow leaved submerged macrophytes (*Myriophyllum* type) with special, species rich subtype of cold, fast watercourses of Lika region; (v) communities of broad leaved *Potamogeton* species characteristic for medium sized and large rivers; and (vi) communities with *Callitriche* species restricted to small, slow flowing watercourses with organic or muddy substrate. Each vegetation type was associated with biogeographical regions, river types and water quality. Changes of each vegetation type due to river degradation were described and used for establishing of macrophyte-based index for the ecological quality assessment of rivers.

SPECIES, EASY TO CREATE, DIFFICULT TO DESTROY

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A summary of different *species concepts* and their application in plants is presented, up to a tentative unitary definition, excerpted from Warren Wagner's work (1984):

> In the light of present usage, I would define *species as a convenient taxonomic category that defines a unit of organismic diversity in a given time frame and composed of individual organisms that resemble one another in all or most of their structural and functional characters, that reproduce true by any means, sexual or asexual, and constitute a distinct phylogenetic line that differs consistently and persistently from populations of other species in gaps in character state combinations including geographical, ecological, physiological, morphological, anatomical, cytological, chemical, and genetic, the character states of number and kind ordinarily used for species discrimination in the same and related genera, and if partially or wholly sympatric and coexistent with related species in the same habitats, unable to cross or, if able to cross, able to maintain the special distinctions.*

Different ways to be a species need obviously different experimental approaches to taxonomy. However, the main problem is that the vast majority of described (and currently accepted) species in plants are still in the so-called William Bertram Turrill's "*alpha*" taxonomy. You may think that it is a problem limited to species described in the past, but this is not the case! In addition, even in those groups where more or less accurate biosystematic studies were carried out (i.e. Turrill's "*beta*" to "*omega*" taxonomy), rarely the obtained results give a direct evaluation of the biological relevance of a species or of the evolutionary processes underlying it; more often, these experimental results allow only indirect, not resolute, inferences.

The basic idea of the lecture is to evidence, both theoretically and on concrete examples, that to formally describe a new species (/subspecies /variety) was, and still is today, a relatively easy task, even with rather poor biological documentation. When later scholars study it with different approaches, it may happen that their new experimental systematic data do not support any concrete biological distinctiveness of the taxon. Despite this, it may be very difficult to definitely state that a species falls in synonymy (i.e. it is a heterotypic synonym) with another.

Although the analytical tools available in the last decades to taxonomists became more and more powerful, the subjectivity in defining *ranks* is still apparent, concerning not only the generic and suprageneric levels (a notoriously difficult task), but also the specific and infraspecific categories.

This should be kept in mind not only by taxonomists, but by all plant biologists in general. No solutions are at hand, but a single word is crucial for anyone managing species, either as scientific names or biological units: *awareness*.

Tema simpozija

Evolucija, taksonomija i filogenija

Symposium topic

Evolution, taxonomy and phylogeny

VRSTE RODA *ENTOMONEIS* U JADRANSKOM MORU

Mejdandžić, M.[1]*, Bosak, S.[1], Gligora Udovič, M.[1], Peharec Štefanić, P.[1], Kružić, P.[1], Špoljarić, I.[3,4], Mršić, G.[3,4], Orlić, S.[2], Ljubešić, Z.[1]

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Rod *Entomoneis* Ehrenberg predstavlja penatne dijatomeje koje uglavnom nastanjuju brakične i morske sedimente, rjeđe plankton i slatke vode. Dijatomeje ovog roda odlikuju se sa složenom strukturom silicijevih ljušturica, sinusiodnim uzdignutim kanalom rafe, morfološki promjenjivim fibulama te brojnim pojasevima u cingulumu. Specifične morfološke značajke ovih dijatomeja su torzija stanice za 90° obzirom na uzdužnu os stanice te slaba silificiranost ljušturice. U Jadranu su do sada zabilježene tri različite vrste roda *Entomoneis* - *E. alata*, *E. paludosa* i *E. pulchra* od kojih nijedna nije kultivirana i temeljito analizirana morfološkim i molekularnim analizama. Tijekom projekta BIOTA (Bio-tracing Adriatic Water Masses) i ekspedicije provedene u veljači i ožujku 2015. te ožujku 2016. godine u jugoistočnom Jadranu te uzorkovanja provedenih u srednjem Jadranu (Park Prirode Telašćica i Nacionalni Park Kornati) tijekom lipnja i listopada 2015., sakupljeni su brojni uzorci u kojima su determinirane vrste roda *Entomoneis*. Iz navedenih uzoraka stanice su ručno izolirane mikropipetom i nasađivanjem na agar te kultivirane u Guillard F2 mediju. Tijekom ekspedicije 2015. u mrežnim uzorcima fitoplanktona pronađene su neobične stanice ovog roda (do 200 stanica L^{-1}) te su kultivirana tri monoklonalna soja. Nakon morfoloških analiza svjetlosnom i elektronskom mikroskopijom (TEM SEM) te molekularnih analiza kultivata (filogenija na bazi tri genska markera: SSU, rbcL, psbC) zaključili smo da vjerojatno predstavljaju novu vrstu roda *Entomoneis*. Molekularna i taksonomska analiza na soju izoliranom iz srednjeg Jadrana otkrile su još jednu moguću novu vrstu za znanost. Istraživanja koja se trenutno provode na rodu *Entomoneis* predstavljaju novi doprinos taksonomskim istraživanjima fitoplanktona u Jadranskom moru kao i taksonomskim istraživanjima dijatomeja općenito.

ENTOMONEIS SPECIES IN THE ADRIATIC SEA

Mejdandžić, M.[1]*, Bosak, S.[1], Gligora Udovič, M.[1], Peharec Štefanić, P.[1], Kružić, P.[1], Špoljarić, I.[3,4], Mršić, G.[3,4], Orlić, S.[2], Ljubešić, Z.[1]

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The genus *Entomoneis* Ehrenberg includes mostly epipelic, brackish, marine or freshwater pennate diatoms. Structurally this genus possess complex frustules, characterized by bilobate raphe-bearing keel elevated from the valve body, the morphologically variable junction lines and numerous girdle bands. Most recognizable morphological features of these diatoms are 90°cell torsion around apical axis and slightly silicified frustules. Up to date, three different *Entomoneis* species have been recorded in the Adriatic Sea – *E. alata*, *E. paludosa* and *E. pulchra* and none of them has been cultivated and thoroughly analysed through morphological and molecular analysis. For purposes of this study several oceanographic cruises were conducted – BIOTA (Bio-tracing Adriatic water masses) expedition conducted in February/March 2015 and March 2016 in the south-eastern Adriatic Sea, and middle Adriatic cruises (Telašćica Nature Park and Kornati National Park) conducted during June and October 2015. During these cruises, numerous *Entomoneis* cells were harvested. Cells were manually isolated by micropipette and agar plating techniques and long-term cultured in Guillard's F2 marine enrichment solution. In 2015 BIOTA cruise the enigmatic taxon was found in the water samples in low abundances (up to 200 cells L^{-1}) and three monoclonal strains were established from plankton net samples. After thorough morphological observations (light, scanning and transmission electron microscopy) and molecular analyses (SSU, rbcL, psbC gene phylogenies) from these cultivated strains we concluded they belong to a new *Entomoneis* species. The same molecular and taxonomical analyses on the strain isolated from middle Adriatic revealed yet another possible new species for science. On-going study on genus *Entomoneis* is promising and challenging for the phytoplankton in the Adriatic Sea and for diatom taxonomy in general.

RASPROSTRANJENOST RODOVA *PROCHLOROCOCCUS* I *SYNECHOCOCCUS* U JUŽNOM JADRNSKOM MORU

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Mikrobna fitoplanktonska zajednica koju zastupaju pikocijanobakterije roda *Prochlorococcus* i *Synechococcus*, ima iznimno važnu ulogu u kruženju ugljika i nutrijenata u moru. U ovom radu istražila se abundancija i genetička mikroraznolikost roda *Prochlorococcus* i *Synechococcus*, dva najzastupljenija roda mikrobnih fitoplanktonskih zajednica, tijekom zimskih ekspedicija provedenih u južnom Jadranu (veljača/ožujak 2015. i ožujak 2016., BIOTA ekspedicije). Vertikalna distribucija je analizirana u i ispod eufotičke zone u južnojadranskoj kotlini, jednog od ekološki posebno važnog mediteranskog područja. Abudancija i prostorna distribucija istraživane su metodama protočnog citometra i tekuće kromatografije (HPLC), a genetička mikro-raznolikost analizirana je koristeći knjižice klonova 16S-23S ribosomalne DNA ITS regije. Ovo je prvo detaljno istraživanje s naglaskom na abundanciju različitih sojeva i ekotipova bogate pikocijanobakterijske zajednice rodova *Prochlorococcus* i *Synechococcus* u južnojadranskoj kotlini.

DISTRIBUTION OF *PROCHLOROCOCCUS* AND *SYNECHOCOCCUS* ECOTYPES IN THE SOUTHERN ADRIATIC SEA

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The microbial phytoplankton community represented by the picocyanobacteria *Prochlorococcus* and *Synechococcus*, have an important role in oceanic carbon fixation and nutrient cycling. In this study, the abundance and genetic microdiversity of these two most abundant members of microbial phytoplankton communities was examined during winter cruises conducted in the southern Adriatic Sea (February/March 2015 and March 2016, BIOTA expeditions). Vertical distribution was analyzed within and below the euphotic zone in the South Adriatic Pit as one of the ecologically important Mediterranean hot spots. Abundance and spatial distribution was estimated by flow cytometry and HPLC method, while genetic microdiversity was studied using clone libraries of the 16S-23S ribosomal DNA Internal Transcribed Spacer (ITS) region. This is the first detailed study with focus on the abundance of clades and ecotypes of rich picocynobacterial *Prochlorococcus* and *Synechococcus* communities in the South Adriatic Pit.

TAKSONOMIJA I PROSTORNA RASPODJELA KOKOLITOFORIDA U JUŽNOM JADRANU: ZIMSKI ASPEKT

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Kokolitoforidi, fotosintetski jednostanični organizmi, jedna su od najvažnijih skupina morskog fitoplanktona. Od izuzetne su važnosti u kruženju elemenata u prirodi jer osim fotosinteze i pretvaranja anorganskog ugljika u organski, sintetiziraju kalcijev karbonat za izgradnju kokolita, kalcitnih pločica kojima su obloženi. Taksonomija kokolitoforida je izuzetno zahtjevna zbog malih dimenzija stanica kao i zbog ultrastrukturnih obilježja vrste koja su vidljiva samo pod skenirajućim elektronskim mikroskopom (SEM). Životni ciklus kokolitoforida je složen, a u njemu dolazi do izmjene haploidne i diploidne faze. Stanice se u diploidnoj i haploidnoj fazi morfološki razlikuju što je dodatni izazov u njihovoj taksonomiji, te se u zadnja dva desetljeća radi velika revizija taksonomije kokolitoforida. Kokolitoforidi su u Jadranskom moru nedovoljno istraženi. U svrhu ispitivanja hipoteze da pojedine vrste kokolitoforida mogu biti indikatori porijekla vodenih masa u Jadranskom moru, provedena su oceanografska istraživanja u južnom Jadranu u zimskom razdoblju (veljača/ožujak 2015., ožujak 2016.). Istraživanje je provedeno na 15 postaja raspoređenih u tri transekta: P-transekt (P100-P1000), M-transekt (M100-M1000), V-transekt (V80-V100), te je sakupljeno i analizirano 183 uzorka fitoplanktona i popratnih fizikalno-kemijskih čimbenika. Dodatno su uzeti uzorci mora koji su na terenu filtrirani na polikarbonatni filter 2μm pora za SEM analizu. Za filogenetsku analizu uzeti su živi uzorci iz kojih su u laboratoriju stanice kokolitoforida ručno izolirane mikropipetom i nasađivane na agar te kultivirane u Guillard F/2 mediju. Maksimalna brojnost mikrofitoplanktona (1.97×10^4 stanica/L) te nanofitoplanktona (4.40×10^4 stanica/L) zabilježena je u površinskim uzorcima na postajama P100A i P120A. Mikrofitoplanktonom su dominirale dijatomeje, a nanofitoplanktonom kokolitoforidi. Detaljnijom kvalitativnom i kvantitativnom metodom SEM-a određene su 54 svojte kokolitoforida, a maksimalna brojnost je bila zabilježena na postaji P100A na 35 m ($1{,}1 \times 10^5$ stanica/L). Dominatne vrste bile su *Emiliania huxleyi, Syracosphaera molischii* i *Syracosphaera* sp.

TAXONOMY AND SPATIAL DISTRIBUTION OF COCCOLITHOPHORS IN THE SOUTH ADRIATIC: WINTER ASPECT

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Coccolithophores, single cell photosynthetic algae, are one of the most important counterparts of marine phytoplankton. They are important primary producers and major contributors to the biogeochemical carbon cycle. By the calcifying process the cells produce calcium carbonated cocoliths that form the cell wall. Taxonomy of coccolithophores is extremely challenging due to the small cell size and species specific ultrastructural features visible only by scanning electron microscope (SEM). The life cycle is complex, including haploid and diploid phases that are morphologically distinct. Due to difficulties the coccolithophores taxonomy is under complete revision in the last two decades.

Coccolithophores in the Adriatic Sea are poorly known. In order to test the hypothesis of coccolithophores as possible bio-tracers of specific water- masses, a crusie was conducted in southern Adriatic during winter period (February/March 2015, March 2016). 15 Stations on three transects (P-transect (P100-P1000), M-transect (M100-M1000), V-transect (V80-V100)) were chosen and total of 183 samples for phytoplankton and physical-chemical parameters were collected. Additional samples for in microscope analysis (SEM) of coccolithophores community were collected and immediately upon sampling filtered on 2µm-pore-size polycarbonate filter. For phylogenetic analyses, live coccolitophore cells were isolated with micropipette and agar plating techniques and maintained in culture (agar and Guillard's F/2 medium).

Maximal abundance of microphytoplankton (1.97×10^4 cells/L) and nanophytoplankton (4.40×10^4 cells/L) were recorded in the surface samples on stations P100A and P120A. Microphytoplankton was dominated by diatoms while nanophytoplankton by coccolithophores. In depth analyses of coccolithophores reviled 54 taxa with maximum abundance (1.1×10^5 cells/L) recorded on Station P100A in the subsurface layer. Dominant species were *Emiliania huxleyi, Syracosphaera molischii* and *Syracosphaera* sp.

Tema simpozija

Flora, ekologija, vegetacija i biogeografija

Fiziologija, anatomija i morfologija

Symposium topic

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Physiology, anatomy and morphology

EFFECTS OF LAND USE CHANGES ON FLORISTIC RICHNESS AT LANDSCAPE SCALE: TRADITIONAL LAND USE - VS. LAND ABANDONMENT AND SPONTANEOUS SUCCESSION OF VEGETATION

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Traditional land use, e.g. grazing and mowing has been ceased during the last decades on the majority of grasslands in Hungary, which caused dramatically decrease of grassland area. Abandonment of agricultural fields resulted in shrub encroachment, therefore shrublands area have been considerable increased. As a consequence of such processes a decline of richness of native flora is expected at landscape level. To reveal effects of land use changes on plant species richness (on the pattern of species pool) our study was performed in a colline region of southern Hungary, in the landscape with extensive agriculture, and with numerous old-fields abandoned in the last 50 years. We used a large data set collected in the last 18 years on permanent plots and also data collected by using a chronosequence approach (space for time substitution). We observed main transitions in land use changes in the study area: 1) great part of abandoned croplands were rapidly (during 25-30 years) spontaneously converted into shrublands; 2) some of the abandoned grasslands overgrown by shrubs, but after removing shrubs they have been re-used as pasture or regularly mowed; 3) some of the abandoned croplands were converted in grasslands during the last 15-20 years by short time (several years) extensive grazing and by regularly mowing (once or twice a year). Grazing and mowing favoured grassland species and prevented shrub encroachment. Benefits of such management approved the importance of traditional agricultural practice: old-fields were commonly used as extensive pasture, because grazing animals accelerated the regeneration of natural vegetation by removing biomass and by introducing propagules of valuable grassland species. Greatest negative effect of land use changes on plant species richness was detected on grassland plots which had previously been overgrazed and then completely abandoned for a long time. We suggest that the practice of traditional land use (extensive grazing and mowing) have been favoured rich native flora, while abandonment caused a recent decline at landscape level at two decades time scale.

PROLJETNA FLORA JUŽNIH PADINA SVILAJE (JUŽNA HRVATSKA)

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Iako je flora hrvatskih planina u posljednja dva stoljeća relativno dobro istražena, Svilaja je do danas ostala gotovo botanički nepoznata. Stoga je obavljeno preliminarno terensko istraživanje južnih padina planine tijekom proljeća 2010. (ožujak-svibanj). Područje istraživanja obuhvaćalo je epimediteransku zonu i dijelom brdski vegetacijski pojas, koje karakterizira mozaik kamenjarskih pašnjaka i niskih šikara. Tijekom istraživanja zabilježeno je 200-ak biljnih svojti. Pronalazak vrste *Gentiana dinarica* Beck je vjerojatno njen prvi recentni nalaz u Hrvatskoj. Zabilježene su i vrlo rijetke vrste sa svega nekoliko nalaza u Hrvatskoj - *Chouardia lakusicii* (Šilić) Speta i *Matthiola fruticulosa* (L.) Maire. Svilaja je na južnom rubu areala u Hrvatskoj za pronađenu NATURA 2000 vrstu *Pulsatilla grandis* Wender, ali i za lokalno rijetke vrste *Gentiana cruciata* L. i *Platanthera bifolia* (L.) Rich. Zabilježeno je i 9 svojti orhideja, od kojih je većina česta za ovo područje. No, orhideja *Coeloglossum viride* (L.) ima najbliže populacije tek mnogo sjevernije, na Velebitu i Poštaku. U ranoproljetnom aspektu područja ističe se endemični *Crocus biflorus* Mill. ssp. *weldenii* (Hoppeet Fürnr.) K.Richt. Iako *Orthilia secunda* (L.) House dolazi u višim - bukovim, jelinim i smrekovim šumama, ovdje je pronađena na nižim nadmorskim visinama, unutar nasada crnog bora (*Pinus nigra* Arnold). Kako je tradicionalno korištenje prostora u vidu ispaše i sječe gotovo potpuno napušteno, većina ovih rijetkih vrsta je izravno ugrožena nestankom otvorenih travnjačkih staništa. Stoga su nova terenska istraživanja na čitavoj planini od izuzetne važnosti.

SPRING FLORA OF THE SOUTHERN SLOPES OF SVILAJA MT (SOUTHERN CROATIA)

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Although Croatian mountains have been largely floristically studied during the last two centuries, the Svilaja Mt remained practically unexplored. In order to fill this gap, preliminary field study of the southern mountain slopes was carried out during the spring season (March-May) 2010. The study area included epi-Mediterranean and partially montane altitudinal vegetation belt, characterized by mosaic of calcareous rocky pastures and low shrublands. Around 200 plant taxa were recorded during the study. Noteworthy, finding of *Gentiana dinarica* Beck is most probably the first recent record in Croatia. Very rare species, *Chouardia lakusicii* (Šilić) Speta and *Matthiola fruticulosa* (L.) Maire with only few known records in Croatia so far, were also found on Svilaja Mt. NATURA 2000 species *Pulsatilla grandis* Wender, in large populations, as well as locally rare *Gentiana cruciata* L. and *Platanthera bifolia* (L.) Rich., were recorded, reaching here the southernmost border of its Croatian areal. The majority of nine recorded orchid taxa are common for this region, however the nearest populations of *Coeloglossum viride* (L.) Hartm. are far on the North (Velebit Mt and Poštak Mt). Early spring flora is characterized by large populations of endemic *Crocus biflorus* Mill. ssp. *weldenii* (Hoppeet Fürnr.) K.Richt. The species *Orthilia secunda* (L.) House, affiliated to beech, fir and spruce forests, was found here on much lower elevations, within planted *Pinus nigra* Arnold stands. Since traditional management of the landscape through pasturing and coppicing is widely abandoned, the majority of this rare species are directly endangered by reduction of open habitats. Therefore, new field studies extended to the whole mountain are extremely important.

FITOGEOGRAFSKE ZNAČAJKE PORODICE KAĆUNA (ORCHIDACEAE) U HRVATSKOJ

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Porodica kaćuna je u Hrvatskoj flori zastupljena sa 181 svojtom. Ciljevi ovog istraživanja je bio ispitati prostornu rasprostranjenost i brojnost svojti kaćuna Hrvatske te predvidjeti promjene u rasprostranjenosti svojti u ovisnosti o klimatskim promjenama. Ovi ciljevi su ostvareni upotrebom SDM -a (Species distribution models) kombinirajući podatke o zastupljenosti svojta i okolišnih varijabli koristeći algoritam za podatke prisutnosti, MAXENT. Dobiveni rezultati ukazuju na veću zastupljenost kaćuna u priobalnim dijelovima (mediteranska i alpska biogeografksa regija), a manju u istočnim kontinentalnim dijelovima Hrvatske. Prema okolišnim varijablama promjena u rasprostranjenosti za 2050. g. će biti značajna u odnosu na sadašnje stanje.

PHYTOGEOGRAPHICAL CHARACTERISTICS OF ORCHIDS (ORCHIDACEAE) IN CROATIA

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The Orchid family embraces around 181 taxa in Croatian flora. The goal of this research was to assess the spatial distribution and species richness of Croatian orchids and to predict the changes in distribution of taxa in dependence on climatic changes. These goals were achieved by Species Distribution Models and combining them with botanical collection records and ecological variables using presence – only data algorithm, MAXENT. The results indicate higher species richness in coastal parts (Mediterranean and Alpine biogeographic regions) and lower species richness in eastern continental parts. According to ecological variables the distribution of orchids in 2050 will be significant in comparison to present state.

MORFOLOŠKA VARIJABILNOST BRIJESTA VEZA (*ULMUS LAEVIS* PALL.) U HRVATSKOJ

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Brijest vez (*Ulmus laevis* Pall.) vrlo je važna vrsta plemenite listače, prvenstveno rasprostranjena na prostoru središnje i istočne Europe, gdje se javlja u sklopu nizinskih poplavnih šuma. Iako vrijednost drvne mase brijesta veza i mogućnosti njezine eksploatacije nisu komparabilne s onima ostalih europskih autohtonih brijestova, brijest vez se često primjenjuje u urbanom šumarstvu kao ornamentalna vrsta. Štoviše, pojavnost brijesta veza od velike je važnosti za očuvanje stabilnosti ekosustava nizinskih poplavnih šuma. Frekventno pridolazi većinom u mješovitim šumama hrasta lužnjaka. Populacije brijesta veza trenutno su limitirane obzirom na veličinu, te su podložne fragmentaciji, kao rezultatu antropogenih aktivnosti u okolišu. Posebice valja istaknuti negativan utjecaj na stanište u smislu promjene načina korištenja zemljišta i zahvata hidroregulacije. Na području istočne Europe populacije brijesta veza dodatno su ugrožene pandemijom holandske bolesti brijesta, koja je uzrokovala katastrofalno sušenje adultnih stabala. Cilj ovog istraživanja bio je utvrditi morfološku varijabilnost listova u prirodnim populacijama brijesta veza u Hrvatskoj. S ciljem određivanja stupnja međupopulacijske i unutarpopulacijske varijabilnosti brijesta veza morfometrijskom analizom obuhvaćeno je 12 folijarnih obilježja, te su podaci izmjere obrađeni suvremenim statističkim metodama. U istraživanje je uključeno 6 populacija brijesta veza u Hrvatskoj. Signifikantne razlike između populacija utvrđene su za sva promatrana svojstva, osim za svojstvo duljine lisne plojke. Ukupni koeficijent varijabilnosti kretao se od 15,62 % za broj primarnih zubaca subapikalne regije lista do 55,73 % za svojstvo bazalne asimetrije. Razdjelba ukupne varijance pokazala je da je su za većinu varijabli razlike između populacija veće u odnosu na komponentu varijabilnosti pripisanu razlikama između stabala pojedine populacije. Primjenom klaster analize generirane su dvije distinktne skupine populacija (1. Čazma, D. Miholjac, Garešnica; 2. Đurđevac, Županja, N. Gradiška). Grupiranje populacija prema UPGMA dendrogramu reflektira sličnosti u značajkama mikrostaništa, te nije povezano s geografskom udaljenošću između pojedinih populacija.

MORPHOLOGICAL VARIABILITY OF WHITE ELM (*ULMUS LAEVIS* PALL.) IN CROATIA

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The European white elm (*Ulmus laevis* Pall.) is an important noble hardwood tree species, principally inhabiting riparian deciduous forests across Central and Eastern Europe. Despite the fact that is not highly prized for its timber in relation to other European native elm species and considered as tree of poor exploitation possibilities, it is often used as ornamental tree in urban forestry. Furthermore, it is a tree of great relevance for maintenance of ecosystem stability of riparian forests, where it occurs as a common member, mainly in mixed oak forests. Nowadays, natural white elm populations are small and fragmented due to anthropogenic activities concerning land conversion and water regulation management. Additionally, *U. laevis* populations in Eastern Europe have been heavily affected by the Dutch elm disease, which has caused enormous dieback of adult trees. The goal of this research was to describe the patterns of morphological variation in natural populations of *U. laevis* in Croatia. In order to estimate interpopulation and intrapopulation variability of *U. laevis* we have morphometricaly analyzed 12 foliar morphological traits by applying contemporary statistical methods. White elmtrees from 6 natural *U. laevis* populations in Croatia were encompassed by this research. Significant differences for all analyzed traits except leaf blade length were confirmed on interpopulational level. Overall variability coefficient ranged from 15,62 % for number of primary teeth, measured in the subapical region of the leaf to 55,73 % for the leaf base asymmetry trait. When it comes to partitioning of variance, amount of variability explained by differences among populations for majority of variables was higher when compared to differences among trees in particular population. Two distant groups of populations were obtained upon cluster analysis (1. Čazma, D. Miholjac, Garešnica; 2. Đurđevac, Županja, N. Gradiška). In line with UPGMA dendrogram, it can be argued that arrangement pattern of analysed populations was generated due to microhabitat conditions, rather than according to geographical distance.

AEROBIOLOŠKA DINAMIKA PELUDA CRKVINE NA PODRUČJU GRADA SPLITA, 2005. - 2013.

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U razdoblju od 2005. - 2013. na području grada Splita provedeno je aerobiološko istraživanje s ciljem istraživanja dinamike pojavljivanja peluda crkvine u zraku i rizika od alergije na pelud crkvine. Crkvina je korovna biljka iz roda *Parietaria* čija pelud ima visok alergijski potencijal. Rasprostranjena je na obalnom području Mediterana gdje je među glavnim uzročnicima polinoza. Prema udjelu u godišnjem peludnom indeksu i zastupljenosti u peludnom spektra grada Splita, crkvina je na drugom mjestu. Njezin pelud u zraku je prisutan gotovo cijele godine, a najviše dnevne koncentracije bilježe se u travnju. Unutar istraživanog razdoblja uočen je trend porasta vrijednosti godišnjih peludnih indeksa te maksimalnih dnevnih koncentracija. Korelacije između dnevnih koncentracija peluda crkvine i meteoroloških parametara statistički su značajne. Utjecaj temperature je pozitivan, dok je utjecaj vlage i oborina negativan.

AEROBIOLOGICAL DYNAMICS OF THE *PARIETARIA* POLLEN TYPE IN THE AIR OF THE CITY OF SPLIT, 2005-2013

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The aim of this aerobiological study during the period from 2005 to 2013 in the city of Split was to investigate the dynamics of appearance of the *Parietaria* pollen type in the air and to calculate the allergy risk. The *Parietaria* is a weed plant whose pollen has a high allergenic potential. It is widespread in coastal areas of the Mediterranean where it is among the major causes of pollinosis. According to the abundance in the pollen spectrum of Split, the *Parietaria* pollen takes the second place. It´s pollen was present almost all year round in the air of the city of Split with the highest daily concentrations recorded in April. Within the study period, there was an upward trend in the value of annual pollen indices and maximum daily concentrations. The correlations between daily pollen concentrations and meteorological parameters were statistically significant. The influence of the temperature was positive, while the humidity and the precipitation showed negative influence.

Tema simpozija — **Symposium topic**

Fiziologija, anatomija i morfologija — **Physiology, anatomy and morphology**

Primijenjena botanika — **Applied botany**

DIFFICULTIES IN THE MORPHOLOGICAL DIFFERENTIATION OF *HELLEBORUS* SPECIES IN ISTRIA

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The genus *Helleborus* is represented in the northwestern Istria by 7 species. Some of them are rather easy to determine and to differ from other species. These are *Helleborus foetidus* (newcomer, anthropogenicly introduced as well as escaped from culture), *H. niger* and *H. orientale* (newcomer, escaped from culture).

Really difficult is the determination of morphologically very similar species, which also show a wide variety in leaf shape. These are *Helleborus dumetorum*, *H. multifidus*, *H. odorus* and *H. viridis*.

The distribution area of these 4 species overlap in Istria, so that there are no really clear borders of distribution. The dominating species in this region is *Helleborus multifidus*, especially its subsp. *istriacus*. The other 3 species are rare and are therefore often overlooked and the herbarium species are frequently mismatched to *H. multifidus*. In addition all these 4 species hybridise, so that you may find all kind of transitions between all taxa.

The number of morphological characteristics is high enough for a good separation of all *Helleborus* species. The problem is just, that in several cases you need the leaf characteristics in combination with the flower characteristics for a definitely result.

Besides the cultivation of plants collected in the field to see both, leaves and flowers, we have no other possibilities for absolutely secure determinations. Sometimes is also possible to visit a habitat in nature in two different periods to see the growth and developing. But for the revision of herbarium material there is often no other way than to determine the specimen with the suffix cf.

WHAT DO WE KNOW ON SALT RESISTANCE IN BRYOPHYTES? CASE STUDIES ON SELECTED MOSSES

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Bryophytes, an old group of plants whose ancestors settled the lands already in Mesozoic, and adjusted to terrestrial life, have no representatives in sea waters. It seems most of them also avoid salt-land ecosystems. However, the first experimental approach showed that they can cope with salt stress in various extents, even though they avoid such harsh environments. Here we present the results of selected moss species tested to salt stress, namely *Physcomitrella patens, Entosthodon hungaricus, Hennediella heimii, Atrichum undulatum* and *Polytrichum formosum.* They were chosen the way to be phylogenetically, morpho-anatomically and ecologically distant and different. The exposure to salt stress (short- and long-term exposure) was performed in the controlled *in vitro* conditions. Various biochemical and eco-physiological parameters were recorded and compared. It can be inferred that all of the tested species cope to some extent to salt stress. However, the way of coping varies among species. Also the short-term exposure to stress, increase the survival in comparison to long-term exposure. *Physcomitrella patens, Entosthodon hungaricus* and *Hennediella heimii* showed to have various ways of cell sugar economy involved into salt-tolerance, while in all species also phenolic compounds, tocopherol, different xanthophyll compounds and proline can be responsible for salt-resistance. Among tested antioxidative enzymes, superoxyddismutase had much higher activity and more activated isoforms in two facultative halophytic mosses (*E. hungaricus* and *H. heimii*) comparing to other investigated species. All these parameters showed *E. hungaricus* and *H. heimii* to be more salt stress tolerant moss species than other tested representatives in accordance with their ecological features.

SURVEY OF BALKAN HALOPHYTIC FLORA: FROM BIODIVERSITY TO BIOACTIVITY

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Halophytic flora and vegetation are remarkable indicators of various types of salt affected soils. Maritime and continental saline habitats of the Balkans are distributed in a form of mosaic-like pots, occupying less than 5% of the total region area. These habitats are known as very fragile and changeable due to different environmental and human impacts, and are of a great conservation concern. Halophytic vegetation encompasses various phytocoenoses distributed in range of salinity value, starting from very saline coastal and inland habitats composed of obligate halophytes such as: *Salicornia* spp., *Crithmum maritimum, Suaeda maritima, Cakile maritima, Salsola* spp*., Spergularia maritima*, etc. (Thero-Salicornietea class), towards slightly salinized meadows belonging to the Molinio-Arrhenatheretea class. Although some of the halophytic species are widely distributed around the world, like *Salicornia europea, Atriplex littoralis,* and *Suaeda maritima*, some others are endemics, such as *Suaeda pannonica, Rorippa kerneri, Lepidium cartilagineum, Stachys milanii* and *Plantago schwarzenbergiana*. Besides studies on stress tolerance mechanisms, physiology and genetic fingerprinting, in addition to ecology and eco-geography, the recent attention was paid on characterization of their biologically active compounds. In our former studies, several salt tolerant species were identified for high content of phenolic and flavonoid compounds and related strong antioxidant anti-mutagenic activity, mainly referring to *Statice gmelinii* and *Artemisia santonicum* and *Atriplex littoralis*, respectively. In addition to review on floristic biodiversity and classification of Balkan halophytic vegetation, the results of screening of secondary metabolite profiles are provided. The LC/DAD/MS analyses of methanolic extracts were carried out by an Agilent 1200 HPLC instrument. Spectral data from all the peaks were accumulated in the range of 190–450 nm and chromatograms were recorded. Compounds were characterized by their retention times, mass spectra and UV spectra. Upon LC-DAD-MS/ESI TOF MS analysis, a tentative identification of main polyphenolic compounds was conducted, showing presence of phenolic acids, mainly derivatives of caffeic acid, as well as flavonoid glycosides and components which will be further characterized. Relevance of obtained results were discussed in term of need for conservation measures and possible use of halophytes as source of novel nutraceuticals and pharmaceuticals.

ETNOBOTANIČKO ISTRAŽIVANJE NA ĆIĆARIJI (ISTRA, HRVATSKA): KORIŠTENJE SAMONIKLOG BILJA I GLJIVA

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Istra je kroz mnoga stoljeća bila na raskrižju kulturne razmjene i trgovine između Austrijskog carstva i Mletačke Republike, pa se na ovom području danas susreću i spajaju mnoge kulture. Brdovita visoravan Ćićarija je krško područje u unutrašnjosti sjevernog dijela poluotoka Istre (Hrvatska), koju karakteriziraju brojne ponikve, epi-mediteranska klima i tipična mediteranska flora. Zbog depopulacije i promjena načina života te nedovoljne dokumentacije na istraživanom području postoji opasnost gubitka znanja o korištenju samoniklih biljaka i gljiva. U ovom istraživanju, provedenom 2015. - 2016. godine, zabilježena su tradicionalna znanja i stanje korištenja samoniklih biljaka za hranu i piće, kao i poznavanje gljiva. Na području 24 naselja je provedeno pedeset (50) intervjua kojima je obuhvaćeno 75 ispitanika (38 ženskih i 37 muških) lokalnog porijekla, prosječne dobi 67 godina. Dokumentirano je oko 200 biljnih svojti i 30 vrsta gljiva, u prosjeku 37 svojti po intervjuu. Naši rezultati pokazuju da se biljke koriste na razne načine: kao sirove salate, kuhano povrće i sirovi plodovi, u čajevima, sirupima, džemovima, likerima i rakijama. Puno biljaka ima i specifičnu medicinsku uporabu. Najčešće prikupljene vrste su: *Cornus mas* (drijen), *Rubus ulmifolius* (kupina), *Sambucus nigra* (bazga), *Urtica dioica* (kopriva), *Rosa canina* (pasja ruža, šipak), *Taraxacum officinale* (maslačak), *Tamus communis* (bljušt), *Sorbus domestica* (domaća oskoruša), *Asparagus acutifolius* (šparoga), *Cichorium inthybus* (divlja vodopija), *Prunus spinosa* (trnina), *Foeniculum vulgare* (koromač) i *Salvia officinalis* (ljekovita kadulja). Rezultati također pokazuju da se danas na istraživanom području koristi više od 30 vrsta gljiva, dok je u prošlosti sakupljano svega nekoliko vrsta. Razne vrste gljiva se spominju na 82% ukupno provedenih intervjua. Zanimljivo je da ispitanici i dan danas redovito beru i jedu voće sakupljeno u prirodi, a često koriste i neke od fitoterapeutskih biljaka. Posebna karakteristika lokalne gastronomije je priprema kajgane (lokalni naziv: fritaja) s mladicama veprine (*Ruscus aculeatus*). Svi herbarski primjerci su digitalizirani i dostupni u ZAGR virtualnom herbariju (http://herbarium.agr.hr/).

ETHNOBOTANY RESEARCH ON ĆIĆARIJA MT. (ISTRIA, CROATIA): THE USE OF WILD PLANTS AND MUSHROOMS

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For many centuries Istria was at the cross-roads of cultural exchanges and trade between the Austrian Empire and the Republic of Venice, and so even today it continues to be a center of multicultural interactions. The Ćićarija is an inland karstic territory in the northern part of Istria peninsula (Croatia), characterized by numerous dolines, epi-Mediterranean climate and a typical Mediterranean flora. Due to depopulation, change of lifestyle, and not sufficient documentation on the researched area, there is a threat of wild plants and mushrooms use knowledge loss. Consequently, we investigated local traditional knowledge and present use of wild plants for food and beverages as well as the use of mushrooms in 24 settlements was recorded. Fifty (50) interviews that included 75 local informants (38 female and 37 male), with an average age of 67, were conducted in 2015 and early 2016. The use of approximately 200 plant taxa and 30 mushroom species were documented, with the average of 37 records per interview. Our results showed that the plants are used raw as salads, cooked as vegetables, raw fruit, for teas, sweet drink concentrates, jams, in liqueurs and schnapps. A lot of plants have specific medicinal usage. The most commonly collected species are: *Cornus mas, Rubus ulmifolius, Sambucus nigra, Urtica dioica, Rosa canina, Taraxacum officinale, Tamus communis, Sorbus domestica, Asparagus acutifolius, Cichorium inthybus, Prunus spinosa, Foeniculum vulgare*, and *Salvia officinalis.* We found that a small number of Mushrooms were collected on the Ćićarija area in the past, but nowadays people collect more than 30 mushroom species (82% of the interviewees). Interesting is that participants still regularly pick and eat fruits in the nature, and often use some of phytotherapeutic plants. A particular feature of the local cuisine arescrambled eggs (local term: fritaja) prepared with young shoots of *Ruscus aculeatus*. All herbarium specimens are digitized and available in ZAGR Virtual herbarium (http://herbarium.agr.hr/).

ANATOMY OF ARCHAEOLOGICAL WOOD CHARCOALS AT URARTIAN SITE OF AYANIS IN VAN PROVINCE, EASTERN TURKEY

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Ayanis is located on eastern shore of Lake Van in eastern Turkey. Wood charcoal remains recovered from Urartian site of Ayanis were studied on the basis of main wood anatomical properties. In the reflected light microscopy, definable anatomical features of wood charcoals belonging to softwoods were growth ring boundary, transition from earlywood to latewood, tangential and radial tracheid diameter, bordered-pit diameter and wall thickness in tracheid, cross-field pitting, ray width, resin canal diameter and resin canal number / 10 mm^2. In addition, definable anatomical features of wood charcoals belonging to hardwoods were growth ring boundary, porosity, tangential vessel diameter, radial vessel diameter, vessel groupings, perforation plate and intervessel pit arrangement. As a result, wood charcoals were identified as two different genera: *Pinus* sp. (*Pinus cf sylvestris*) and *Betula* sp.

Tema simpozija

Flora, ekologija, vegetacija i biogeografija

Konzervacijska biologija, zaštita prirode i okoliša

Symposium topic

Flora, ecology, vegetation and biogeography

Conservation biology, environmental and nature protection

CONTRIBUTION TO THE EXPLORATION OF THE BRYOPHYTE FLORA OF CROATIA IN LAST FIVE YEARS WITH A SPECIAL ATTENTION TO THE SPECIES OF CONSERVATION INTEREST

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Croatia is bryologically one of the best-known regions of former Yugoslavia and even in Southeast Europe. As a part of the Austro–Hungarian Monarchy, the country was researched during 19th and early 20th century mostly by foreign bryologists. Afterwards, local researchers in 1950-ies and 1960-ies were mostly focused only on the bryophyte flora karst rivers. Therefore, bryology has been a neglected research field in the country for many years. Many species have only 100 year-old records; hence, new studies on bryophytes are necessary.
Since 2011, several bryological field trips were organised in co-operation between the Hungarian Natural History Museum and the University of Zagreb. Mainly national parks and other protected areas were investigated: Gorski Kotar Region, National Park Plitvička jezera, North Velebit, Papuk Mts, Žumberačka gora, and saline grasslands at Trpinja in Western Srijem.
During these field trips more than 1700 specimens were collected. 35 species (6 liverworts and 29 mosses) were reported for the first time in Croatia. 34 populations of 14 bryophyte species were included in the Red data book of European bryophytes and populations of a further 12 species (2 liverworts and 10 mosses) of European conservation interest being on the candidate list of the new Red data book of European bryophytes were found. Besides these, several populations of species rare on the Balkans, especially mosses of wetlands, atlantic-subatlantic species, and boreal leafy hepatics, were also discovered. An overview of the species important from a conservation point of view in various habitat types will be provided.

FLORA OF BARTIN IN THE WESTERN BLACK SEA REGION OF TURKEY

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The total number of taxa of Turkey is over 12000. These taxa belong to 167 families and 1320 genera. The number of endemic species in Turkey's flora is about 4000. Bartin province is located in the Western Black Sea Region of Turkey, and it is surrounded by the provinces of Kastamonu in the East, of Karabük in the South, and of Zonguldak in the West. These proviences are within Euxine zone of Euro-Siberian Phytogeographic Region. In this study, the flora of Bartin has been investigated. After revaluation of plant samples collected from the field, 1146 taxa belonging to 104 families and 487 genera are determined. The number of endemic species in Bartın is 24.

KONAČNA ISTRAŽIVANJA VASKULARNE FLORE I KARTIRANJE STANIŠTA NA PODRUČJU GRADA SLATINE, HRVATSKA

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Istraživanja vaskularne flore provode se na području grada Slatine i okolnih naselja od 2009. godine, najvećim su dijelom usmjerena na samoniklu floru, no uključuju i povremene nalaze kultiviranih biljaka te onih koje su dospjele van uzgoja. Zaključno s 2015. godinom biljna raznolikost istraženog područja bilježi ukupno 816 biljnih svojti (16,3 % od ukupne flore Hrvatske) raspodijeljenih unutar 109 porodica i 420 rodova vaskularne flore. Odjeljak Pteridophyta broji 16 svojti, dok u odjeljak Spermatophyta ulazi 800 biljnih svojti. Tri najbrojnije porodice redom su Poaceae (76 svojti), Asteraceae (66 svojti) i Fabaceae (48 svojti). Fitogeografska analiza pokazuje dominaciju eurazijskog flornog elementa (30 %) i kozmopolita (23 %), dok među životnim oblicima očekivano prevladava hemikriptofitska flora (43 %). Biljnu raznolikost slatinskog područja sačinjavaju i 90 svojti alohtone flore, među kojima je prisutno 35 invazivnih svojti. Kao najčešće invazivne na istraživanom području mogu se izdvojiti *Solidago gigantea* Aiton, *Robinia pseudoacacia* L., *Conyza canadensis* (L.) Cronquist, *Erigeron annuus* (L.) Pers. te *Ambrosia artemisiifolia* L. koja je česta na nešumskim područjima, mjestimično zauzimajući i čitave zapuštene oranice. Također, prisutan je značajan broj biljnih svojti koje pripadaju Crvenoj listi (2 CR, 6 DD, 6 EN, 16 NT, 17 VU) i zakonom strogo zaštićenih svojti (43 svojte), a poznate su i 2 endemične biljke (*Cardamine waldsteinii* Dyer, *Helleborus atrorubens* Waldst. et Kit.). Kao posebno vrijedne i vrlo rijetke na nacionalnoj razini bitno je spomenuti nove nalaze svojti *Elatine alsinastrum* L., *Eleocharis ovata* (Roth) Roem. et Schult. te *Scirpus supinus* L. koje dolaze u povremeno plavljenim mikrodepresijama, unutar sveze Nanocyperion. Iako su provedena detaljna istraživanja, 67 starih nalaza koji uglavnom datiraju iz 1957. godine još uvijek nije potvrđeno. Razlog tomu jednim je dijelom degradacija staništa, no ne isključuje se ni dvojbena determinacija određenog broja svojti (npr. *Edraianthus tenuifolius* (Waldst. et Kit.) A.DC.). Tijekom 2016. godine provest će se konačni napori u vidu temeljitog kartiranja staništa (prateći Nacionalnu klasifikaciju staništa, NKS) te inventarizacije kultiviranih biljaka koje rastu isključivo u vrtovima i parkovima. Kao rezultat navedenoga, uz ažuriranje popisa vaskularne flore, bit će izrađena i prva detaljna karta staništa za slatinsko područje.

FINAL RESEARCH OF THE VASCULAR FLORA AND HABITAT MAPPING IN THE CITY OF SLATINA, CROATIA

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The research of vascular flora has been conducted in the City of Slatina and neighbouring areas since 2009, focusing mostly on wild flora but also including occasional records of cultivated plants and those that have escaped cultivation. Up to 2015 the plant diversity of the investigated area registered 816 plant taxa in total (16,3 % of Croatian flora) which are classified into 109 families and 420 genera of vascular flora. Division Pteridophyta contains 16 taxa while 800 plant taxa belong to division Spermatophyta. Three most numerous families are Poaceae (76 taxa), Asteraceae (66 taxa) and Fabaceae (48 taxa). Phytogeographical analysis shows frequent occurence of eurasian (30 %) and cosmopolitan (23 %) floral elements, whereas among the life forms hemicryptophyte flora (43 %) dominates as expected. The plant diversity of the Slatina area also consists of 90 taxa of allochthonous flora, among which 35 invasive taxa are present. The most common ones in the researched area are *Solidago gigantea* Aiton, *Robinia pseudoacacia* L., *Conyza canadensis* (L.) Cronquist, *Erigeron annuus* (L.) Pers. and *Ambrosia artemisiifolia* L. which is frequent in non-forest areas and in some places covers entire abandoned fields. Additionally, there is a significant number of plant taxa on the Red List (2 CR, 6 DD, 6 EN, 16 NT, 17 VU) and plants strictly protected by the law (43 taxa), including 2 endemic plants (*Cardamine waldsteinii* Dyer, *Helleborus atrorubens* Waldst. et Kit.). As particularly valuable and very rare on the national level, new records should be noted regarding the taxa *Elatine alsinastrum* L., *Eleocharis ovata* (Roth) Roem. et Schult. and *Scirpus supinus* L. all of which occur in occasionally flooded microdepressions, within the alliance Nanocyperion. Even though detailed research has been conducted, 67 earlier records mostly dating back to 1957 have still not been confirmed. This is partially caused by habitat degradation, but erroneous remarks regarding some plant taxa are also not excluded (e.g. *Edraianthus tenuifolius* (Waldst. et Kit.) A.DC.). During 2016 final efforts are under way to conclude detailed habitat mapping (following the National habitat classification, NKS) and to document the cultivated plants growing strictly in gardens and parks. As a result, the checklist of vascular flora will be updated and the first elaborate habitat map will be produced for the City of Slatina and its surroundings.

AKTUALNA RAZNOLIKOST LIŠAJSKE FLORE U HRVATSKOJ

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Projekt integracije u EU Natura 2000, opsežni je projekt iz područja zaštite prirode koji se zadnjih godina intenzivno provodi u Republici Hrvatskoj. Obuhvaća ulaganja u zaštićena područja i područja ekološke mreže, jačanje kapaciteta za praćenje stanja bioraznolikosti i upravljanje ekološkom mrežom. U okviru projektnih aktivnosti koje se odnose na utvrđivanje stanja istraženosti svih sastavnica bioraznolikosti, tijekom 2013. i 2014. godine urađena je inventarizacija lišajske flore Hrvatske. Glavni cilj bio je prikupljanje i georeferenciranje svih taksonomskih i distribucijskih podataka o lišajskim svojtama, obradom dostupnih literaturnih izvora i pregledom zbirki lišajeva i primjeraka u dva nacionalna te pet herbarija u inozemstvu. Temeljem prikupljenih podataka utvrđeno je da aktualnu lišajsku floru Hrvatske čine ukupno 962 svojte, svrstane u 217 rodova i 84 porodice lihenizirani i nelihenizirani gljiva. Najbrojnije su porodice: *Verrucariaceae* (121 svojta), *Teloschistaceae* (89) i *Physciaceae* (66); dok su među rodovima najbrojniji: *Caloplaca* (71 svojta), *Cladonia* (56) i *Lecanora* s 51 svojtom. Prema podacima iz literaturnih izvora ukupno je u bazu podataka unijeto i georeferencirano 7.888 nalaza lišajskih svojti. Najstarije nalaze lišajeva za područje Hrvatske zabilježio je 1829. godine na planini Učki talijanski botaničar Tommasini. Pregledom lišajskih zbirki pohranjenih u istraživanim herbarijima zabilježeni su i obrađeni podaci s ukupno 5.540 etiketa. Najviše sakupljenih lišajeva potječe s područja planine Velebit (703 primjerka), slijede otok Hvar (475), Istra (396), područje grada Rijeke i Kvarnersko primorje (394), Gorski kotar (360) i južna Dalmacija s 312 primjeraka. Najveći broj primjeraka sakupljen je u razdobljima 1907. - 1918., te 1924. - 1932. godine. Među starijim istraživačima i sakupljačima lišajeva na području Hrvatske ističu se: Fran Kušan, Julius Baumgartner, Miroslav Servit, Jenö Béla Kümmerle i Albert Latzel. U proteklih dvadeset godina obnovljena su lihenološka istraživanja u Hrvatskoj i postignut je značajan doprinos boljem poznavanju lišajske flore kao dijelu ukupne nacionalne bioraznolikosti.

ACTUAL STATE OF DIVERSITY OF THE LICHEN MYCOTA IN CROATIA

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Project entitled: EU Natura 2000 Integration Project, is a comprehensive project in the field of nature protection which has been intensively implemented in the Republic of Croatia during last years. The project comprises investments in protected areas and ecological network sites, strengthening capacities for monitoring biodiversity and for management of the ecological network. Within project activities related to defining level of knowledge about all biodiversity components, an inventory of the lichen mycota of Croatia has been undertaken during 2013 and 2014 year. The main objective was collecting and geo-referencing all taxonomic and distribution data on lichen taxa by listing available literature sources and checking the lichen collections and voucher specimens at two national herbaria and five herbaria abroad. Based on the collected data, it was determined that currently known lichen mycota of Croatia comprises 962 taxa, classified into 217 genera and 84 families of the lichenized and non-lichenized fungi. The most numerous among families are: *Verrucariaceae* (121 taxa), *Teloschistaceae* (89) and *Physciaceae* (66); and among the genera: *Caloplaca* (71 taxa), *Cladonia* (56) and *Lecanora* with 51 taxa. According to data obtained from the literature, a total of 7,888 records for lichen taxa had been put into the data base and geo-referenced. The oldest records on lichens from the area of Croatia are being recorded in 1829 on the Učka Mountain by Italian botanist Tommasini. By checking the lichen collections kept in the herbaria, data from total of 5,540 labels had been recorded and processed. Most of the collected lichens originated from area of the Velebit Mountain (703 specimens), followed by Island of Hvar (475), Istra (396), area of the City of Rijeka and Kvarner littoral region (394), Gorski kotar (360) and southern Dalmatia with 312 specimens. The highest number of specimens was collected in periods: 1907-1918 and 1924-1932. Among the older lichen researchers and collectors, following are distinguished: Fran Kušan, Julius Baumgartner, Miroslav Servit, Jenö Béla Kümmerle and Albert Latzel. Lichen studies in Croatia are revived in the last twenty years, and significant contribution is achieved for better knowledge on lichen mycota as part of the total national biodiversity.

Tema simpozija

Konzervacijska biologija, zaštita prirode i okoliša

Edukacija, promocija i strukovno djelovanje

Symposium topic

Conservation biology, environmental and nature protection

Education, promotion and progress in botany

DIGITALIZACIJA STARIJIH GODIŠTA ČASOPISA ACTA BOTANICA CROATICA (1925. - 2001.)

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Acta Botanica Croatica međunarodni je znanstveni časopis u izdanju Biološkog odsjeka Prirodoslovno matematičkog fakulteta Sveučilišta u Zagrebu, koji je 2015. godine obilježio svoju devedesetu obljetnicu i ulazak u deseto desetljeće izlaženja. Od svog osnutka 1925. godine, časopis ima ulogu vodećeg prijenosnika znanstvenih informacija iz područja botanike u Hrvatskoj. Uz prekide u izlaženju, do danas je objavljeno ukupno 74 volumena časopisa i jedno posebno izdanje. Od 2002. godine članci u izvorno elektroničkom obliku pohranjuju se na portal hrvatskih znanstvenih časopisa u otvorenom pristupu – Hrčak. U svrhu zaštite izvornika te veće dostupnosti cjelovitog sadržaja časopisa Acta Botanica Croatica kao nacionalne znanstvene baštine, započeli smo digitalizaciju starijih godišta časopisa, od 1925. do 2001. godine. Digitalizacija je provedena u Središnjoj biološkoj knjižnici, uz financijsku potporu Biološkog odsjeka PMF-a. Skenirano je 60 volumena časopisa i jedno posebno izdanje, odnosno 1056 članaka koji su sadržavali preko 11500 stranica i 131 tabelu. Materijal je skeniran ručno, u rezoluciji 300 dpi, čemu je slijedilo kreiranje PDF dokumenata te oblikovanje teksta pomoću OCR (Optical Character Recognition) programa. Pohranom na portal Hrčak, članke je moguće pregledavati i pretraživati prema autoru, naslovu i ključnim riječima. Više od 8000 posjeta digitaliziranim člancima u prva dva mjeseca nakon objavljivanja, podatak je koji govori u prilog potrebi i važnosti prezentiranog sadržaja i u suvremenim botaničkim istraživanjima.

DIGITALIZATION OF OLDER ISSUES OF THE JOURNAL ACTA BOTANICA CROATICA (1925-2001)

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Acta Botanica Croatica, an international scientific journal published by the Department of Biology, Faculty of Science, University of Zagreb, celebrated its 90th anniversary in 2015 and entered the 10th decade of publishing. Since it was founded in 1925 the journal has had a leading role as a mediator of scientific information in the field of botany in Croatia. With some gaps in continuity, until nowadays the total of 74 volumes and one special issue have been published. The journal moved to Open Access publishing starting with 2002 through the central portal of Croatian scientific journals - Hrčak. In order to preserve the original and to provide wide access to the complete contents of Acta Botanica Croatica as a local scientific heritage, we started with digitalization of the older material (1925-2001). The digitalization has been made in the Central Biological Library and was financially supported by the Biology Departement of the Faculty of Science. The source material covers 60 volumes and one special issue, containing 1056 articles with more than 11500 pages and about 131 plates. Issues were scanned manually in 300 dpi resolution, followed by creating PDF documents and OCR (Optical Character Recognition) program reading. The articles were made online through the portal Hrčak and are searchable by the author, title or keywords. More than 8000 visits to the digitized material in only two month after the publishing argues in favour of its importance for the contemporary botanical investigations.

IN-SITU CONSERVATION OF MEADOW PLANT SPECIES

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Beside in-situ conservation of single vulnerable plant species populations, equally important is in-situ conservation of endangered habitat types. In any case, today also grasslands belong into especially vulnerable habitat types. Overgrowing and changed environmental management are leading into its reduction and poorness of natural seed bank. This than also leads into disappearance of some sensitive plant species. Since 1998 University Botanic Gardens has rented a dry meadow on the edge of city of Ljubljana (Slovenian capital), where in-situ some grassland plant species are protected. This meadow is semi dry Central European meadow rich in orchids and belongs to the *Bromion erecti* community, with more than 120 plant species detected. Each year population condition of some plant species, listed on the red list of endangered species (*Gladiolus ilyricus, Anacamptis pyramidalis,Gymnadenia conopsea, Lilium bulbiferum* subsp. *bulbiferum*, *Ophrys holosericea, Orchis coriophora, Orchis militaris, Orchis morio, Orchis tridentata, Orchis ustulata*), is monitored. For this grassland conservation only once per year, in late summer when most of plant seeds are already ripe, grass is mowed. Beside that all invasive species from surrounding abandoned fields, which also are appearing on the grassland, are cut immediately. In areas with highest plant diversity the hay gravel is then collected. We used it for making new dry grassland meadows on degraded surfaces. Each year also seeds from species growing on this dry meadow are collected and stored at permanent seed bank in the part being used for seed exchange. We contributed also seeds of 10 different plant species into the Millennium Seed Bank (Kew).

BOTANIČKI PRISTUP U RJEŠAVANJU PROBLEMA U UZGOJU I PRERADI ROGAČA (*CERATONIA SILIQUA* L.)

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Tijekom provođenja istraživačkog projekta TEUCLIC (HRZZ-IP-11-2013-3304) uočene su određeni problemi u uzgoju i preradi rogača koji su rezultat nedostatnog botaničkog znanja glede morfologije plodova i sjemenki rogača (*Ceratonia siliqua* L), ali i fiziologije cvatnje. Ovaj rad obrađuje dvije studije slučaja u kojima su isključivo primjenom znanja temeljne botanike i uz korištenje adekvatnih istraživačkih metoda, riješeni određeni problemi u uzgoju i tehnologiji sušenja i prerade rogača. Pri tome, najveći dio vremena utrošen je na premoštenje rascjepa između različitih pristupa korištenjem tehnika različitih komunikacijskih alata. Postignuti rezultati posljedica su interdisciplinarnog i interaktivnog pristupa svih dionika u istraživanjima i krajnjih korisnika istraživačkih rezultata.

BOTANICAL APPROACH IN PROBLEM SOLVING IN GROWING AND PROCESSING OF CAROB TREE (*CERATONIA SILIQUA* L.)

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During the conduction of research project TEUCLIC (HRZZ-IP-11-2013-3304) some problems in carob growing and processing of carob pods and seeds were detected, as a consequence of insufficient botanical knowledge about morphology of carob (*Ceratonia siliqua* L) pods and seeds and also about physiology of anthesis. In this presentation two study cases will be exposed, in which some problems in carob growing and technology of drying of carob pods and seeds were solved exclusively by usage of basic botanical knowledge. However, bridging the gap between different approaches and disciplines by using different communication tolls, took a very long time. Achieved results are consequence of interdisciplinary and interactive approach of all stakeholders in research as well as final users of research results.

„ISPOD RADARA“ – INVAZIVNA *REYNOUTRIA* × *BOHEMICA* CHRTEK ET CHRTKOVÁ (POLYGONACEAE) U HRVATSKOJ

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Slučaj svojte *Reynoutria* × *bohemica* započinje 1983. godine, kada je ova svojta prvi puta opisana u Češkoj, kao hibrid između azijskih vrsta *R*. *japonica* Houtt. i *R*. *sachalinensis* (F. S. Petrop.) Nakai in T. Mori, a koje su obje strane i invazivne u Europi. Ove vrste ne dolaze zajedno u svojem prirodnom području rasprostranjenosti, te se smatra da je hibrid nastao u područjima gdje su unesene.

Iako je prvi puta opisana 1983. godine, revidirani herbarijski materijal pokazuje da je ova svojta prisutna u europskoj hortikulturi barem od 1872. godine, a kao naturalizirana barem od 1954. godine. Nažalost, širenje ove svojte je prilično zanemareno zbog velike sličnosti sa roditeljskim vrstama, te zapisi iz mnogih dijelova Europe ističu vjerojatnost čestog krivog bilježenja svojte *R*. × *bohemica* kao jednog od roditelja. Situacija u Hrvatskoj nije drugačija – obje roditeljske vrste se bilježe od sredine XX stoljeća, ali hibrid još uvijek nije naveden u popisu flore, iako je, prema našim osobnim saznanjima, u Hrvatskoj široko rasprostranjen.

Glavni cilj ovog istraživanja je konačno uključivanje svojte *R*. × *bohemica* na popis flore Hrvatske, te početak raspleta trenutačne zbrke koja vlada između ove tri svojte. Iz tog razloga smo pregledali primjerke roda *Reynoutria* iz svih herbarijskih zbirki (ZA, ZAHO, CNHM, ZAGR), te prikupili novi materijal s terena. Iako bi rasprostranjenost ovih svojti trebalo pažljivo preispitati tijekom idućih godina, prema našim osobnim opažanjima, *R*. × *bohemica* je daleko najrasprostranjenija svojta ovog roda u Hrvatskoj.

„FLYING UNDER THE RADAR“ – INVASIVE *REYNOUTRIA* × *BOHEMICA* CHRTEK ET CHRTKOVÁ (POLYGONACEAE) IN CROATIA

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The case of *Reynoutria* × bohemica begins back in the 1983, when this taxon was firstly described from the Check Republic as a hybrid between Asian *R*. *japonica* Houtt. and *R*. *sachalinensis* (F. S. Petrop.) Nakai in T. Mori, both alien and invasive in Europe. In their native range, the two taxa are not sympatric; thus the hybrid is considered to originate in the introduced range.

Although firstly described in 1983, revised herbarium specimens show that *R*. × *bohemica* occurs in European horticulture since (at least) 1872, and as naturalized since (at least) 1954. Unfortunately, the spread of this taxon had been largely neglected, due to the similarity with parental species. Reports from many European countries emphasize the probability of frequently recording *R*. × *bohemica* as one of its parents. The situation in Croatia is not different – both parental species have been recorded since the mid 20th century, but the hybrid is still not listed on the checklist, although, according to our personal knowledge, appears to be widely distributed.

The main aim of this study was to finally include *R*. × *bohemica* into Croatian checklist, and to begin the unravelling of the existing confusion between the three taxa. For this purpose, we have revised specimens of *Reynoutria* spp. from all Croatian herbaria (ZA, ZAHO, CNHM, ZAGR), and collected new specimens from the field. Although the distribution of all three taxa should be carefully reviewed in the following years, according to our personal observations, *R*. × *bohemica* is by far the most widespread in Croatia.

INVAZIVNE VRSTE – MJERE SMANJENJA NEGATIVNOG UTJECAJA NA OKOLIŠ

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Invazivne vrste su sve veća prijetnja očuvanju bioraznolikosti, stoga je nužno da se mjere sprječavanja njihovog širenja počnu primjenjivati i tijekom pojedinih faza planiranja i provedbe zahvata u okolišu. Prilikom procjene utjecaja na okoliš, a tijekom obilaska lokacije planiranog zahvata, moguće je uočiti invazivne vrste. Osim zatečenih invazivnih vrsta na lokaciji, pronalazak istih je moguć i unutar projektne dokumentacije krajobraznog uređenja, što uslijed realizacije takvog projekta ima jednak negativan utjecaj na bioraznolikost. U takvim slučajevima potrebno je definirati odgovarajuće mjere zaštite okoliša koje nalažu uklanjanje prisutnih jedinki, odnosno zamjenu planiranih invazivnih vrsta neinvazivnima kako bi se spriječilo njihovo daljnje širenje i izbjegao negativan utjecaj. Zahvatima koji se nalaze unutar ekološke mreže potrebno je posvetiti posebnu pozornost. Ovim radom prikazani su zahvati za koje je procjenom utjecaja na okoliš utvrđena opasnost od negativnog utjecaja invazivnih vrsta na bioraznolikost te mjere koje su predložene kako bi se utjecaj izbjegao. U radu je dan primjer postupanja s invazivnom alohtonom vrstom japanski dvornik (*Reynoutria japonica*), koja predstavlja veliku opasnost bioraznolikosti zbog brzog širenja i zauzimanja staništa te utjecaja na sastav tla mijenjanjem omjera hranjiva i lučenjem alelokemikalija. Mjere zaštite prilikom uklanjanja ove invazivne vrste moraju uključiti više faza – od same pripreme i fizičkog uklanjanja biljke pa sve do adekvatnog načina zbrinjavanja njenih ostataka i supstrata u kojem je rasla. Osim ovog primjera, u radu je opisana problematika (ne)namjernog uvođenja alohtonih invazivnih vrsta kroz hortikulturne zahvate odnosno projekte krajobrazne arhitekture. Krajobraznim arhitektima se stoga preporuča posebna pažnja kod odabira biljnog materijala i provjera odabranih vrsta prema preliminarnom popisu invazivnih stranih biljnih vrsta na svom području, kako bi se izbjeglo uvođenje invazivnih vrsta na ovakav način. Ovo je posebno važno istaknuti iz razloga što problematika uzgoja, prodaje i samog postupanja s invazivnim vrstama još uvijek nije u cijelosti regulirana na području Europske unije.

INVASIVE SPECIES – MITTIGATION MEASURES TO REDUCE ENVIRONMENTAL IMPACTS

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Invasive species are growing threat to the biodiversity. Therefore it is essential to apply mitigation measures during planning and implementation stages of various interventions to prevent their spread. Using environmental impact assessment instruments, it is possible to spot the invasive species. In addition to finding the existing invasive species at the site, it is also possible to find the same within documents of landscape design, which consequently could have the same negative impact on biodiversity. In such cases it is necessary to define appropriate mitigation measures that require the removal of present individuals or replacement of planned invasive species with a non-invasive one to prevent their further spread and to avoid the negative impact. Projects located within Natura 2000 network need to pay special attention. This paper presents cases for which the environmental impact assessment identified the risk of negative impacts of invasive species on biodiversity and proposed mitigation measures to avoid the impact. The paper gives an example of dealing with the invasive alien species *Reynoutria japonica*, which is a major threat to biodiversity due to its rapid expansion, occupation of habitats and impact on soil structure by changing the ratio of nutrients and secretion of allelochemicals. While removing invasive species, mitigation measures must include several stages – from the planning phase and physical removal of the plant, up to adequate care of its residues and substrate in which it grew. In addition to this example, paper describes the problem of (un)intentional introduction of nonnative invasive species through horticultural projects and landscape designs. Therefore, it is recommended for landscape architects to pay special attention when selecting plant material and checking the preliminary list of invasive alien plants in their area in order to avoid the introduction of invasive species by landscaping. This is especially important to stress out because the problem of growing, selling and dealing with invasive species is still not fully regulated in the EU.

VREDNOVANJE OTOKA VELI BRIJUN S ASPEKTA BIOLOŠKE RAZNOLIKOSTI

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Brijunsko otočje je od 1983. godine zaštićeno u kategoriji nacionalnog parka, a od 2007. godine dio je nacionalne ekološke mreže (koja je 2013. godine postala dio europske ekološke mreže Natura 2000). Međutim, prostor Velog Brijuna, najvećeg otoka Brijunskog otočja, pod izraženim je antropogenim utjecajem što se negativno odražava na biološku raznolikost područja. Kako bi se omogućio budući razvoj i adekvatno upravljanje prostorom Velog Brijuna, uz istovremenu zaštitu njegovih prirodnih i kulturnih vrijednosti, izrađena je „Studija krajobraznog i prostornog identiteta otoka Veli Brijun“. U sklopu navedene studije otok je također vrednovan s aspekta biološke raznolikosti s ciljem izrade smjernica za očuvanje i obnovu biološke raznolikosti Velog Brijuna.

S obzirom da na području Velog Brijuna nedostaju detaljni (prostorni) podaci o rasprostranjenosti flore, faune i gljiva te da se očuvanje ekosustava osigurava očuvanjem povoljnog stanja stanišnih tipova, vrednovanje otoka s aspekta biološke raznolikosti temeljilo se na procjeni stanja postojećih stanišnih tipova. U tu svrhu razvijena je nova metodologija vrednovanja prostora koja se sastojala od tri faze:

(1) izrade karte staništa Velog Brijuna za potrebe vrednovanja (M 1:2.500, MPK 0,2 ha);
(2) analize značaja stanišnih tipova za očuvanje biološke raznolikosti; te
(3) izdvajanja područja sa specifičnim ciljevima zaštite staništa.

Dobiveni rezultati potvrdili su prisutnost izrazitog antropogenog utjecaja na staništa Velog Brijuna - preko 70% ukupne površine otoka ocijenjeno je kao područje pod izrazitim antropogenim utjecajem, dok je tek 7,5% ukupne površine ocijenjeno kao područje vrlo visokog značaja za biološku raznolikost. Na temelju dobivenih rezultata izdvojeno je 10 područja sa specifičnim ciljevima zaštite staništa te je za svako područje dan niz smjernica usko vezanih uz prepoznate specifične ciljeve. Pored navedenih smjernica, predložene su također opće smjernice za očuvanje biološke raznolikosti Velog Brijuna.

EVALUATION OF THE ISLAND OF VELI BRIJUN FROM THE ASPECT OF BIODIVERSITY

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Brijuni archipelago is protected as a national park since 1983 and in 2007 it became a part of the national ecological network (which became part of the European ecological network Natura 2000 in 2013). However, the biggest island in the Brijuni archipelago – Veli Brijun – is under considerable anthropogenic influence which negatively affects island's biodiversity. To enable future development and adequate management of the island, while conserving the natural and cultural values of the area, "Study of Landscape and Spatial Identity of Veli Brijun Island" was conducted. As a part of the Study, evaluation of the island from the aspect of biodiversity was carried out in order to propose informed guidelines for conservation and restoration of area's biodiversity.

Since detailed (spatial) data on the distribution of flora, fauna and fungi are lacking and since ecosystem conservation is ensured by conserving the favourable habitat condition, the island was evaluated from the aspect of biodiversity by assessing the condition of present habitats. Therefore, a new method for area evaluation was developed that encompassed three phases:

(1) preparation of the habitat map of Veli Brijun for the purpose of evaluation (scale 1:2.500, min. mapping area 0.2 ha);
(2) evaluation of the habitats' importance for conserving biodiversity;
(3) identification of the areas with specific targets for habitat protection.

The results confirmed the presence of considerable anthropogenic influence on habitats of Veli Brijun – more than 70 % of the total island's surface was assessed as an area under significant anthropogenic influence, while only 7.5% of the total area was assessed as an area of a high importance for biodiversity conservation. Based on the results, 10 areas with specific targets for habitat protection were recognized and guidelines were proposed, closely related to those specific targets. Apart from aforementioned guidelines, general guidelines for island's biodiversity conservation were proposed.

PRIMJENA OBRAZACA ZA PROCJENU RIZIKA INVAZIVNOSTI BILJNIH SVOJTI U HRVATSKOJ - PRELIMINARNA USPOREDBA

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Prilikom namjernog unosa novih biljnih svojti u neku zemlju, postoji mogućnost da unesena svojta pokaže invazivan karakter. Kako bi se umanjio rizik unosa potencijalno invazivnih vrsta na neko područje, primjenjuju se obrasci za procjenu rizika invazivnosti. U Hrvatskoj dosad nije primjenjen niti jedan od dostupnih obrazaca te ne postoje javno dostupne informacije i/ili preporuke vezane uz upotrebu i primjenjivost istih na nacionalnoj razini. Proveli smo preliminarnu usporedbu četiri obrasca - (1) EPPO prioritization process for invasive alien plants; (2) Australian Weed Risk Assessment; (3) Great Britain Non-native Species Risk Assessment i (4) Transport, Establishment, Abundance, Spread, Impact (TEASI) framework, koji predstavljaju tri različita pristupa problemu procjene invazivnosti. Svaki od navedenih obrazaca korišten je pri procjeni invazivnosti četiri svojte čiji je stupanj invazivnosti na prostoru Hrvatske već poznat - (1) invazivne strane svojte, (2) naturalizirane strane svojte, (3) autohtone svojte invazivnog karaktera, (4) autohtone svojte koja ne pokazuje invazivan karakter. Na temelju dobivenih rezultata, za svaki obrazac prikazana je njegova uspješnost u procjeni rizika, primjenjivost na nacionalnoj razini, uočeni nedostaci (npr. nedovoljan broj informacija nužnih za procjenu, pogrešna interpretacija pitanja i rezultata). Rezultati usporedbe ukazuju na mogućnost implementacije pojedinih dijelova svakog obrasca prilikom budućih procjena rizika u Hrvatskoj.

APPLICATION OF RISK ASSESSMENT FOR PLANT INVASIVENESS IN CROATIA – A PRELIMINARY COMPARISON

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Intentional introduction of plant species creates a possibility for a species becoming invasive. Different risk assessments are applied across the world to reduce the invasibility risk. So far none of the available risk assessments were applied in Croatia, and we have no accessible information or recommendations about use and applicability of nationwide risk assessments. We conducted a preliminary comparison of 4 risk assessments – (1) EPPO prioritization process for invasive alien plants; (2) Australian Weed Risk Assessment; (3) Great Britain Non-native Species Risk Assessment and (4) Transport, Establishment, Abundance, Spread, Impact (TEASI) framework. These assessments represent three different approaches for predicting invasiveness. We applied each of the four risk assessments to four plant species with a known invasive status in Croatia - (1) invasive allochthonous species, (2) naturalized allochthonous species, (3) native species with a known invasive character, (4) native species without an invasive character. Results of the risk assessment application show, for each risk assessment, the degree of prediction success, nationwide applicability, limitations of the methodology (i.e. the lack or inaccessible information needed to complete the assessment, erroneous interpretation of the questions). The results of the comparison show the possibility of implementation of certain parts of each assessment in future risk assessments in Croatia.

Tema simpozija

Evolucija, taksonomija i filogenija

Konzervacijska biologija, zaštita prirode i okoliša

Symposium topic

Evolution, taxonomy and phylogeny

Conservation biology, environmental and nature protection

RAZNOLIKOST I TAKSONOMIJA HETEROPLOIDNE VRSTE *KNAUTIA DRYMEIA* HEUFF.

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Knautia drymeia Heuff. je morfološki varijabilna, diploidna i tetraploidna šumska prizemna vrsta rasprostranjena u jugoistočnoj Europi i susjednim područjima. Diploidi su disjunktno rasprostranjeni, te jedna grupa dolazi na području sjevernog Apeninskog poluotoka i proteže se preko južnih obronaka Alpa prema sjeverozapadnom dijelu Balkanskog poluotoka, dok je druga grupa ograničena na područje jugoistočnog dijela Balkanskog poluotoka i južnih Karpata. Tetraploidi dolaze između te dvije grupe na Balkanskom poluotoku, i na području preko Alpa prema Panonskoj ravnici i područjima sjeveroistočno od Alpa. Tetraploide populacije sa središnjih Apenina uglavnom se tretiraju kao endemska vrsta *K. gussonei*, iako srodstveni odnosi između dvije svojte još uvijek nisu razjašnjeni. Cilj istraživanja bio je istražiti genetsku strukturu među diploidima, dobiti uvid u porijeklo tetraploida te usporediti morfologiju i dobivene genetske grupe s današnjom taksonomijom s ciljem provjere taksonomskog statusa *K. gussonei* Szabó i podvrsta *K. drymeia*. Također je evolucija svojti uspoređena sa šumskim refugijima dobivenim temeljem palinoloških podataka. AFLP analiza i multivarijantna statistika morfoloških karakteristika provedena je na 57 populacija rasprostranjenih na području areala *K. drymeia*. *K-means* grupiranje, usporedba *in-silico* i uočenih tetraploida, te *relaxed random walks* filogeografska analiza upotrebljeni su za proučavanje genetske strukture i evolucije. Genetska struktura je korelirana s geografskom pozicijom, te su dobivene četiri genetske grupe unutar kojih je uključena i *K. gussonei.* Rasprostranjenost diploida sugerira postojanje glacijalnih refugija na sjeverozapadnom i jugoistočnom Balkanu. Poliploidi su se razvili barem dva puta, kao autopoliploidi unutar sjeveroistočne i unutar jugoistočne grupe, te kao aloploiploidi između sjeveroistočne i jugoistočne grupe. Morfološke razlike nisu u skladu niti s genetskim grupama niti s taksonomijom. Rezultati genetske i morfološke analize stoga ne podržavaju *K. gussonei* kao zasebnu vrstu niti razdiobu svojte *K. drymeia* na postojeće podvrste. S obzirom na rezultate istraživanja predlažemo tretiranje *K. drymeia* kao jedinstvene genetski i morfološki varijabilne svojte.

DIVERSIFICATION AND TAXONOMY OF HETEROPLOID *KNAUTIA DRYMEIA* HEUFF.

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Knautia drymeia Heuff. is a morphologically variable, diploid and tetraploid temperate forest understory species distributed in southeastern Europe and adjacent areas. Diploids are disjunctly distributed, with one group ranging from the northern Apennine Peninsula over the southern margins of the Alps to the north-western-most Balkan Peninsula and the second one being restricted to the south-eastern Balkan Peninsula and the southern Carpathians. Tetraploids occur in intermittent areas on the Balkan Peninsula and extend into the Alps, the Pannonian plain and the areas north-east of the Alps. Tetraploid populations from the central Apennines have mostly been treated as independent endemic species, *K. gussonei*, however the relationship between the two taxa remain unclear. The aim of this study was to explore the genetic structure within the diploids, to provide insights into the origin of the tetraploids and to contrast morphology and genetic groups with current taxonomy in order to evaluate the status of *K. gussonei* Szabó and the intraspecific taxa of *K. drymeia*. Additionally, spatiotemporal diversification was compared with forest refugia identified based on palynological evidence. Amplified fragment length polymorphism fingerprinting and multivariate analyses of morphological characters were performed on 57 populations spanning the distribution area of *K. drymeia*. K-means clustering, comparison of *in-silico* tetraploids and observed tetraploids, and a phylogeographic analysis using relaxed random walks were used to infer genetic structure and spatiotemporal evolution. The genetic structure was strongly geographically correlated and yielded four genetic groups; *K. gussonei* was inseparable from *K. drymeia*. Distributions of diploid lineages are suggestive of glacial refugia in the north-western-most and south-eastern Balkan Peninsula. Polyploids originated at least two times, as autopolyploids within North-eastern and South-eastern Groups and probably as allopolypoloids from North-eastern and South-eastern Groups. Morphological divergence did neither correspond to the genetic groups nor to current taxonomy. Therefore, genetic and morphometric data did neither confirm recognition of *K. gussonei* as distinct species nor support recognition of subspecies within *K. drymeia*. Hence, we propose treating *K. drymeia* as morphologically and genetically variable species without infraspecific taxa.

IS THE STATE BORDER ALSO A BIOGEOGRAPHICAL ONE?

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At first the title question may seem just provocative with the only logical answer: no. But quite often the natural barriers as mountain ranges or rivers have been used as clear landmarks since ancient times to delimit also the political entities. But this is not the only factor that would cause floristic differences beyond the border. We can think of several other factors as e.g. coordination of floristic exploration from different centers resulting in geographical and taxonomic bias (causing only ostensible differences!), differences in agricultural strategies and practices again coordinated from different centers, movement of anthropogenic vectors mainly within the state borders (like agri-mechanization, heavy building machinery, road or railway maintenance, ...), different nature-conservation approaches and strategies, differences in ornamentals supply in the markets etc. All these factors are probably not very important in a long term, but can result in short term floristic differences. A comparison of vascular plant flora of a 40 km wide belt along the state border between Slovenia and Croatia has been used to answer the title question and to interpret the recognized differences. The rough impression along the discussed border is, that it can not act as a real biogeographical border. There are very few obvious differences like predominantly limestone coast in Croatian Istria vs. flysch coast in Slovenia.

Two datasets for comparison were obtained from Centre for cartography of fauna and flora (»Flora Slovenije« database) and Flora Croatica Database. Presence of vascular plant taxa in the 20 km border belt and number of records were used for comparison, so the lists had 2394 taxa for Slovenian side and 2854 taxa for Croatian side. In the first phase automatic comparison of lists were made resulting in 1253 common taxa, i.e. 52% of Slovenian and 44% of Croatian lists, but in each consecutive phase the number of matching taxa was slightly increasing. Second phase was manual matching check to exclude incompatibility because of slightly different spelling, author abbreviation, orthographic variants etc. Third phase checked for the synonyms used in both databases as valid names. Fourth phase searched for the common denominator in taxonomically critical groups, and finally, in the fifth phase two lists of taxa present only on one side of the border were produced. From that lists in the sixth phase taxa recorded in other parts of the county but not in the study area were excluded and finally for the remaining taxa expert evaluation of probability of presence was conducted.

CONSERVATION GENETICS OF *DAPHNE BLAGAYANA* FREYER (THYMELAEACEAE)

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Daphne blagayana Freyer is a small decumbent bush from the family Thymelaeaceae. Its present distribution range is fragmented and comprises the Balkan Peninsula and the southern Romanian Carpathians. Due to its rarity it is protected by national legislation in almost all countries within its range. The aim of this study was to assess the conservation status of *D. blagayana* throughout its distribution range, using chloroplast DNA (cpDNA) and AFLP markers. Sampling was conducted at 21 locations across the entire distribution range. Chloroplast DNA and AFLP markers were used as a tool for assessing its conservation status. The phylogeographic analysis included 95 plants from 21 populations. The study was based on the analysis of five spacer regions of chloroplast DNA: *rpl20-rps12*, *atpB-rbcL*, *trnL-F*, *psbA-trnH* and *trnK-matK* with the gene *matK*. The results suggest the existence of three clusters: the northern cluster (SLO), including Slovenian and Italian populations, the southern cluster (J), including populations from Macedonia, Montenegro and southern BiH, and the central cluster (SR), including the remaining populations. Both haplotype and nucleotide diversity were highest in the central cluster and lowest in the northern cluster. In the second part of the study we assessed genetic structure and gene flow between 13 selected populations using dominant AFLP markers. The results showed a relatively strong genetic differentiation (F_{ST}= 0.4) and absence of gene flow among distant populations. Using the programs STRUCTURE and BAPS populations were subdivided into 2 and 7 groups, respectively. The groupings proposed by STRUCTURE and BAPS were not fully congruent with cpDNA clusters. This incongruence might be attributed to different reproduction strategies within populations, and to different modes of inheritance of chloroplast and nuclear DNA. Based on both marker systems we can suggest the identification of three evolutionarily significant units (ESU) and one additional management unit (MU), on which conservation efforts should be focused in the future.

PLANT COLONIZATION INTO NATURAL GAP OPPENINGS IN FOREST

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Beside human activity the natural disasters are the events that are changing the forest ecosystems. Among the most obvious changes there are gap openings in the forests. They are formed either due to deforestation or due to breakage from wind or ice or due to wood fires. In any case these gap openings are areas of colonization for those plant species that were not competitive with tree species within the phase of continuous forest stand. At the same time unfortunately such gap openings are also potential sinks for invasive plant species. Of course the plant species structure on these gaps is changing in dependence on their time of formation. In all phases from the time of gap formation until the reestablishment of forest stand the plant species structure can change for several times or at least the coverage and frequency of single species are changing. Within our research plant species structure in the gap opening, newly formed due to ice breakage in the beech juvenile forest, was compared for three different vegetation seasons. Between both areas plant species structure was compared, estimates for coverage, coverage type and frequency have been made. Additionally we tried to establish which donor populations have colonized the gap. It has been established that in newly formed gap openings the number of plant species was higher than in beech juvenile forest. In the gap openings the species, characteristic as well for forest undergrowth (*Omphalodes verna, Cardamine enneaphyllos, Anemone nemorosa*,…) as for sunny and open areas (*Calaminthe grandiflora, Fragaria vesca, Prunella vulgaris, Ajuga reptans*…) were present. During study of the colonization paths it has been established, that especially the species *Tussilago farfara* and *Petasites albus* are coming into the gap openings through the forestry pathways.

PNEOPHYLLUM CETINAENSIS – IZ MORSKOG U SLATKOVODNO STANIŠTE

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Pneophyllum cetinaensis je jedina poznata slatkovodna koralinska alga. Opisana je u rijeci Cetini gdje naseljava gotovo cijeli riječni tok. Više je čimbenika bilo važno u prilagodbi morskog pretka na slatku vodu i uspješno napredovanje rijekom. Najvažnije prepreke koje sprječavaju invaziju morskih vrsta u slatke vode su: regulacija osmotskog tlaka, koncentracija iona, pH razina, niska temperatura, stalno ispiranje, izvor hrane, kompeticija i slobodan životni prostor. Alga *Pneophyllum cetinaensis* savladala ih je sve u recentnom geološkom vremenu. Prilagodba na slatku vodu vjerojatno se dogodila u jednom od triju velikih paleo estuarija. Posebne značajke krške rijeke Cetine učinili su kolonizaciji rijeke mogućom: tvrda voda koja je olakšala osmoregulaciju, voda bogata otopljenim kalcijevim karbonatom bitna za kalcifikaciju, pH vrijednost slična razini u moru. U rijeci Cetini alga *Pneophyllum cetinaensis* nije se susrela s kompetitorima i predatorima. Najčešće se razvija na oblutcima koji u Cetini uglavnom nisu naseljeni drugim sesilnim organizmima. Odsustvo specijaliziranih grejzera koristilo je naseljavanju. Uzvodno napredovanje i širenje olakšano je posebno izraženom zoohorijom pomoću slatkovodnih puževa koji su ujedno predominantni makrobeskralješnjaci krških rijeka. Izgleda da su krške, karbonatne rijeke umjereno toplog područja jedine rijeke u kojima je potencijalno moguća invazija koralinskih algi, primarno morskih organizama.

PNEOPHYLLUM CETINAENSIS – FROM MARINE TO FRESHWATER HABITAT

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Pneophyllum cetinaensis is the only known freshwater coralline alga. It is described from the Cetina River where it is established in almost entire river flow. Several factors were important in the adaptation of its marine ancestor to the freshwater and successful progression into the river. The most serious obstacles preventing invasion of marine species into fresh water are the regulation of osmotic pressure, ionic concentration, pH level, low temperature, constant runoff, food resources, competition and available living space. All of these were surmounted by *P. cetinaensis* in recent geological history. Adaptation to the freshwater was probably done in one of three large paleo-estuaries. The particular characteristics of the karst Cetina River, such as hard water (made osmoregulation easier) enriched with dissolved calcium carbonate (important for calcification) and a pH similar to the marine environment, made colonization of the river possible. *Pneophyllum cetinaensis* did not encounter competitors and predators in the Cetina River. It develops regularly on cobbles and pebbles which are in the Cetina river mostly uncolonized by sessile organisms. The absence of specialized grazers favoured the establishment. The upstream advance and dispersal is facilitated by exceptionally pronounced zoochory by freshwater gastropods which are typically for the karst river, predominant among benthic macroinvertebrates. It seems that karst, carbonate rivers of a worm-temperate zone are the only potential ones for invasion of primary marine coralline algae.

POSTERSKA PRIOPĆENJA

Tema simpozija

Evolucija, taksonomija i filogenija

POSTER PRESENTATIONS

Symposium topic

Evolution, taxonomy and phylogeny

RAZNOLIKOST VRSTA RODA *PSEUDO-NITZSCHIA* TIJEKOM POJAVE DOMOIČNE KISELINE U ŠKOLJKAŠIMA IZ KAŠTELANSKOG ZALJEVA U SREDNJEM JADRANU

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Poznato je više od 45 vrsta roda *Pseudo-nitzschia* od kojih je za 16 vrsta potvrđena sposobnost sinteze toksina domoične kiseline (DK). Cilj našeg istraživanja bio je odrediti sastav vrsta *Pseudo-nitzschia* tijekom razdoblja kada je u školjkašima izmjerena domoična kiselina. Uzorkovanje je provedeno na području Kaštelanskog zaljeva, u razdoblju od studenog 2015. do siječnja 2016. godine. Maseni udio domoične kiseline u školjkašima *Venus verrucosa* bio je nizak, značajno ispod dopuštenog dok je najviša zabilježena brojnost vrsta *Pseudo-nitzschia* spp. iznosila 1.85 x 10^5 st L^{-1}, početkom studenog.

Morfološkom analizom na pretražnom elektronskom mikroskopu određeno je šest vrsta roda *Pseudo-nitzschia*: *P. calliantha*, *P. delicatissima*, *P. fraudulenta*, *P.* cf *pseudodelicatissima*, *P. subfraudulenta* i *Pseudo-nitzschia* sp. Od spomenutih vrsta *P.* cf *pseudodelicatissima* pronađena je u svim uzorcima. Tijekom istraživanog razdoblja sastav *Pseudo-nitzschia* vrsta se mijenjao. Vrste *P.* cf *pseudodelicatissima*, *P. delicatissima* i *P. calliantha* zabilježene su tijekom prvog mjeseca uzorkovanja. U prosincu je vrsta *P. subfraudulenta* prevladavala nad vrstom *P.* cf *pseudodelicatissima* dok je najveća raznolikost zabilježena tijekom siječnja kada su u morskoj vodi zabilježene sve spomenute vrste. Dobiveni rezultati predstavljaju prva taksonomska istraživanja roda *Pseudo-nitzschia* u Kaštelanskom zaljevu.

DIVERSITY OF *PSEUDO-NITZSCHIA* SPECIES DURING OCCURRENCE OF DOMOIC ACID IN SHELLFISH FROM KAŠTELA BAY, CENTRAL ADRIATIC SEA

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The diatom genus *Pseudo-nitzschia*, today comprises of more than 45 species, out of which 16 species have been confirmed to produce potent neurotoxin domoic acid (DA). The aim of our research was to clarify the composition of *Pseudo-nitzschia* species in the period when domoic acid has been present in the shellfish. Sampling was conducted in Kaštela bay, from November 2015 till January 2016. Concentrations of DA in shellfish *Venus verrucosa* were low, far below regulatory limit while the highest abundance of *Pseudo-nitzschia* spp. reached 1.85×10^5 cells L^{-1} in the surface layer, at the beginning of November.

Morphological analyses by Scanning Electron Microscopy revealed the presence of six *Pseudo-nitzschia* species: *P. calliantha*, *P. delicatissima*, *P. fraudulenta*, *P.* cf *pseudodelicatissima*, *P. subfraudulenta* and *Pseudo-nitzschia* sp. Among them, *P.* cf *pseudodelicatissima* was found during the entire investigated period. Relative contribution of each *Pseudo-nitzschia* species (%) has changed over the investigated period. During the first month of sampling species *P.* cf *pseudodelicatissima*, *P. delicatissima* and *P. calliantha* have been recorded. In December *P. subfraudulenta* prevailed over the *P.* cf *pseudodelicatissima* while the highest diversity has been noticed in January when all six observed species have been recorded. These results present first taxonomical investigation of genus *Pseudo-nitzschia* in Kaštela bay.

RAZNOLIKOST DIJATOMEJA PLITVIČKIH JEZERA

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Nacionalni park Plitvička jezera svjetski su priznati krški fenomen sastavljen od 16 kaskadno postavljenih jezera međusobno odijeljenih sedrenim barijerama. Uz proces osedravanja, najvažniji doprinos ljepoti i raznolikosti ovog zaštićenog ekosustava čini biološka komponenta, prvenstveno alge kremenjašice (dijatomeje) kao najznačajniji dio planktonske i bentičke zajednice. Alge kremenjašice zbog svoje se raznolikosti i široke rasprostranjenosti te specifičnih ekoloških prilagodbi koriste kao vrlo osjetljivi pokazatelji ekološkog stanja sustava. Upravo poznavanje dijatomejskih vrsta, odnosno njihova pravilna identifikacija i točan popis, igraju ključnu ulogu u karakterizaciji vodenih ekosustava. Uzorci planktona i bentosa prikupljeni su jednom mjesečno tijekom vegetacijskog razdoblja u razdoblju od lipnja 2015. do srpnja 2016. godine na dva najveća jezera sustava Plitvičkih jezera - Kozjak i Prošće. Laboratorijska obrada uključivala je čišćenje uzoraka i izradu trajnih preparata za identifikaciju algi kremenjašica i izradu foto zbirke. Pregledom trajnih preparata utvrđeno je više od 150 vrsta, s nekoliko za znanost potencijalno novih, te nekoliko endemskih vrsta dijatomeja. Sastav dijatomejske zajednice dvaju jezera prikazan je u tabličnom obliku, zajedno sa fotografijama najznačajnijih predstavnika.

DIVERSITY OF DIATOMS IN THE PLITVICE LAKES

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Plitvice Lakes National Park is a world-known natural karst phenomenon composed of 16 cascading lakes separated by natural travertine barriers. Along with tufa formation, biological element constitutes the most important component to the beauty and diversity of this protected ecosystem, with diatoms as the most important part of planktonic and benthic communities. Owing to their diversity, wide distribution and species-specific environmental constraints diatoms are commonly used as very sensitive indicators of the ecological status of aquatic ecosystems. Therefore, correct and accurate identification of diatom species plays a crucial role in the characterization of aquatic ecosystems. Samples of plankton and benthos were collected monthly during the vegetation period from June 2015 to July 2016 in the two largest lakes of Plitvice Lakes NP, Kozjak and Prošće. Laboratory work included cleaning of samples and preparation of permanent slides for diatom identification and preparation of photographic collection. Slide inspection revealed more than 150 diatom species, with several potentially new to science, along with several endemic species. Diatom composition in two lakes is presented in tabular form, together with photographs of the most important representatives.

DIJATOMEJE MRTVOG MORA (OTOK LOKRUM, JADRANSKO MORE)

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Rad je sastavni dio projekta kojim se istraživanju taksonomija i ekologija bentoskih dijatomeja na istočnoj obali Jadrana. U travnju 2016., ukupno je 25 mikroskopskih stakalaca (predmetnica) uronjeno u Mrtvo more na dubinu od 0,5 m. Mrtvo more je poluzatvoreni plitki morski ekosustav (najveća dubina 6 m, površina 0,1 ha), koji se nalazi unutar rezervata šumske vegetacije na otoku Lokrumu ispred Dubrovnika. Tijekom ljeta sustav je pod značajnim antropogenim utjecajem (kupači). Cilj rada je istražiti strukturu i abundanciju dijatomeja te opisati sukcesiju svojta na finoj vremenskoj skali. Istraživanja se provode u razdoblju od 25 tjedana. Svakih tjedan dana, po jedna predmetnica se izvadi te nježno ispere sterilnom morskom vodom. Kvantitativna analiza biofilma se provodi pomoću svjetlosnog mikroskopa (LM) brojanjem živih stanica pod povećanjem od 60x, a vrijednosti su preračunate na površinu od 1 cm^2. Detaljna analiza strukture i abundancije dijatomeja provodi se na trajnim preparatima (materijal je tretiran vodikovim peroksidom) svjetlosnim mikroskopom Nikon E600 uz povećanje od 1000x. Kako bi se utvrdio potpuni sastav bentoskih dijatomeja u Mrtvom moru, dodatno su uzimani uzorci s kamenite podloge (litofilne dijatomeje) te sa smeđih i zelenih algi (epifitske svojte). Tijekom svakog uzorkovanja dijatomeja, mjereni su temperatura mora i salinitet, a uzimani su, također, uzorci za analizu ekoloških parametara (koncentracija hranjivih soli i klorofila *a*).

BENTHIC DIATOMS OF THE DEATH SEA (ISLAND OF LOKRUM, ADRIATIC SEA COAST)

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The present study is being developed in the framework of a research project dealing with taxonomy and ecology of benthic diatomsin the Croatian part of southern Adriatic Sea. Starting in April 2016, 25 microscope slides were merged into a Death Sea at the depth of 0.5 m. The Death Sea is semi-closed shallow marine ecosystem (maximum depth of 6 meters, the area of 0.1 ha), located within a special reserve of forest vegetation on the island Lokrum in front of Dubrovnik. During summer season, the Dead Sea is under significant anthropogenic influence (swimmers). The aim of this study is to explore the benthic diatom composition and abundance and seasonal dynamics of diatoms on a fine time scale. The experiment was carried out for 25 weeks and every week another microscope slide was taken out and gently plunged into sterile seawater. A quantitative biofilm assay was performed by light microscope (LM) observations by counting valves of life material under low magnification of 60x. Values were standardized to a sample surface of 1 cm^2. Detail diatom analysis was performed on permanent slides of processed material (hydrogen peroxide treated) with Nikon E600 microscope under magnification of 1000x. In order to make detailed analysis of benthic diatom assemblages of the Death Sea and provide information about host-dependence, additional to samples of microscope slides, samples of rocks (epilithic diatoms) and green and brown macroalagae (epiphytic diatoms) were also collected and prepared for diatom analysis. During experiment, environmental conditions (temperature of the sea, salinity, nutrients and chlorophyll *a*) were determined weekly.

DIATOMS OF RIVERS NERETVA, CETINA AND TREBIŠNJICA IN BOSNIA AND HERZEGOVINA

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In the period from 1896 to 2010, a total of 124 sites were investigated in basins of three rivers in Bosnia and Herzegovina: 88 in the Basin of Neretva River, its tributaries, natural and artificial lakes and wetlands; 25 in the Basin of Cetina River and 11 sites in the Basin of Trebišnjica River. This paper presents diatom list, systematic affiliations, synonyms and ecological preferences of certain taxa. A total of 522 diatoms were identified and classified in 72 genera and 10 families. Genera with the highest number of taxa was *Navicula*, with 73 taxa (47 species, 23 varieties and 3 forms) and followed by *Nitzschia,* with 41 taxa (33 species, 7 varieties and 1 form) and *Gomphonema* with 33 taxa (21 species, 11 varieties and 1 form). A total of 32 genera (44.5 %) were represented with two or one taxa.

TIPIZACIJA ALGI KREMENJAŠICA ANTE JURILJA (1910. - 1981.) 1948. I 1954. U OHRIDSKOM JEZERU

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Prof. dr. sc. Anto Jurilj, hrvatski algolog, živio je između 1910. - 1981. godine. Za svog radnog vijeka od 40-tih do 60-tih godina prošlog stoljeća djelovao je u Tetovu (Makedonija), Beogradu (Srbija), Zagrebu (Hrvatska) i Sarajevu (Bosna i Hercegovina). Njegov znanstveni rad obuhvaćao je morfologiju, taksonomiju i evoluciju algi kremenjašica. Publicirao je četiri važna djela o kremenjašicama Ohridskog jezera. Dva od četiri rada uključuju opise novih vrsta iz Ohridskog jezera (Jurilj 1948., 1954.). U radovima iz 1956. i 1957. opisuje svoj koncept evolucije i filogenije Surirelloidnih vrsta. U radu iz 1954. godine Jurilj je zabilježio 50 novih vrsta, iako samo 49 opisuje kao nove za znanost. Također u istom radu odbacuje tri prethodno opisna roda: *Helisella* Jurilj, *Iconella* Jurilj i *Plagiodiscus* Jurilj i prebacuje vrste tih rodova u rod *Surirella* ili u novo opisani rod *Scoliodiscus*. Sveukupno Jurilj (1948., 1954.) je opisao 44 nove vrste algi kremenjašica u Ohridskom jezeru, četiri nove kombinacije i jedan izmijenjeni opis. Do 2014. godine osnovni problem tipizacije opisanih vrsta bila je nemogućnost pronalaska originalne zbirke. Nakon Juriljeve smrti 1981. godine zbirka je bila izgubljena. Kroz razne kontakte, u čak 10 godina, nije ju bilo moguće pronaći. Zahvaljujući prof. dr. sc. Damiru Viličiću 2014. godine, zbirka je pronađena u Zagrebu. Također, prof. dr. sc. A. Jurilj za vrijeme svog rada je posjetio dr. sc. Friedricha Hustedta u Plönu, u Njemačkoj i donirao mu 20 uzoraka koji su danas dio Hustedtove kolekcije u Alfred Wegener Institutu u Bremerhavenu (BRM, Accession Nos 8240-8251). Uzorci u BRM imaju iste oznake kao i originalni Juriljevi materijali i korišteni su u ovom radu zajedno s originalnom zbirkom i dodatno nađenim uzrocima, u tipizaciji i opisu morfoloških varijabilnosti i značajka vrsta koje je opisao Jurilj.

TYPIFICATION OF DIATOMS DESCRIBED BY ANTO JURILJ (1910—1981) IN 1948 AND 1954 FROM LAKE OHRID

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Dr. Anto Jurilj (1910-1981) was Croatian algologist who worked in Tetovo (Macedonia), Belgrade (Serbia), Zagreb (Croatia) and Sarajevo (Bosnia and Herzegovina) from 40s to 60s of the 20th century. Most of Jurilj's scientific work was on the taxonomy, evolution and structure of diatoms. Dr. Anto Jurilj published four articles concerning the diatom flora of Lake Ohrid. Two of his articles Jurilj (1948, 1954) included descriptions of new diatom taxa from Lake Ohrid, while the two later articles (Jurilj 1956, 1957) were concerned with his concept on the evolution and phylogeny of Surirelloid diatom taxa. In the 1954 publication, Jurilj stated that he had found 50 new taxa, although only 49 were treated as new to science. In this publication (1954) he also rejected three of his previously described genera: *Helisella* Jurilj, *Iconella* Jurilj and *Plagiodiscus* Jurilj, transferring the species to *Surirella* or to newly established genus *Scoliodiscus* which accommodated species previously described as *Plagiodiscus*. In summary, Jurilj (1948, 1954) provided descriptions for a total of 44 new taxa from Lake Ohrid and its watershed, four new combinations and one emended description. Until 2014 one of the main problems typifying the species introduced by Jurilj was to find original material. After his death in 1981, the location of his collections could not be traced. During a period of 10 years and many contacts with his former students, we were still not able to locate his original collection. In 2014 thanks to prof. Damir Viličić the collection was found in Zagreb. However, Jurilj visited Dr. Friedrich Hustedt in Plön, Germany and donated to him 20 samples, which are now part of the Hustedt Diatom collection in the Alfred Wegener Institute in Bremerhaven (BRM, Accession Nos 8240-8251). The samples in BRM have the same labels as the original material collected by Jurilj and these together with original collection, were used to typify and provide better description of the species introduced by Jurilj. We examined original slides designate the types and also all available samples and slides in BRM to find additional specimens for improved description of the morphological variability and characteristics of the species.

MORFOLOGIJA PELUDA I SJEMENKI RODA *HYPERICUM* L. (HYPERICACEAE) – TAKSONOMSKE IMPLIKACIJE

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Veliki rod *Hypericum* L. (Hypericaceae) obuhvaća oko 470 vrsta, rasprostranjen je u cijelom svijetu, a podijeljen je na 30 sekcija i 6 podsekcija. Iako je molekularna filogenija roda dosta dobro istražena, ostala taksonomska istraživanja roda *Hypericum* su još uvijek u tijeku. Cilj našeg istraživanja bio je ispitati mogući taksonomski i evolucijski značaj mikromorfologije za ovaj rod. Stoga su pomoću skenirajućeg elektronskog mikroskopa istraženi pelud i sjemenke 32 svojte (iz 14 sekcija). Rezultati su pokazali nove značajke peluda i sjemenki za 14 vrsta roda *Hypericum*, neke nove nepravilnosti morfologije njihovog peluda, a neki od naših rezultata su slični rezultatima prethodnih istraživanja. Peludna zrnca većine istraženih svojti su tri-stefanokolporatna, s mikroretikulatnom do retikulatnom ornamentacijom eksine. Pelud nekih svojti pokazao je nepravilnosti te je imao više od tri aperture, a time je izgubio svoju polarnost. Unatoč jedanaest različitih tipova peludi u prethodnom istraživanju, naši rezultati ukazuju na manji broj peludnih tipova za rod *Hypericum*. Morfologija sjemenki pokazala je karakterističnu skulpturiranost eksoteste, vjerojatno kao posljedicu razlike u debljini stijenke stanica vanjskog sloja. Pretpostavljamo da bi ova obilježja sjemenki roda *Hypericum* mogla pomoći razlikovanju pojedinih taksonomskih skupina, ali i pokazati opći evolucijski trend razvoja morfologije sjemenki roda od valjkastih do okriljenih i/ili usko krilatih. Naši rezultati istraživanja skenirajućim mikroskopom također su pokazali i neke nove skulpture eksoteste. Ukratko će biti komentirane različite taksonomske implikacije istraživanih mikromorfoloških značajki, posebno one koje bi se mogle koristiti za razlikovanje nekih svojti roda *Hypericum*.

POLLEN AND SEED MORPHOLOGY OF THE GENUS *HYPERICUM* L. (HYPERICACEAE) - TAXONOMICAL IMPLICATIONS

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The large genus *Hypericum* L. (Hypericaceae) comprises about 470 species, grows all over the world, and is divided into 30 main sections and 6 additional subsections. Although its molecular phylogeny is well researched, taxonomic studies of other characters of the genus *Hypericum* are still on-going. The aim of our study was to investigate the possible taxonomical and evolutionary significance of micromorphology for the genus. Therefore, pollen and seeds of 32 taxa (from 14 sections) were studied by scanning electron microscopy. The results showed new features of pollen and seeds for 14 *Hypericum* species, some new irregularities of their pollen morphology, and some of our results are similar to previous studies. Pollen grains are regularly three-stephanocolporate with a microreticulate to reticulate ornamentation pattern. Some taxa showed irregularities. They can produce more than three apertures and hence loose its polarity. In spite of eleven distinct pollen types in a previous research, our results pointed to a smaller number of pollen types for the genus *Hypericum*. Seeds morphology showed the characteristic features of the exotesta sculpture, probably caused by the differences in the wall thickness of the cells of the outer layer. These are probably the most distinctive feature of *Hypericum* seeds that help to distinguish entire sections and show a general evolutionary trend of seed morphology from cylindrical to carinate and/or narrowly winged. Our SEM observations also showed some new exotesta sculptures. Different taxonomical implications of the researched micromorphological features, especially those which could be used for delimitation of some taxa of the genus *Hypericum,* will be briefly discussed.

ESSENTIAL OIL COMPOSITION OF *CENTAUREA ATROPURPUREA* WALDST. & KIT. FROM LIKA (CROATIA)

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Centaurea atropurpurea Waldst. & Kit. (Asteraceae) is an endemic Carpatho-Balkanic species. The composition of essential oil from fresh flowering heads of *C. atropurpurea* from Lika (Croatia) was analysed. The essential oil was obtained by simultaneous distillation and extraction using Likens–Nickerson type apparatus. The oil was analysed by GC with flame ionization detector (GC-FID) and gas chromatography–mass spectrometry (GC-MS). In total, 49 compounds were identified, representing 89.3% of the total of oil. The essential oil was dominated by oxygenated sesquiterpenes and sesquiterpene hydrocarbons (43.8% and 24.8%, respectively). The principal constituents were identified as caryophyllene oxide (31.4 %), ß-caryophyllene (17.8 %) and germacrene D (3.9%). Other compounds (aliphatic and aromatic hydrocarbons) represented 17.6% of the total oil. According to the literature data, germacrene D is the dominant constituent of the essential oil of various *Centaurea* species, but caryophyllene oxide is also the dominant component in some *Centaurea* species from the Balkans, which might be of taxonomic significance.

RAZNOLIKOST MIKROFITOPLANKTONA ZIMI U JUŽNOM JADRANU

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Južni Jadran ima važnu ulogu u izmjeni vodenih masa iz Jadrana i Mediteranskog mora. Dok uz zapadnu obalu Jadranskog mora istječe jadranska voda u Mediteransko more, kao kompenzaciju uz istočnu obalu ulazi voda iz Mediteranskog mora. Upliv tople Levantinske intermedijarne vode visokog saliniteta i Jonske površinske vode u Jadran povećan je zimi, ali varira od godine do godine zbog klimatskih oscilacija koje se odvijaju od Atlantika do Jugoistočnog Mediterana. Duboka konvekcija događa se u zimskom periodu kada je voda koja ulazi u Jadran iz Jonskog mora izložena povremenim epizodama bure, hladnog i suhog sjevernog vjetra. Hlađenje površinske vode rezultira njenim tonjenjem u dublje slojeve i miješanjem različitih vodenih masa, te uzrokuje prijenos hranjivih soli iz dubokih rezervoara na površinu čime te hranjive soli postaju dostupne za primarne proizvođače. Duboka konvekcija također prenosi površinske organske čestice, uključujući i stanice fitoplanktona u duboko more puno brže nego uobičajenim procesima tonjenja.

U sklopu HRZZ projekta BIOTA, u Južnom Jadranu provedena su oceanografska istraživanja u zimskom razdoblju (veljača/ožujak 2015.; ožujak 2016. godine) kako bi se istražili specifični obrasci termohaline cirkulacije i raspodjele planktona na tom području. Istraživanje se odvijalo na 15 postaja duž dva transekta: (i) od Dubrovnika do izobate od 1000 m (P100 – P1000), te (ii) od izobate od 1000 m do otoka Lastova (M100 – M1000). Sakupljeni uzorci (183) analizirani su inverznim svjetlosnim mikroskopom te je određen sastav i brojnost mikrofitoplanktonskih vrsta. Maksimalna brojnost mikrofitoplanktona (1.97×10^4 stanica/L) zabilježena je u površinskim uzorcima na postajama P100 i P120, dok je minimum zabilježen na postaji P600 na dubini 500 m (100 stanica/L).

Taksonomskom analizom određena je 131 svojta mikrofitoplanktona, od kojih su dominirale dijatomeje s 95 morfotipova. Dominantne vrste dijatomeja bile su vrste *Chaetoceros affinis, Chaetoceros cf. constrictus, Chaetoceros decipiens, Asterionelopsis glacialis*, grupa *Pseudo-nitzschia pseudodelicatissima* i *Bacteriastrum furcatum.* Preliminarnim analizama je zabilježen veliki broj neidentificiranih penatnih dijatomeja. Zabilježeno je 25 vrsta dinoflagelata, a najbrojnija vrsta je bila *Ceratium fusus*. Također, zabilježeno je 6 taksona kokolitoforida, s dominacijom vrste *Calciosolenia brasiliensis,* 3 taksona silikoflagelata, 1 takson euglenofita te *Myrionecta rubra*, miksotrofni cilijat.

MICROPHYTOPLANKTON WINTER DIVERSITY IN THE SOUTH ADRIATIC SEA

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South Adriatic Sea is influenced by the regular exchange of water with the Eastern Mediterranean. Levantine Intermediate Water (LIW) and Ionian Surface Water (ISW) flow into the Adriatic along the east coast. Inflow of LIW and ISW is greater during winter, but often, depending on climate oscillations from the Atlantic and east Mediterranean, varies on annual basis. The deep convection events occur during winter when the ISW is exposed to occasional episodes of „bura“, cold and dry northerly wind. The cooling of surface layer results in its mixing with deep water masses causing a nutrient transport from the deep reservoirs to the surface, and ultimately, making them available to primary producers. Conversely, these events additionally transport surface organic particles, including phytoplankton cells to the deep sea by a faster rate than by regular sinking mechanisms.

An oceanographic research (BIOTA cruise) was conducted in the southern Adriatic in winter period (February / March 2015; March 2016) in order to explore specific patterns of thermohaline circulation and plankton distribution in the investigated area. The research was conducted at 15 stations along two transects: (i) from Dubrovnik to the isobath of 1000 m (P100 - P1000), and (ii) from the isobath of 1000 m to the island of Lastovo (M100 - M1000). The collected samples (183) were analysed using inverse light microscopy, and the composition and abundance of microphytoplankton was determinated. The maximum observed abundance of microphytoplankton (1.97×10^4 cells / L) was recorded in the surface samples from stations P100 and P120, while the minimum was recorded at station P600 at 500 m depth (100 cells / L).

Total number of 131 species of microphytoplankton was identified using taxonomic analysis, and the diatoms dominated the microphytoplankton community with 95 morphotypes. The dominant species of diatoms were *Chaetoceros affinis, Chaetoceros* cf. *constrictus, Chaetoceros decipiens, Asterionelopsis glacialis, Pseudo-nitzschia pseudodelicatissima* group and *Bacteriastrum furcatum.* Preliminary analyses recorded a great number of unidentified pennate diatoms and 25 species of dinoflagellates with *Ceratium fusus* as most abundant. Additionally, 6 species of coccolitophorids were recorded with *Calciosolenia brasiliensis* as the most common species, 1 euglenophyta and 1 mixotrophic ciliate, *Myrionecta rubra*.

RAZNOLIKOST KOKOLITOFORIDA U OTVORENIM VODAMA SREDNJEG JADRANA

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U svrhu promicanja posljednjih taksonomskih istraživanja Coccolitophoridae, glavni cilj ovog rada je ilustriranje najnovijih otkrića morfološke raznolikosti ove grupe služeći se SEM tehnikom. Coccolithophoridae (HAPTOPHYTA) je zajednica autrotrofnih planktonskih organizama koji imaju važnu ulogu u kruženju ugljika, ali su često podcijenjeni zbog njihove male veličine. Rad prikazuje preliminarne rezultate dobivene tijekom zimskog krstarenja 2015. godine na četiri postaje uzduž profila u srednjem Jadranu.

Najveća gustoća kokolitoforida zabilježena je u površinskom sloju i smanjivala se prema dubljim slojevima. Najbrojnija vrsta bila je *Emiliania huxleyi*. Dominirale su vrste taksonomskog reda Syracosphaerales koje pokazuju dimorfizam u diploidnoj i haploidnoj fazi što je uzrokovalo probleme u identifikaciji. Između ostalih zabilježene su: *Calciosolenia murrayi, C. brasiliensis, Syracosphaera anthos, Syracosphaera pulchra, S. epigrosa, S. hastata, S. nana, S. rotula, S. ossa.*

VARIABILITY OF COCCOLITHOPHORIDS IN OPEN WATERS OF THE CENTRAL ADRIATIC SEA

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In order to promote recent studies in taxonomy of Coccolitophorids, the main objective of the paper is illustrating recent findings of morphological diversity of this group using SEM technique. Coccolithophorids (HAPTOPHYTA) are autotrophic plankton component important for global carbon cycle but often underestimated due to its small sizes. Preliminary results were gained from winter cruise in 2015 taken along Central Adriatic transect at four stations.
The highest density of Coccolithophorids was observed in surface layers decreasing towards deeper layers. The most abundant species at investigating sites was *Emiliania huxleyi.* The dominating order was Syracosphaerales that shows dimorphism in diploid and haploid phase causing problems in previous taxonomic identification. Among others we found *Calciosolenia murrayi, C. brasiliensis, Syracosphaera anthos, Syracosphaera pulchra, S. epigrosa, S. hastata, S. nana, S. rotula, S. ossa.*

DIATOMS FROM ANCIENT LAKE OHRID AS PALAEOECOLOGICAL INDICATORS OF CLIMATE CHANGE DURING MARINE ISOTOPE STAGES 11-10. PRELIMINARY RESULTS

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Long sediment records spanning multiple glacial-interglacial cycles offer potential to increase understanding of the Earth's climate system and future climate scenarios. Lake Ohrid, (Macedonia/Albania) is the oldest existing lake in Europe and age estimates vary 1.2–5.0 million years (Ma). An international deep drilling campaign was performed at Lake Ohrid within the scope of the Scientific Collaboration on Past Speciation Conditions of Lake Ohrid (SCOPSCO) project, which retrieved a 569 m (> 1.2 Ma) continuous sediment record. This study focuses on the diatom response to climate and environmental change during Marine Isotope Stages (MIS) 11–10 (ca. 425,000–335,000 years), MIS11 being a possible analogue for our current interglacial. Marked shifts in diatom composition occur, whereby *Cyclotella* sp. nov., a species with high morphological variability in shape, size and ornamentation, and *C. fottii* (a dominant in MIS2-1) are dominant in MIS11, while *C. ocellata* and *C. minuscula* have higher abundance during the glacial stage MIS10. Three diatom assemblage zones (ODAZ) can be identified in MIS11 based on CONISS analysis. The first period ODAZ1 (425-411 ka) is characterized by the higher abundance of facultative planktonic and benthic species as well as with high abundance of eutrophic taxa (*Stephanodiscus* spp.) compared to the two following zones. ODAZ2 (411 - 377 ka) is characterized by shifts in the relative abundance of *Cyclotella* sp. nov., *C. minuscula* and *C. ocellata*, with an increasing trend in the latter at the expense of *C.* sp. nov, and punctuated by two distinct peaks of the small (3-7 µm) planktonic *S. minutulus*. Zone ODAZ3 (377 - 365 ka) is characterized by very low abundance of *C. ocellata*, with *Cyclotella* sp. nov. reaching a maximum abundance of > 60 % at ca. 370 ka. MIS 10 is divided in two diatom assemblage zones (ODAZ4 and ODAZ5). The transition to ODAZ4 (365 - 342 ka) is marked by an increase in *C. minuscula*, followed subsequently by co-dominance with *C. ocellata,* at the expense of *Cyclotella* sp. nov. This is the opposite of the predicted response based on the results of previous studies on MIS2-1 transition. The presence of *Asterionella formosa* throughout indicates enhanced nutrient availability, with a marked increase ODAZ5 (342 - 335 ka) where *S. minutulus* also peaks. Overall, the record exhibits marked shifts in nutrient availability which may indicate nutrient limitation at the peak of MIS11 due to strong stratification. High nutrient availability at the start of MIS11 and during the latter part of MIS10 suggests nutrient input from the catchment, but require additional multi-proxy analysis to improve interpretation.

Tema simpozija

Fiziologija, anatomija i morfologija

Symposium topic

Physiology, anatomy and morphology

EFFECTS OF HEAVY METAL CONTAMINATED WATER ON PHENOLICS CONTENT IN *MENTHA AQUATICA*

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General contamination of heavy metals in the environment is a major global concern which has provoked the emergence of phytoremediation technologies for cleaning aquatic ecosystems. Heavy metals are released into the environment from a wide range of natural and anthropogenic sources.

The current study focused on the impact of four heavy metals (Lead, Cadmium, Zinc and Cooper) on phenolics content of *Mentha aquatica* before and after exposure to heavy metal contaminated water of Bosna River. The Pb, Zn, Cu and Cd contents of water samples from three sampling sites in Bosna River were determined by graphite furnace atomic absorption spectrophotometry. Total phenolics content in leaves and root was measured using the Folin-Ciocalteu's method with gallic acid as a standard.

In the present study concentration of cadmium was higher comparing to all other investigated elements. The exposure of *M. aquatic* to heavy metal contaminated water resulted in a significant decreased of total phenolics content in leaves. Phenolic content of *M. aquatica* roots after the wastewater exposure was found to be increased, again a manifestation of adaptation against heavy metal and oxidative stress.

M. aquatica is a promising candidate for phytoremediation of wastewater polluted with different metals and can be used for natural wetland cultivation.

ODREĐENA MORFOMETRIJSKA I KEMIJSKA SVOJSTVA MIRISAVE LJUBIČICE (*VIOLA ODORATA* L.) OVISNO O MEDIJU UZGOJA

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Mirisava ljubičica, *Viola odorata* L. pripada rodu *Viola*, koji obuhvaća još 500-tinjak vrsta od kojih su većina niske zeljaste jednogodišnje ili višegodišnje biljke rasprostranjene širom umjerenih zona sjeverne i južne polutke (Dole i Wilkins, 1999). Osim mirisave ljubičice, rod *Viola* zastupljen je u našoj flori s još 21 vrstom (Domac, 2002). Listovi porodice *Violaceae* su jednostavni, naizmjenični i imaju razvijene palistiće. Cvjetovi su im zigomorfni, ponekad aktinomorfni, dvospolni, a mogu biti kleistogamni, građeni od 5 lapova i 5 nejednakih latica, od kojih je najdonja produžena prema natrag u šuplju ostrugu (Dubravec, 1996; Sweetviolets Society). Mirisava ljubičica cvate u uvjetima kontinentalne klime rano u proljeće (ožujak – travanj) nježnim cvjetovima privlačnog mirisa. Zbog privlačnih mirisnih cvjetova domaće stanovništvo i izletnici često je beru kao simbol proljeća na prirodnim staništima. To uzrokuje znatno smanjenje brojnosti prirodnih populacija, naročito u blizini velikih urbanih centara. Cilj ovog istraživanja je odrediti utjecaj najpovoljnijeg medija rasta na neka morfometrijska svojstva mirisave ljubičice (broj listova i cvjetova, dužina i širina lisne plojke) i na količinu vitamina C u listu. Broj listova je svojstvo koje je mjereno kontinuirano jednom mjesečno od listopada 2010. do srpnja 2011 dok je broj cvjetova mjeren u periodu cvatnje (u listopadu, studenom i prosincu 2010. i siječnju, veljači, ožujku, travnju i svibnju 2011.). Dužina i širina lisne plojke mjereni su u četiri navrata (listopad i studeni 2010. i travanj i svibanj 2011.) Mjerenja su obavljena elektronskom pomičnom mjerkom. Uzorkovanje listova za sadržaj vitamina C obavljeno je u dva navrata dok su cvjetovi prikupljani jednokratno, u vrijeme najintenzivnije cvatnje. Prema rezultatima istraživanja vidljivo je da su biljke najvećeg broja i veličine listova kao i cvjetova izmjerene na mediju s više organske tvari i s nižom pH reakcijom. Najveći sadržaj vitamina C u listu utvrđen je na biljkama uzgajanim na mediju s više organske tvari i kreće se od 69,40 do 108,80 mg/100 g svježeg uzorka.

CERTAIN MORPHOMETRIC AND CHEMICAL PROPERTIES OF SWEET VIOLET *(VIOLA ODORATA* L.*)* DEPENDING OF THE GROWING MEDIA

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Sweet violet (*Viola odorata* L.) belongs to the genus *Viola*, which includes about 500 species of which are mostly low herbaceous annual or perennial plants widespread throughout the temperate zones of the northern to the southern hemisphere (Dole and Wilkins, 1999). It is wide–spread all across Croatia, along with the mentioned species. Domac (2002) lists further 19 species of the same genus. The simple leaves of plants with either habit are arranged alternately; the acaulescent species produce basal rosettes. Plants always have leaves with stipules that are often leaf-like. The flowers are formed from five petals; four are upswept or fan-shaped petals with two per side, and there is one broad, lobed lower petal pointing downward. Sweet violet blooms in continental climate conditions in early spring (March-April) with delicate flowers of attractive scent because of which it is frequently gathered from it is natural habitats. This causes a significant reduction in the number of natural populations, especially near large urban centers. The aim of this study was to investigate the influence of the optimum growing media on some morphometric properties of sweet violet: number of leaves and flowers, length and width of leaf blade and the amount of vitamin C in the leaf. The number of leaves is a property that is measured continuously once a month from October 2010 to July 2011, while the number of flowers measured during flowering period of sweet violet (October, November and December 2010 and January, February, March, April and May 2011). Length and width of leaf blade were measured on four periods (October and November 2010 and April, May 2011). The measurements were carried out by electronic caliper. Sampling leaves for the content of vitamin C was carried out on two periods while the flowers are collected only once, during the most intense flowering period. The results show that the higher organic matter and lower pH resulted in a greater number of leaves and flowers. Vitamin C in leaves of sweet violet ranged from 69.40 to 108.80 mg/100 g fresh weight.

EFFECTS OF SALINITY AND TEMPERATURE ON GERMINATION OF THE INVASIVE *AMORPHA FRUTICOSA* L. (FABACEAE)

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Amorpha fruticosa L. is an invasive shrub originating from North America, adapted to different soil and climatic conditions. The species reproduces sexually producing large amounts of small seeds, allowing the colonisation of new areas. Although the tolerance to salinity is reported to be low in its native range, *Amorpha fruticosa* has also been found in the immediate vicinity of the sea in its invaded range; in the Northern Adriatic it was for example found growing from the rocks on piers or on sandy beaches, constantly exposed to salty water. The aim of this study was to test the impact of different NaCl concentrations and temperatures on seed germination. Seeds were collected from six localities both from the proximity of the sea and from the continental area. Seed germination was tested in 0 mM, 200 mM, 400 mM and 600 mM NaCl at 15 °C and 25 °C. While 52 and 43 % of seeds germinated in distilled water at 25 °C and 15 °C, respectively, germination was (almost) completely inhibited in 600 mM NaCl at both temperatures. On average, germination was significantly lower at 15 °C in 200 mM and 400 mM NaCl. After 34 days, all non-germinated seeds were transferred to distilled water in order to study the recovery of germination after salt inhibition. The recovery was much higher at 15 °C than at 25 °C (35 vs. 7 %, respectively), suggesting the toxic effect of NaCl at lower temperatures.

FITOKEMIJSKA KARAKTERIZACIJA I ANTIOKSIDATIVNI POTENCIJAL OSAM VRSTA RODA *GALIUM* L.

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Vrste roda *Galium* L. od davnina se primjenjuju u narodnoj medicini kao diuretici, koleretici, adstrigensi, sedativi, u liječenju gihta, bubrežnih i žučnih kamenaca, proljeva, kao i kod problema s kožom te u saniranju rana, kod lomova kostiju i epilepsije, a vrsta *Galium verum* L. jedna je od najčešće primjenjivanih vrsta ovog roda. Nadzemni dijelovi osam vrsta roda *Galium* (*Galium corrudifolium* Vill., *G. cruciata* (L.) Scop., *G. divaricatum* Pourret ex Lam., *G. lucidum* All., *G. mollugo* L., *G. palustre* L., *G. parisiense* L. i *G. verum* L.) sabrani su 2012. godine u okolici Šibenika tijekom razdoblja cvatnje. Fitokemijska karakterizacija vrsta provedena je na suhom usitnjenom biljnom materijalu kao i u 80%-tnim metanolnim ekstraktima pripremljenim ultrazvučnom ekstrakcijom. Sadržaj ukupnih fenola i flavonoida određen je spektrofotometrijski koristeći Folin-Ciocalteu-ov reagens i aluminijev klorid, dok je sadržaj iridoida procijenjen koristeći Trim-Hill-ov reagens. Procjena antioksidativnog potencijala temeljena je na dvije *in vitro* metode, koje koriste 2,2-difenil-1-pikril-hidrazil radikal (DPPH) i 2,2'-azino-bis(3-etilbenzotiazolin-6-sulfonska kiselina (ABTS) radikal.

Sve uspoređene vrste pokazale su pozitivne reakcije na flavonoide i iridoide, dok je većina vrsta sadržavala saponine, steroide, triterpene i tanine. Sadržaj ukupnih fenola, koji se kretao između 61.5 i 111.0 mg ekvivalenta galne kiseline/g suhog ekstrakta, bio je najviši u uzorku vrste *G. cruciata*, dok je uzorak vrste *G. verum* sadržavao najveću količinu flavonoida (23.1 mg ekvivalenta kvercetina/g suhog ekstrakta) i iridoida (461.3 mg ekvivalenta aukubina/g suhog ekstrakta). Oba ispitivanja antioksidativnog učinka ukazala su da vrste *G. cruciata* (IC_{50} = 27.6-30.3 µg/mL) i *G. divaricatum* (IC_{50} = 30.3-34.7 µg/mL) zajedno s vrstom *G. verum* (IC_{50} = 30.7-36.7 µg/mL) imaju najveći antioksidativni potencijal.

Rezultati ovog istraživanja podržavaju poznata ljekovita svojstva vrste *G. verum,* ali također ukazuju na to da srodne vrste poput *G. cruciata*, *G. divaricatum* i *G. palustre,* posjeduju potencijal za buduća istraživanja.

PHYTOCHEMICAL SCREENING AND ANTIOXIDANT POTENTIAL OF EIGHT MEMBERS FROM THE GENUS *GALIUM* L.

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Species from the genus *Galium* L. have long been used in folk medicine as diuretics, choleretics, adstringents, sedatives, in the treatment of gout, kidney stones and gallstones, diarrhea, skin disorders and wounds, bone fractures and epilepsy, with *Galium verum* L. being one of the most commonly used. Aerial parts of eight *Galium* taxa (*Galium corrudifolium* Vill., *G. cruciata* (L.) Scop., *G. divaricatum* Pourret ex Lam., *G. lucidum* All., *G. mollugo* L., *G. palustre* L., *G. parisiense* L. and *G. verum* L.) were harvested from the Šibenik area in Croatia during their flowering season in 2012. Phytochemical screening of the taxa was done on dry powdered plant material as well as on 80%-methanolic extracts prepared by ultrasound-assisted extraction. Contents of total phenolics and flavonoids were determined spectrophotometrically by using the Folin-Ciocalteu's reagent and aluminium chloride, respectively, while iridoid content was evaluated by using the Trim-Hill reagent. Evaluation of antioxidant potential was based on two *in vitro* assays, the 2,2-diphenyl-1-picrylhydrazyl (DPPH) and the 2,2'-azino-bis-3-ethylbenzothiazoline-6-sulphonic acid (ABTS) assay.

All investigated species gave positive reactions for flavonoids and iridoids, while most of them contained saponins, steroids, triterpenes and tannins. Total phenolic content, which ranged from 61.5 to 111.0 mg gallic acid equivalents/g dry extract, was highest for *G. cruciata*, while *G. verum* contained the highest amount of flavonoids (23.1 mg quercetin equivalents/g dry extract) and iridoids (461.3 mg aucubin equivalents/g dry extract). Both antioxidant activity assays indicated that *G. cruciata* (IC_{50} = 27.6-30.3 µg/mL) and *G. divaricatum* (IC_{50} = 30.3-34.7 µg/mL) together with *G. verum* (IC_{50} = 30.7-36.7 µg/mL) have the greatest antioxidant potential.

The results of this study support the known healing properties of *G. verum*, but also suggest several related species, namely *G. cruciata*, *G. divaricatum* and *G. palustre*, as candidates for further research.

AIR POLLUTION TOLERANCE INDEX (APTI) OF *PLANTAGO MAJOR* L. IN THE IRONWORK AREA ZENICA (BOSNIA AND HERZEGOVINA)

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The study examined the air pollution tolerance index (APTI) of *Plantago majo*r L. found in the area of ironwork Zenica. Leaf samples of *Plantago major* were collected from air-polluted site (Tetovo) and control site (Mt. Smetovi). Four physiological and biochemical parameters including ascorbic acid content, total leaf chlorophyll, leaf extract pH and leaf relative water content (RWC) were used to calculate APTI. Results showed that, in comparison between the two sites, the values of APTI were higher in the polluted site (9.11 mg/g fr. wt) than the control site (8.32 mg/g fr. wt), which indicates that *P. major* is very tolerant species on air-pollution considering high APTI values.

INFLUENCE OF SALICYLIC ACID PRE-TREATMENT ON GERMINATION, VIGOUR AND GROWTH PARAMETERS OF *SILENE SENDTNERI* BOISS.

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Seed germination and seedling emergence is considered to be one of the critical stages in plant growth cycle. Low germination and low seedling vigour can reduce number of plants in natural habitats, especially when it comes to endemic and rare plants. Seed priming technique has been known to improve seed germination and seedling vigour under different environmental conditions. Aim of this study was to evaluate effectiveness of seed priming in improving of seed germination, seedling vigour and growth characteristics of endemic plant *Silene sendtneri*. Experiment was conducted in randomized manner with five replications consisted of four different concentrations of salicylic acid as a pre-treatment. The results showed that seedling length and seedling vigour was increased when seed were pre-treated with 10 mg L^{-1} salicylic acid. Seed germination remained more or less the same.

PRELIMINARY PHYTOCHEMICAL SCREENING OF SECONDARY METABOLITES IN LEAVES AND BARK IN 25 DENDRO SPECIES

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Plants produce a huge and diverse range of secondary metabolites, organic compounds which are considered as nonessential for plant development, but may have very important role in the adaptation of plants to particular environmental conditions. Additionally, secondary metabolites are also very important for humans, who use them in medicine, pharmacology, food and cosmetics industries. In this study, the presence of eight types of secondary metabolites (anthocyanins, coumarins, emodins, fatty acids, phenols, saponins, steroids and tannins) in 25 dendro species, collected near Sarajevo (Bosnia and Herzegovina) in July 2013, was evaluated by rapid phytochemical screening methods. To our knowledge, the presence of six types of secondary metabolites is recorded for the first time: anthocyanins in one dendro species; both coumarins and phenols in five dendro species; emodins in six dendro species; saponins in eight dendro species; and tannins in four dendro species. This preliminary study draws attention to the need for further studies of the active compounds identified in the analyzed species and for the assessment of their potential antimicrobial and antioxidant activities.

TOTAL PHENOLICS, ANTIOXIDATIVE POTENTIAL AND ANTIMICROBIAL ACTIVITY OF METHANOL EXTRACTS OF *SILENE SENDTNERI* BOISS.

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The purpose of this study was to evaluate total phenolic and flavonoid contents, and antioxidant and antimicrobial activities of methanolic extracts, from inflorescence, stem, rhizome and seeds of endemic species Sendtner's campion (*Silene sendtneri* Boiss., Caryophyllaceae). The content of both total phenols and flavonoids were determined by UV/VIS spectrophotometry, and results were expressed in mg of gallic acid or catechine equivalents per gram (mg GAE g^{-1}; mg CE g^{-1} respectively) of dry plant material. The antioxidant activity of plant extracts was determined by 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity. Antimicrobial activity of extracts was evaluated by measuring the inhibition's zone against selected test microorganisms: *Staphylococcus epidermididis*, *Staphylococcus aureus* subsp. *aureus*, *Salmonella abony, Escherichia coli* and *Candida albicans*. The highest content of total phenol compounds in the investigated extracts was in inflorescences (11.587 mg GAE g^{-1} DW) and the lowest in rhizome (2.017 mg GAE g^{-1} DW). The inflorescence extracts were the richest with total flavonoids (69.824 mg CE g^{-1} DW), while flavonoids were not detected in the rhizome extracts. Duncan's test showed the presence of significant differences between inflorescence and rhizome extracts from others according to total phenols ($p<0.01$). The highest antioxidant activity was exhibited by stem's extracts (IC_{50}: 20.51 mg mL^{-1}), and the lowest was recorded from rhizome's (IC_{50}: 61.89 mg mL^{-1}). All methanol extracts showed moderate to weak antibacterial activity against the test organisms, with the most pronounced activity against *Staphylococcus epidermididis*, and the lowest against *S. aureus* subsp. *aureus*. Antifungal activity against *Candida albicans* was moderate. Since the methanol extracts of stem, inflorescence and seeds of *S. sendtneri* are potential natural antioxidant and antimicrobial preparations against analyzed bacteria and the fungus, it is necessary to analyze and compare *S. sendtneri* extracts in different solvents in order to isolate and identify their chemical constituents and potential bioactive compounds.

CUMULATIVE EFFECT OF SALICYLIC ACID ON SEED GERMINATION OF *SILENE SENDTNERI* BOISS.

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Silene sendtneri Boiss. is an endemic plant of Balkan Peninsula. During storage seed deterioration and decrease in germination rate usually follows and it is essential to find different methods for germination stimulation during longer periods of storage. Aim of this study was to evaluate the effect of salicylic acid as a stimulant for reduced germination rate of stored seeds. Seed germination was tested after 24 months of storage by cultivation in Petri dishes containing different concentrations of salicylic acid as well as control. Cumulative effect of salicylic acid was estimated using different parameters: germination percent, germination speed, and germination synchrony, radicle, plumule and seedling length, radicle, plumule and seedling fresh weight as well as seedling vigour index. Germination percent was not affected by cumulative effect of salicylic acid, but synchrony and seed vigour were increased. Salicylic acid had inhibitory effect on radicle and plumule length. Our results indicated that salicylic acid can be good choice for improvement of germination synchrony and seedling vigour for *Silene sendtneri*. Such results indicate that this treatment could be used also for other species with high percent of seed deterioration and germination rate reduction during short term storage in conservation laboratories.

KVANTIFIKACIJA VARIJABILNOSTI OBLIKA PLODOVA NIZINSKOG BRIJESTA (*ULMUS MINOR* MILL. SENSU LATISSIMO) NA PODRUČJU HRVATSKOG SREDOZEMLJA TEMELJEM ELIPTIČKIH FOURIEROVIH DESKRIPTORA

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Nizinski brijest (*Ulmus minor* s.l.), plemenita listača nizinskih šuma Europe, odlikuje se sposobnošću generativnog i vegetativnog načina razmnožavanja. Iako je u prošlosti smatran primarno seksualnom vrstom, *U. minor* s.l. trenutno preferira vegetativni način razmnožavanja, te se u nekoj mjeri može smatrati i klonalnom vrstom. Razlozi za promjenu načina razmnožavanja mogu se pronaći u masivnom odumiranju adultnih stabala na terenu uslijed pojave holandske bolesti brijesta, kao i uništavanju staništa uslijed hidroregulacijskih zahvata. Nizak urod sjemena, visok udio šturih plodova, sterilnost ženskih cvjetnih dijelova i partenokarpija česte su pojave u populacijama nizinskog brijesta. U malim i fragmentiranim populacijama dominira aseksualni način širenja putem tjeranja iz žilja. Cilj ovog istraživanja bio je utvrditi varijabilnost kontura oblika plodova u prirodnim populacijama *U. minor* s.l. na području hrvatskog Sredozemlja putem eliptičkih Fourierovih deskriptora. Istraživanjem su obuhvaćeni isključivo simetrični elementi varijabilnosti, utvrđeni na 750 kontura plodova. Matrica Fourierovih koeficijenata uspostavljena je temeljem 20 harmonika, dok je svaka kontura bila opisana preko 77 eliptičkih Fourierovih koeficijenata. Eliptički Fourierovi deskriptori mogu poslužiti kao vrlo praktični alat velike osjetljivosti pri opisivanju morfološkog obrasca varijabilnosti oblika plodova brijesta. Korištenjem analize glavnih komponenti, a na temelju varijanca-kovarijanca matrice, generirane su četiri oblične varijable. Udio objašnjene varijance za prvu glavnu komponentu iznosio je 65,2% , odnosno 14,6% za drugu glavnu komponentu. Kumulativni doprinos svih četiriju glavnih komponenti u ukupnoj varijanci iznosio je više od 93,3%. Prema rezultatima analize varijance, provedene na skorovima glavnih komponenti, sva stabla unutar populacija su se međusobno značajno razlikovala, i to za sve promatrane glavne komponente. Utvrđena je i signifikantna razlika u drugoj glavnoj komponenti između jednog para populacija.

QUANTIFICATION OF *ULMUS MINOR* MILL. SENSU LATISSIMO FRUIT SHAPE VARIABILITY IN CROATIAN MEDITERRANEAN VIA ELLIPTIC FOURIER DESCRIPTORS

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The European field elm (*Ulmus minor* Mill. s.l.), noble hardwood tree species of the European lowland forests, is known to reproduce by seed and vegetatively. Although primarily considered sexual species in the past, nowadays *U. minor* s.l. favours vegetative reproduction and therefore it can be considered a clonal species at some extent. The reasons for this modification can be sought in massive dieback of adult trees in the field due to Dutch elm disease and habitat destruction due to negative water regulation activities. Empty samara production, low seed set, female sterility and parthenocarpy are of common occurrence in *U. minor* s.l. populations. Furthermore, in small and fragmented populations, lacking adult trees, plants are reproducing solely asexually through sprouting from roots. In this research we assessed fruit outline shape variability in natural populations of *U. minor* s.l. from Mediterranean part of Croatia by means of elliptic Fourier descriptors. Exclusively symmetrical shape variability elements of total 750 fruit outlines were encompassed by subsequent shape analyses. Matrix of Fourier coefficients was based on 20 harmonics and 77 elliptic Forier coefficients were defined for each outline. Elliptic Fourier descriptors proved to be very practical technique of great accuracy in describing the morphological pattern of shape variability in elm fruits. By use of Principal Component Analysis, four shape variables were generated from the variance-covariance matrix. Proportional explained variance for the first and the second principal component was 65,2% and 14,6% respectively. The cumulative contribution of all four principal components to the total variance proved to be higher than 93,3%. According to the analysis of variance, conducted on PC scores, all trees within populations differed significantly for every principal component observed. Significant difference for the second principal component in one population pair was also confirmed.

Tema simpozija

Konzervacijska biologija, zaštita prirode i okoliša

Symposium topic

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NOVA NALAZIŠTA SAMOBORSKE GROMOTULJE (*ALYSSUM MONTANUM* L. SSP. *PLUSCANESCENS* (RAIM. EX BAUMGARTNER) TRPIN, BRASSICACEAE) IZVAN POSEBNOG REZERVATA BREŽULJAK KOD SMEROVIŠĆA I PRIJEDLOG NOVE KATEGORIJE UGROŽENOSTI

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Samoborska gromotulja (*Alyssum montanum* L. ssp. *pluscanescens* (Raim. ex Baumgartner) Trpin) endemična je svojta iz porodice krstašica (Brassicaceae). Prema Crvenoj knjizi vaskularne flore Hrvatske smatra se kritično ugroženom svojtom te je strogo zaštićena Zakonom o zaštiti prirode. Rasprostranjena je samo u Sloveniji i Hrvatskoj. Jedino je nalazište ove svojte u Sloveniji njezino klasično nalazište (*locus classicus*), kamenolom u Žičama u općini Slovenske Konjice (Štajerska), koje je zaštićeno kao prirodni spomenik. U Hrvatskoj je dosad bila poznata jedino iz posebnoga botaničkog rezervata Brežuljak kod Smerovišća, u blizini grada Samobora (Zagrebačka županija), koji također zahvaća dio kamenoloma. Godine 2015. rekognosciranjem šireg područja zabilježena su tri nova nalazišta samoborske gromotulje, izvan posebnog rezervata, ali u njegovoj neposrednoj blizini. Dva se nalaze u istom, a jedno u susjednom kamenolomu. Godine 2016. sva su nalazišta posjećena i procijenjen je broj jedinki na svakom od njih. Dosad poznato nalazište u posebnom rezervatu najmanje je površinom i brojem jedinki, dok je površinom najveće, a brojem jedinki najbogatije novootkriveno nalazište u drugom kamenolomu.

Primjenom kriterija za određivanje kategorija crvenog popisa IUCN-a, predlaže se promjena kategorije ugroženosti samoborske gromotulje iz kritično ugrožene (CR) u ugroženu svojtu – EN B1ab(iii)+2ab(iii). Prema tipizaciji uzroka ugroženosti IUCN-a, najveći uzrok ugroženosti samoborske gromotulje predstavljaju 3.2 Rudnici i kamenolomi te 9.4 Smeće i kruti otpad.

Budući da se najveći dio populacije samoborske gromotulje trenutačno nalazi izvan područja posebnog rezervata, smatramo kako je njegove granice potrebno proširiti, čime bi se zaštitila sva nalazišta ove rijetke svojte, uključujući i okolnu šumsku vegetaciju.

NEW LOCALITIES OF *ALYSSUM MONTANUM* L. SSP. *PLUSCANESCENS* (RAIM. EX BAUMGARTNER) TRPIN (BRASSICACEAE) OUTSIDE OF SPECIAL RESERVE BREŽULJAK KOD SMEROVIŠĆA AND NEW THREAT CATEGORY PROPOSED

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Samobor alyssum (*Alyssum montanum* L. ssp. *pluscanescens* (Raim. ex Baumgartner) Trpin) is an endemic taxon from the family Brassicaceae. According to the Red Book of Vascular Flora of Croatia it is considered Critically Endangered and therefore it is strictly protected by the Nature Protection Act. Its area of distribution encompasses only Slovenia and Croatia. The only one locality in Slovenia is its *locus classicus* in the quarry Žiče in the municipality Slovenske Konjice (Styria), which is protected as natural monument. In Croatia it was only known from the special botanical reserve Brežuljak kod Smerovišća, near Samobor (Zagreb County), where this reserve also partly encompasses quarry. In the year 2015 during the reconnaissance of the wider area, three new localities of Samobor alyssum, outside of special reserve, but in its proximity, were discovered. Two of newly recorded localities are situated in the same quarry, while one is located in the neighbouring quarry. In the year 2016 all localities were visited and the number of individuals of Samobor alyssum on each locality was estimated. Previously known locality in the special reserve is the smallest in terms of area size and number of individuals, while the locality in another quarry is the largest in area size and the richest in number of individuals.

By the application of the criteria for IUCN Red List Categories, we suggest to reassign Samobor alyssum to a lower category of threat i.e. to downlist it from Critically Endangered (CR) to Endangered, EN B1ab(iii)+2ab(iii). According to the Unified Classification of Direct Threats of IUCN, 3.2 Mining & quarrying and 9.4 Garbage & solid waste are the most important direct threats to Samobor alyssum.

Since most of the population of Samobor alyssum is currently outside of the special reserve, we believe that it is necessary to expand its borders, in order to protect all localities of this rare taxon, including also the surrounding forest vegetation.

KLIJAVOST SJEMENA OSAM VRSTA RODA *HYPERICUM* L.

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Klijanje sjemena prvi je kritični događaj tijekom razvoja biljke te ključni čimbenik reproduktivne biologije. Dobra klijavost je neophodna za uspješnu uspostavu biljnih zajednica kao i za učinkovit vrtni uzgoj. Provjera klijavosti sjemena je nužna i danas aktualna, osobito u botaničkim vrtovima kojima je jedna od uloga očuvanje biljne raznolikosti.

U Botaničkom vrtu F. Kušan Farmaceutsko-biokemijskog fakulteta uzgaja se dvadesetak vrsta roda *Hypericum* L. Osim ljekovitoj vrsti *H. perforatum* L. i nekolicini endema, ostalim vrstama ovog roda klijavost sjemena nije proučena. S ciljem boljeg uvida u biologiju klijanja vrsta roda *Hypericum* kao i provjere vijabilnosti sjemena u uvjetima vrtnog uzgoja, određen je stupanj klijavosti sjemena 8 vrsta ovog roda: *H. androsaemum* L., *H. delphicum* Boiss & Heldr, *H. densiflorum* Pursh*, H. hircinum* L*., H. kouytchense* H. Lév, *H. olympicum* L., *H. patulum* Thunb. ex Murray i *H. pseudohenryi* N. Robson. Sjeme je sabrano kroz dvije godine. Testiranja su provedena prema smjernicama ISTA-e (*International Rules for Seed Testing*), a rezultati prikazani kao konačna klijavost i brzina klijanja. Također, provjeren je utjecaj stratifikacije (7 dana/8 °C) i giberelinske kiseline (0,025%) na klijavost.

Vrijednosti konačne klijavosti razlikuju se između vrsta i u rasponu su od 11% (*H. densiflorum*) do 90% (*H. pseudohenryi*). U skladu s tim, brzina klijanja u rasponu je od 6 dana (*H. hircinum*, *H. patulum*) do 23 dana (*H. androsaemum*). U većine vrsta postotak klijanja sjemena sabranog u različitim godinama je podjednak. Ipak, izuzetak je sjeme vrsta *H. androsaemum* i *H. olympicum* kojemu je utvrđena visoka razina dormancije budući je mlađe sjeme klijalo u manjem postotku i s duljim periodom odgode. Stratifikacija nije utjecala na klijavost, dok se dodatkom giberelinske kiseline klijavost sjemena većine vrsta signifikantno pospješila, osim u vrsta *H. hircinum* i *H. patulum*. Najniži postotak klijavosti imalo je sjeme vrsta *H. androsaemum* i *H. densiflorum* (20 - 41%; 11 - 12%), no klijavost se dodatkom giberelinske kiseline statistički značajno uvećala i do tri puta. Sjeme kineske vrste *H. pseudohenryi* klijalo je u najvećem postotku (85 - 90%).

SEED GERMINATION OF EIGHT *HYPERICUM* L. TAXA

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Seed germination is the first critical stage of plant development and the key factor of reproductive biology. Germination is crucial for successful establishment of wild communities as well as in efficient gardening. Investigation of seed germination is still of great importance, especially in botanic gardens devoted to preserve the world's plant diversity.

Botanical garden F. Kušan of Faculty of Pharmacy and Biochemistry has cultivated more than 20 taxa of the genus *Hypericum* L. Apart from medicinal plant *H. perforatum* L. and several endemics, germination of *Hypericum* has not been studied yet. In order to increase knowledge of germination biology of *Hypericum* as well as to test seed viability in garden conditions, germination of 8 *Hypericum* taxa was investigated (*H. androsaemum* L., *H. delphicum* Boiss & Heldr, *H. densiflorum* Pursh*., H. hircinum* L*., H. kouytchense* H. Lév, *H. olympicum* L., *H. patulum* Thunb. ex Murray and *H. pseudohenryi* N. Robson). Seeds were collected over two years. Tests were carried out following the International Rules for Seed Testing protocols, and defined by the final germination percentage and the germination rate. The effect of prechilling (7 days/8 °C) and the influence of gibberellic acid (0,025%) were also tested.

Final germination percentages were highly variable depending on the taxa, ranging from 11% (*H. densiflorum*) to 90% (*H. pseudohenryi*). Similarly, germination rate varied from 6 days (*H. hircinum*, *H. patulum*) to 23 days (*H. androsaemum*). For the most of the taxa, seeds collected in different years germinated at the similar percentage. However, the exceptions were seeds of *H. androsaemum* and *H. olympicum* which seem to be highly dormant since observed lesser germination of younger seeds. Prechilling had no effect on germination, while gibberellic acid significantly enhanced the germination of the most taxa, except in the case of *H. hircinum* and *H. patulum*. Germination of *H. androsaemum* and *H. densiflorum* seeds was very low (20 - 41%; 11 - 12%), and was promoted significantly by gibberellic acid up to three times. Seeds of the Chinese *H. pseudohenryi* displayed the most efficient germination (85 - 90%).

PROMJENE U POPULACIJAMA GLJIVE *CRYPHONECTRIA PARASITICA* U HRVATSKOJ U POSLJEDNJIH DESET GODINA

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Rak kore pitomoga kestena ozbiljna je bolest koju uzrokuje gljiva *Cryphonectria parasitica* i koja je tijekom prve polovice XX. stoljeća iz istočne Azije unesena u Ameriku i Europu. U Hrvatskoj je bolest prvi puta zabilježena tijekom 50-tih godina XX. stoljeća na području Lovrana, da bi se tijekom sljedećih 20-ak godina proširila čitavim arealom pitomoga kestena, uzrokujući oštećenja i smrt stabala kestena. Jedina uspješna metoda (biološke) kontrole ove bolesti je korištenje mikovirusa – *Cryphonectria hypovirus 1* (CHV-1). Širenje mikovirusa kroz populaciju gljive ovisi o tzv. sustavu vegetativne (ne)kompatibilnosti (vc), koji je u slučaju gljive *C. parasitica* kontroliran s najmanje šest bialelnih *vic* lokusa. Posljednje istraživanje raznolikosti vc tipova, kao i prevalencije CHV-1 u populacijama *C. parasitica* na području Hrvatske napravljeno je prije desetak godina. Stoga su tijekom 2014./2015. obavljena terenska istraživanja na tri populacije (Ozalj, Hrvatska Kostajnica i Buje) koje su bile predmetom i prethodnog istraživanja kako bi se utvrdile eventualne promjene u populacijama. Naše istraživanje je pokazalo da je u svim populacijama raznolikost vc tipova značajno porasla: Shanonov indeks raznolikosti 2004./2005. se kretao od 0,63 (Ozalj) do 1,69 (Buje), da bi se tijekom zadnjeg istraživanja povećao na vrijednosti od 1,77 (Ozalj) do 2,45 (Buje). Shanonov indeks raznolikosti povećao se zbog pojave novih vc tipova koji nisu bili zabilježeni prije deset godina i trenutačno su zastupljeni u vrlo malom postotku. Interesantno je i opažanje da je u populacijama u kojima je prije deset godina nađen vrlo veliki postotak hipovirulentih uzoraka (55,8% u Hrvatskoj Kostajnici, 44,1% u Ozlju) on sada znatno manji (30,9% u Hrvatskoj Kostajnici i 27,8% u Ozlju). U Buju u kojem je i prije utvrđena relativno mala prevalencija hipovirulenih uzoraka (12,7%), taj se postotak nije mnogo promijenio (blagi porast na 19%). Ovi brojevi ukazuju na dvije alarmantne činjenice – broj i raznolikost vc tipova je u posljednjih deset godina značajno porastao, dok se istovremeno prevalencija CHV-1 dramatično smanjila zbog otežanog širenja CHV-1 kroz populacije gljive *C. parasitica* i time dovela u pitanje održivost prirodno uspostavljene biološke kontrole.

CHANGES IN POPULATIONS OF *CRYPHONECTRIA PARASITICA* IN CROATIA OVER THE LAST TEN YEARS

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Chestnut blight, a serious disease spread around the World is caused by a fungus *Cryphonectia parasitica*, which was introduced to America and Europe from eastern Asia during the first half of the XX century. In the 50-ties, it was first recorded in Croatia, near Lovran. The fungus then spread through the entire country in the next 20 years, causing damage and death of the chestnut trees. The only successful method of (biological) control is by utilizing a mycovirus – *Cryphonectria hypovirus 1* (CHV-1). Mycovirus spreading through the fungus population is dependent on vegetative (in)compatibility (vc) system, which, in case of *C. parasitica*, is controlled by six biallelic *vic* loci. The last research of vc type diversity and CHV-1 prevalence in populations of *C. parasitica* in Croatia was done ten years ago. Therefore, in 2014/2015 three populations included in previous research were sampled again in order to determine changes in vc type diversity and CHV-1 prevalence. Our research indicated that vc type diversity has increased significantly in the last ten years in all populations, as shown by the increasing values of Shannon's diversity index: from 0,63 (in Ozalj) to 1,69 (in Buje) in 2004/2005 to 1,77 (in Ozalj) to 2,45 (in Buje) in 2014/2015. This increase of diversity was mainly caused by emergence on new vc types, previously not recorded in Croatia. These new vc types are present in small proportion in the investigated populations. Interestingly, populations in which a very high prevalence of hypovirulent isolates was observed in 2004/2005 (55,8% in Hrvatska Kostajnica, 44,1% in Ozalj), in this research showed a significant decrease in CHV-1 prevalence (30,9% of hypovirulent isolates in Hrvatska Kostajnica and 27,8% in Ozalj). In population from Buje, in which hypovirulence was previously not well established (only 12,7% hypovirulent isolates), only a very slight increase in the prevalence of hypovirulent isolates was observed, being 19% in 2014/2015. Our research has uncovered two alarming facts: number and diversity of vc types increased substantially over the last ten years, while the prevalence of CHV-1 dramatically decreased because of the hampered CHV-1 transmission thought *C. parasitica* populations, jeopardizing sustainability of naturally established biological control.

OPTIMIZATION OF DNA ISOLATION FROM FIVE ENDEMIC B&H LAMIACEAE SPECIES

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Plants belonging to Lamiaceae family are generally aromatic and well known for their bioactive constituents. High levels of different secondary metabolites, belonging to various groups of chemicals, such as essential oils or terpenoid and phenolic compounds, have been isolated from many Lamiaceae plants. Present secondary metabolites may interfere with the DNA isolation procedure and downstream applications such as PCR amplification and digestion. In order to perform genetic characterization of Lamiaceae species it is necessary to optimize DNA isolation protocol. In our study, we collected leaves from five endemic Lamiaceae species [*Acinos orontius* (K.Maly) Šilić, *Satureja horvatii* Šilić, *Satureja subspicata* Bartl. ex Vis, *Thymus bracteosus* Vis ex Bentham and *Micromeria pulegium* (Rochel) Benth.]. DNA obtained by CTAB Soltis protocol, which was developed for herbarium specimens and worked well for other plant species, was tested by amplification of trnL (UAA) intron. This protocol resulted with low DNA yield and poor amplification probably due to the presence of secondary metabolites. In order to remove secondary metabolites and obtain high quality genomic DNA we tested modified protocol for medicinal and aromatic plants also based on CTAB method. The modification includes additional chloroform: isoamylalcohol (24:1) purification step and brief isopropanol precipitation. This method solved the problem of low DNA yield and co-precipitation of secondary metabolites and enabled PCR amplification for 94 % of analyzed samples.

UČINAK ONEČIŠĆENJA IZ NAFTNE RAFINERIJE NA SADRŽAJ TEŠKIH METALA I SEKUNDARNE METABOLITE U LIŠAJEVIMA *FLAVOPARMELIA CAPERATA* I *PARMELIA SULCATA*

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Lišajevi se zbog svoje sposobnosti uzimanja tvari i vode direktno iz zraka često koriste kao bioindikatori onečišćenja zraka te za praćenje stanja onečišćenja. Čestice teških metala u zraku uzrokuju različite fiziološke promjene u lišajevima, a osjetljivost na onečišćenje često ovisi o vrsti lišaja. Slavonski Brod ima najzagađeniji zrak u Hrvatskoj zbog blizine rafinerije nafte smještene neposredno preko granice u Bosni i Hercegovini. Podaci mjernih postaja u Slavonskom Brodu pokazuju povećan sadržaj štetnih lebdećih čestica ($PM_{2.5}$) i plinova kao što su sumporni dioksid i sumporovodik. U ovom radu uzorci lišajeva sakupljeni su na 20 ploha u okolici Slavonskog Broda, u radijusu 20 km od rafinerije nafte. Uzorkovane su dvije vrste lišajeva, *Flavoparmelia caperata* i *Parmelia sulcata* koje prirodno dolaze na tom području te su istraženi učinci onečišćenja rafinerije nafte na sekundarne metabolite lišajeva i njihova moguća korelacija sa sadržajem teških metala (kadmij, nikal, olovo i cink) u talusu lišajeva. Na dva mjesta uzorkovanja najbliža rafineriji nafte navedene vrste lišajeva nisu pronađene, što upućuje na jako onečišćenje zraka. Sadržaj olova i cinka bio je povećan u lišajevima sakupljenim na plohama koje se nalaze u gradu ali su ujedno i preko puta rafinerije što ukazuje na kumulativan efekt gradskog i industrijskog onečišćenja. Nisu nađene značajne razlike u sadržaju sekundarnih metabolita atranorina, kloratranorina, usninske i protocetrarične kiseline u lišajevima sakupljenim na različitim plohama uzorkovanja. Međutim, povećan sadržaj salazinske kiseline izmjeren je u lišajevima sakupljenim na plohama bližim rafineriji nafte, što može ukazivati na ulogu salazinske kiseline u zaštiti lišajeva od onečišćenja teškim metalima.

THE EFFECT OF THE OIL REFINERY POLLUTION ON HEAVY METAL CONTENT AND SECONDARY METABOLITES IN LICHENS *FLAVOPARMELIA CAPERATA* AND *PARMELIA SULCATA*

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Lichens, due to their ability to take nutrients and water directly from the air, are commonly used as bioindicators and biomonitors of air pollution. Airborne heavy metal pollutants cause various physiological changes in lichens, although the sensitivity to pollution is species specific. The city of Slavonski Brod has the most polluted air in Croatia due to the oil refinery situated directly across the border with Bosnia and Hercegovina. Reports from monitoring stations in the city show high content of pollutants including fine particles ($PM_{2.5}$), sulphur dioxide and hydrogen sulphide. In this study, two native lichens, *Flavoparmelia caperata* and *Parmelia sulcata* were collected at 20 sites around Slavonski Brod in 20 km radius from the oil refinery. The effects of the refinery pollution on lichen secondary metabolites and the possible correlation with content of metals (cadmium, nickel, lead and zinc) in lichen thalli were evaluated. Investigated species were not recorded at two sampling sites closest to the refinery, confirming the strong pollution effects. Lead and zinc contents were increased in lichen thalli collected at sites within the city and across the refinery indicating the cumulative effect of urban and industrial pollution. No differences in content of secondary metabolites atranorin, chloroatranorin, usnic acid and protocetraric acid were observed between different sites. However, salazinic acid content was slightly increased in lichens growing on closest plots directly across the refinery suggesting its possible role in protecting lichen thalli from metal pollution.

POPIS POTENCIJALNO INVAZIVNIH VRSTA (IAS) KOJE SE UZGAJAJU NA VANJSKIM PROSTORIMA BOTANIČKOG VRTA PRIRODOSLOVNO-MATEMATIČKOG FAKULTETA SVEUČILIŠTA U ZAGREBU

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Kroz povijest su oduvijek botanički vrtovi bili „rasadnici“ stranih biljnih svojti od kojih su se neke proširile u okoliš samih vrtova ili šire, potiskujući domaću, autohtonu floru. Nekih 5500 svojti se uzgaja u Botaničkom vrtu Prirodoslovno matematičkog vrta u Zagrebu (zajedno sa staklenicima!). Na vanjskim je prostorima vrta (bez staklenika!) zabilježeno nekih 590 invazivnih svojti (utvrđenih po bazi DAISIE), odnosno 10,72% od ukupnoga broja svojti u Vrtu. Od toga broja se 491 svojta spominje u nacionalnoj bazi *Flora Croatica Database* (FCD), a 109 svojti nije navedeno u bazi FCD. 183 drvenaste svojte (grmlje i drveće) su zabilježene od ukupnih 590 potencijalnih invazivnih svojti. Sve te svojte su potencijalno opasne za širenje u Europi ili dalje pa im je potrebno ustanoviti stupanj opasnosti kao invazivne svojte. Mnoge od tih svojti su invazivne ili samo za pojedine dijelove Europe ili pak za cijeli europski kontinent. Utvrđeni popis potencijalnih invazivnih svojti će se u sljedećem našem *Delectusu seminum*-u /2016/2017/ naznačiti uz svojte koje smo sakupili za razmjenu s drugim botaničkim vrtovima i arboretumima. U Vrtu ćemo također, uz već nekoliko mjesta gdje se spominju invazivne svojte (IAS), urediti i mjesto gdje će se posjetiteljima pokazati nekoliko najčešćih invazivnih biljnih svojti u Hrvatskoj.

LIST OF POTENTIALLY INVASIVE SPECIES (IAS) THAT ARE GROWN OUTDOORS IN THE BOTANICAL GARDEN, FACULTY OF SCIENCE, UNIVERSITY OF ZAGREB

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Throughout history botanical gardens were always "hotbeds" of foreign plant species of which some have spread in the environment of gardens or beyond, suppressing domestic, indigenous flora. Some 5,500 species are grown in the Botanical Garden of Science in Zagreb (together with greenhouses!). On the outside premises of the garden (without greenhouses) 590 invasive (IAS) species are recorded (determined by the base DAISIE), or 10.72% of the total number of species in the Garden. Of these, 491 species are mentioned in the national Croatian database for plant species *Flora Croatica Database* (FCD) and 109 species are not listed in the database FCD. 183 woody species (shrubs and trees) were recorded from the total 590 potential invasive species. All these species are potentially dangerous for expansion in Europe or further, so it is necessary to establish a degree of risk for invasive species. Many of these species are invasive only for certain parts of Europe or for the entire European continent. The determined list of potential invasive species will be in our next *Delectus seminum* /2016/2017/ indicated by the species we collected for exchange with other botanical gardens and arboretums. In addition to the few places where invasive species are already mentioned, the Garden plans to edit and organise a place where visitors could see some common invasive species in Croatia.

VELIČINA POPULACIJE, STATUS UGROŽENOSTI I MORFOLOŠKA KARAKTERIZACIJA KRITIČNO UGROŽENE CRETNE BREZE (*BETULA PUBESCENS* EHRH.) I KRIŽANCA (*B. x BLATUSAE* PEVALEK) U HRVATSKOJ

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Cretna breza (*Betula pubescens* Ehrh.) u Hrvatskoj dolazi na južnom rubu svog područja rasprostranjenosti te spada u vegetaciju cretnih heliofilnih šikara. Zbog nestajanja svojih prirodnih staništa kritično je ugrožena svojta u flori Hrvatske. Cilj ovoga istraživanja bio je utvrditi recentnu rasprostranjenost i veličinu populacija cretne breze u Hrvatskoj, te hibridogene svojte (*B. x blatusae* Pevalek), križanca između cretne i obične breze (*B. pendula* Roth). Istraživano je na jedine dvije poznate lokacije cretne breze u Hrvatskoj: u Botaničkom rezervatu ˝Đon Močvar˝ kod sela Blatuša (Banovina) i neposredno iznad Ludvić potoka, ispod sela Gradišće (okolica Samobora). Prebrojavanje jedinki pokazalo je da su populacije cretne breze u Hrvatskoj izrazito male i ugrožene; na području Ludvić potoka populacija broji svega tri, a na Đon Močvaru 63 jedinke, od kojih samo manji dio fruktificira. Hibridna (blatuška) breza zabilježena je samo na Đon Močvaru s ukupno 56 jedinki. Na temelju toga procijenjen je stupanj ugroženosti populacija cretne i hibridne breze u Hrvatskoj sukladno IUCN kategorizaciji. Dodatno su na temelju izmjerenih 10 morfoloških svojstava listova obične, cretne i hibridine breze utvrđene razlike u morfologiji lista te predložen determinacijski ključ.

POPULATION SIZE, CONSERVATION STATUS AND MORPHOLOGICAL CHARACTERIZATION OF CRITICALLY ENDANGERED DOWNY BIRCH (*BETULA PUBESCENS* EHRH.) AND HYBRID BIRCH (*B. x BLATUSAE* PEVALEK) IN CROATIA

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Downy birch (*Betula pubescens* Ehrh.) in Croatia is on the southern edge of its area of distribution and is member of bog vegetation. Due to disappearing of its natural habitats it is considered a critically endangered species of Croatian flora. The aim of this research was to determine the recent distribution and population size of downy birch and hibridogenous taxon *B. x blatusae* Pevalek, a hybrid between downy and silver birch (*B. pendula* Roth) in Croatia. The research was performed on the only two known locations of downy birch in Croatia: in Botanical reserve „Đon Močvar“ near the village of Blatuša (Banovina Region) and above the stream Ludvić potok, below the village of Gradišće (surroundings of town of Samobor). The counting of the individuals revealed that populations of downy birch are extremely small and endangered; the population near Ludvić potok consists of only three, while population at Đon Močvar of 63 individuals, of which just a small number fructificate. Hybridogenous birch has been recorded only at Đon Močvar with total of 56 individuals. Based on this results, a risk status according to IUCN categorization for the populations of downy and hybridogenous birch in Croatia has been estimated. In addition, based on measured 10 morphological leaf characters of silver, downy and hybrid birch, morphological differences have been identified and the determination key has been proposed.

GENETIČKA RAZNOLIKOST PITOMOGA KESTENA (*CASTANEA SATIVA* MILL.) U SREDIŠNJOJ EUROPI I ZAPADNOM DIJELU BALKANSKOGA POLUOTOKA

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Još u davnoj prošlosti čovjeku su šume pitomoga kestena predstavljale važan izvor različitih sirovina. Intenzivnim korištenjem kestenovih šuma i nasada te pojavom raka kestenove kore, sredinom prošlog stoljeća došlo je do njihovog propadanja i sušenja. Iz tih je razloga u mnogim europskim zemljama pokrenut niz multidisciplinarnih projekata kojima je svrha očuvanje genskih resursa pitomoga kestena i njegovog povrataka na nekadašnje značajno mjesto u šumskim ekosustavima. Cilj ovog rada bio je utvrditi genetičku raznolikost populacija europskoga pitomoga kestena u središnjoj Europi i zapadnom dijelu Balkanskoga poluotoka. Ukupno je sakupljen 301 uzorak iz 15 populacija, a analiza genetičke raznolikosti provedena je pomoću deset mikrosatelitnih biljega. Ukupno je umnoženo 125 alela, s prosječnom vrijednosti od 12,5 alela po lokusu. Aleleno bogatstvo se kretalo od 4,0 do 6,1, s prosječnom vrijednosti od 4,9. Ni u jednoj populaciji nije utvrđeno statistički značajno odstupanje od Hardy-Weinbergove ravnoteže. Analiza molekularne varijance pokazala je da se najveći udio varijabilnosti može pripisati razlikama između jedinki unutar populacija (86,4%). Nezakorijenjenim stablom utvrđeno je da se većina populacija grupirala u skladu s njihovim geografskim porijeklom. Isti rezultati dobiveni su i Bayesovskom analizom u programu STRUCTURE. Provedene analize upućuju na postojanje tri skupine populacija pitomoga kestena. Dvije skupine populacija utvrđene su u sjevernom području istraživanja i jedna u južnom. Genetička diferencijacija populacija najizraženija je između južnih populacija iz Makedonije i Kosova i ostalih istraživanih populacija iz Hrvatske, Bosne i Hercegovine, Mađarske, Rumunjske i Italije. Rezultati ovog istraživanja izravno mogu doprinijeti razvoju učinkovitijih planova očuvanja i gospodarenja ovom ekonomski važnom i plemenitom vrstom.

GENETIC DIVERSITY OF THE SWEET CHESTNUT (*CASTANEA SATIVA* MILL.) IN CENTRAL EUROPE AND WESTERN PART OF BALKAN PENINSULA

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From the ancient history, sweet chestnut forests represented an important source of various raw materials. Because of intensive exploitation of chestnut forests and plantations, and the appearance of the chestnut blight in the middle of 20th century, chestnut forests have declined. For this reason, in a number of European countries a series of multidisciplinary projects have been launched with the aim of sweet chestnut conservation and chestnut re-establishment to its prior position in forest ecosystems. The aim of this research was to determine the genetic diversity of the sweet chestnut populations in central Europe and western part of Balkan Peninsula. A total of 301 trees from 15 populations were sampled, and genetic variation was analysed using ten microsatellite markers. A total of 125 alleles were detected with an average allele number of 12.5 per locus. The allelic richness per population ranged from 4.0 to 6.1, with a mean value of 4.9. No significant deviations from the Hardy-Weinberg equilibrium were observed at any loci in any population. The AMOVA analysis showed that the largest proportion of molecular variance was caused by the differences between individuals within populations (86.4%). The Neighbour-joining tree showed that most of the populations grouped together in accordance to their geographical position. The results were further confirmed using Bayesian model-based clustering method. The study revealed the existence of three distinct and well-defined groups of sweet chestnut populations. Two groups of populations were detected in the northern part of the studied area, and one in the southern. Genetic differentiation of populations was most pronounced between the southern populations from Macedonia and Kosovo and all other studied populations from Croatia, Bosnia and Herzegovina, Hungary, Romania and Italy. Results of this research can contribute directly to the development of more efficient conservation and management plans for this economically important and noble species.

EKOLOGIJA KLIJANJA SJEMENKI HRVATSKIH ZAKONOM STROGO ZAŠTIĆENIH VRSTA

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U Botaničkom vrtu PMF-a izučavali smo ekologiju klijavosti pet vrsta hrvatskih autohtonih trajnica, kako bismo što bolje razumjeli uvjete potrebne za klijanje njihovih sjemenki. Sve izučavane vrste u Hrvatskoj su zakonom strogo zaštićene, a nalaze se i na popisima vrsta važnih za Europsku uniju (Natura-vrste, na Crvenoj listi IUCN-a, uključene u Direktivu o staništima i Bernsku konvenciju).

Ilirsko-balkanski endem livadni procjepak (*Chouardia litardierei* (Breistr.) Speta) u EU je kritično ugrožena (CR) vrsta, s obzirom na to da je u Sloveniji, jedinoj zemlji EU u kojoj je osim Hrvatske još rasla, gotovo izumrla. Procjepak je u Hrvatskoj još uvijek relativno česta vrsta, kao i grmolika cjelolatična žutilovka (*Genista holopetala* (Koch) Bald.), liburnijski endem koji se smatra osjetljivim (VU) u EU (Slovenija i Italija). Europski endem je i nerazgranjena pilica (*Serratula lycopifolia* (Vill.) A. Kern.), vrsta za koju manjkaju podaci (DD) na IUCN-ovoj, EU- i hrvatskoj Crvenoj listi. Sibirska jezičnjača (*Ligularia sibirica* (L.) Cass.) pronalazi najjužnije europsko stanište u Hrvatskoj, i to na samo jednom lokalitetu, unutar Nacionalnog parka 'Plitvička jezera'. Kao kritično ugrožena vrsta (CR) nalazi se na hrvatskoj Crvenoj listi. Velebitska degenija (*Degenia velebitica* (Degen) Hayek), jedinstvena je hrvatska monotipska vrsta koju pronalazimo na samo nekoliko lokaliteta na Velebitu i Kapeli te je upisana u Crvenoj knjizi Hrvatske kao ugrožena (EN).

Istraživanja su provedena na zrelim sjemenkama sakupljenim na prirodnim lokalitetima u vrijeme njihovog prirodnog raspršivanja, na temelju službenih dozvola Ministarstva zaštite okoliša i prirode. Tijekom pokusa izučavali smo: 1) utjecaj temperature (četiri različita režima) i svjetlosti na klijanje; 2) prisutnost dormancije; 3) prilagođavanje i uzgoj klijanaca (biljaka) unutar Botaničkog vrta u zbirci samoniklih vrsta. Višak uzgojenih biljaka, uz dozvolu Ministarstva, slobodni smo ponuditi na prodaju građanstvu uz certifikat o legalnom uzgoju.

Nakon postavljanja pokusa ostatak sjemenki čuva se u banci sjemena (također uz dozvolu Ministarstva) na temperaturi od -20˚C. Nadamo se da će svi rezultati dobiveni ovim istraživanjem, kao i biljke uzgojene iz sjemenki tijekom pokusa, doprinijeti unaprjeđenju i poboljšanju trajnog čuvanja rijetkih hrvatskih vrsta biljaka na njihovim prirodnim staništima.

SEED GERMINATION ECOLOGY OF CROATIAN STATUTORILY STRICTLY PROTECTED SPECIES

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To improve understanding of how the seeds of Croatian statutorily strictly protected species germinates in various conditions, we studied the germination ecology of five autochthonous perennials listed in the IUCN-, European-, EU- and/or local Red Lists, one or more Annexes of the *Habitats Directive* and *Bern Convention*, as well as NATURA-2000-important species.
Illyrian-Balkan endemic *Chouardia litardierei* (Breistr.) Speta is listed as critically endangered (CR) for EU (since it is nearly extinct in Slovenia, single EU-country besides Croatia where it grows naturally), while in Croatia is still frequent. Shrubby endemic *Genista holopetala* (Koch) Bald. is considered to be vulnerable (VU) in EU (Slovenia and Italy), but is still abundant in Croatia. European endemic *Serratula lycopifolia* (Vill.) A. Kern. is listed as data deficient (DD) in the IUCN-, European-, EU- and Croatian Red lists. *Ligularia sibirica* (L.) Cass. has its European southern-most, but solitary locality in Croatian National park “Plitvice Lakes” and it is listed as critically endangered (CR) in Croatian *Red Data Book*. At last, the single Croatian monotypic genus, *Degenia velebitica* (Degen) Hayek, grows in only several localities of the mountains of Velebit and Kapela and it is recorded as endangered (EN) in Croatian *Red Data Book*.
We conducted laboratory experiments with freshly matured seeds collected in the wild at the time of their natural dispersal, to investigate: 1) the effect of temperature (four different regimes) and light on germination; 2) the existence of seed dormancy; 3) adaptation and cultivation of young seedlings (plants) in the native collections of our Botanical Garden, as required in the special *Permits* obtained from the Croatian Ministry of Environment and Nature Protection.
Also, after the experiments were set, we were permitted to lay the rest of the collected seeds in cryopreservation (permanent seed bank) at the temperature of -20˚C. During the years, we are hoping to obtain the seeds from the plants grown during this research, to be preserved in the seed bank, which will improve conservation of rare Croatian species.

EKOLOGIJA CIJANOBAKTERIJA U POPLAVNOM JEZERU UMJERENOG PODRUČJA

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Cvjetanje cijanobakterija je u današnje vrijeme prepoznato kao karakteristika slatkovodnih eutrofnih ekoloških sustava širom svijeta. U dinamičnim sustavima rijeka-poplavno područje, dinamika i intenzitet plavljenja može se okarakterizirati kao kontrolni čimbenik cvjetanja cijanobakterija jer su one posebno osjetljive na stres uzrokovan plavljenjem. U poplavnom području Kopačkog rita, jednom od najvećih prirodnih poplavnih područja u srednjem dijelu Dunava, tijekom osam godina (2003. – 2010.) provedena su istraživanja fitoplanktona s posebnim naglaskom na razvoj cijanobakterija. Ukupno je utvrđeno 19 vrsta, od kojih 10 vrsta izazivaju cvjetanja. Najzastupljenije su bile nitaste vrste cijanobakterija iz funkcionalnih skupina H1 (*Dolichospermum solitarium*, *D*. *sigmoideum*, *Anabaena planctonica* i *Aphanizaomenon flosaquae*), S1 (*Limnothrix redekei*, *Planktothrix agardhii*, *Pseudanabaena limnetica* i *Planktolyngbya limnetica*) i S_N (*Cylindrospermopsis raciborskii*). Najrazvijenije su bile vrste *P*. *agardhii* (166,8 mg/L u rujnu 2008. godine) i *L*. *redekei* (73,6 mg/L u rujnu 2004. godine) te invazivna vrsta europskih voda *C*. *raciborskii* (91,4 mg/L u kolovozu 2003. godine). Redundancijska analiza pokazuje da su temperatura vode, koncentracija hranjivih tvari i vodostaj Dunava bili glavni čimbenici koji su pogodovali razvoju vrste *C*. *raciborskii*. Velika prozirnost vode i visoka koncentracija nitrata i nitrita pridonijeli su razvoju vrste *L*. *redekeii* te drugim vrstama roda *Limnothrix* (tankim nitastim vrstama reda Oscillatoriales), dok su niske koncentracije dušika pogodovale razvoju vrsta iz rodova *Dolichospermum*, *Anabaena* i *Aphanizomenon*. Dobiveni rezultati ukazuju da su intenzitet i učestalost poplava, zajedno s promjenama jezerskih varijabli, imali značajan učinak na pojavu cvjetanje cijanobakterija.

THE ECOLOGY OF CYANOBACTERIA IN THE TEMPERATE FLOODPLAIN LAKE

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Cyanobacterial blooms are recognized nowadays as a worldwide environmental characteristic of eutrophicated freshwater ecosystems. Flooding dynamic and intensity can be qualified as the controlling factor for cyanobacteria blooms in the dynamic river-floodplain system which are particularly sensitive to stress caused by flooding. We analyzed an eight years (2003–2010) study of the phytoplankton in the Kopački Rit floodplain, one of the largest natural floodplains in the middle section of the Danube River, with special emphasis on the cyanobacterial development. A total of 19 cyanobacterial species were detected, among which 10 bloom-forming taxa can be recognized. Filamentous cyanobacterial species from functional groups H1 (*Dolichospermum solitarium*, *D*. *sigmoideum, Anabaena planctonica* and *Aphanizomenon flosaquae*), S1 (*Limnothrix redekei*, *Planktothrix agardhii*, *Pseudanabaena limnetica* and *Planktolyngbya limnetica*) and S_N (*Cylindrospermopsis raciborskii*) were representative species in the blooms. The most successful in blooming were *P*. *agardhii* (166.8 mg/L in September 2008) and *L*. *redekei* (73.6 mg/L in September 2004) as well as *C*. *raciborskii* (91.4 mg/L in August 2003), an invasive species in the European waters. Redundancy analysis suggested that water temperature, together with nutrients and water level, was the main parameters for the development of *C*. *raciborskii*. *L*. *redekeii* and other *Limnothrix*-like species (thin filamentous Oscillatoriales) were best associated with high transparency and high concentrations of nitrates and nitrites, while *Dolichospermum*, *Anabaena* and *Aphanizomenon* species were characterized by low nitrogen concentrations. All our results demonstrate that the intensity and frequency of flood events together with the changes of in-lake variables had pronounced effects on the appearance of cyanobacterial blooms.

Tema simpozija **Symposium topic**

Primijenjena botanika **Applied botany**

BILJKE U LIJEČENJU TUBERKULOZE

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Tuberkuloza je jedna od najstarijih zaraznih bolesti u svijetu. Do pronalaska streptomicina 1943., korištene su brojne biljke u simptomatskoj terapiji bolesti. U Dubrovačkoj republici za liječenje tuberkuloze, a posebno kod sprječavanja plućnog krvarenja, koristio se sok od koprive. Amatus Lusitanus (1511.-1568.) je preporučivao rakove kuhane u juhi od mesa kopuna, šećer, bademe i mlijeko te sjemenke maka za ublaživanje kašlja. U pučkoj medicini otoka Hvara postoji zapisan recept po kome se 40 jabuka izdube, ispune s malom žličicom sumpora i velikom žlicom maslinovog ulja, potom se polovice sklope, vežu i ostave na suncu 40 dana. Pučka medicina na Pelješcu koristi ljekoviti matičnjak (*Melissa officinalis*) kao lijek kod kašlja, a „bobak" od lovora (*Laurus nobilis*) kao uvarak kod *sičije*. Uvarak od kadulje (*Salvia officinalis*) su godinama smatrali glavnim lijekom protiv tuberkuloze. U Vojnovićevoj drami „*Maškarate ispodkuplja*" (1922.), autor u bolesti sluškinje Anice, spominje da joj treba davati lijek od trava s dubrovačkih stijena svakih sat vremena: "*Od Sansega je* (*Origanum majorana*, op. a.)*, su tri kaplje Ćene ljubice i su dvije Pelina".* U udžbenicima Interne medicine iz 1940. preporučivala se kod suhog bronhitisa i nespecifičnih katara larinksa inhalacija para od kamilice ili *Oleum Pini Pumilionis*. Kod upornih dugotrajnih temperatura preporučivala se kombinacija kinina i laktofenina. Kod tuberkuloze crijeva davali su se pripravci tormentile ili *Radix Pentaphylli* sa ili bez *Extr. Belladonnae*. Od specijalnih preparata bio je tu *Quajacolum carbonicum* (sam ili u kombinaciji s kresolom). Kod prekomjernog znojenja koristi se tinktura *Salviae* ili *Acidi camphorici*. Kod hemoptize davao se uvarak *Folii hamamelidis* uz cimet ili kombinacija kodeina s papaverinom. Da bi se smanjilo iskašljavanje sluzi davao se čaj od *Herbae Equiseti*, *H. Polygoni* i *H. Galeopsidis.* Bila je popularna i kombinacija *H.Thymi*, *H. Droserae*, *H*. *Galeopsidis*, *H. Equiseti* i *H. Polygoni*. U kombinaciji navedenih biljaka koristio se i islandski lišaj. U slučajevima gdje je trebalo spriječiti suhi grčeviti kašalj davala se tinktura kodeina s tinkturom *Belladonnae* uz ekstrakt timijana i *Liquiritiae radix* (*Glycyrrhiza*). Ulje *Terebinthinae* se uzimalo uz toplo mlijeko. S ciljem jačanja organizma davala se kombinacija ribljeg ulja i *Mentha*. Pronalazak tuberkulostatitka donio je značajnu prekretnicu u preživljavanje bolesnika, a time i udaljavanje od korištenja biljaka u liječenju tuberkuloze.

PLANTS IN THE TREATMENT OF TUBERCULOSIS

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Tuberculosis is one of the oldest contagious diseases in the world. Up to discovery of streptomycin in 1943, numerous plants have been used in the treatment of the disease. In Dubrovnik's Republic in the treatment of the tuberculosis, and especially against pulmonary haemorrhage, has been used the wall-pellitory juice. Amatus Lusitanus (1511-1568) recommended crab-fish boiled in the cock soup, sugar, almonds, milk and poppy seeds against cough. In popular medicine of the island of Hvar exists recipe with 40 apples with excavated centres filled with the sulphur and olive oil and let on the sun light for 40 days. Popular medicine of the Pelješac peninsula uses *Melissa officinalis* like a medicine against cough and *Laurus nobilis* like decoct. Decoct from *Salvia officinalis* for the years was the main medicine against tuberculosis. In Vojnović's play „*Maškarate ispodkuplja*“ (1922), the author suggested to sick servant Anica to take medicine of the Dubrovnik's stone's plants (*Origanum majorana*, *Artemisia absinthum*, *Melissa officinalis*) every one hour. In the textbook's of the Internal medicine from the year of 1940, in the treatment of the dry bronchitis and nonspecific catarrh inhalation of the camomile or *Oleum Pini Pumilionis* worked well. For the high fever combination of the kinin and lactoferin has been suggested. In the case of the tuberculosis of the bowel tormentilla decoct or *Radix Pentaphylli* decoct with or without *Belladona* were given. Special medication was *Quajacolum carbonicum* (alone or with the cresolum). In excessive sweating tincture *Salviae* or *Acidi camphorici* were used. In the case of hemoptysis decoct *Folii hamamelidis* with cinnamonor the combination of codeini and papaverinum. To suppress expectoration of the mucus, the tea of *Herbae Equiseti*, *H. Polygoni* and *H. Galeopsidis* have been used. Very popular was a combination of the *H. Thymi*, *H. Droserae*, *H*. *Galeopsidis*, *H. Equiseti* and *H. Polygoni*. Sometimes, they added Island's lichen. When dry strong cough has to be stopped, tincture of codeini and *Belladona* was given with the creeping thyme extract and *Liquiritiae radix* (*Glycyrrhiza*). *Terebinthinae* Oil was taken with the hot milk. With the target of enforcing the body, combination of the oleum jecoris and *Mentha* has been given. The discovery of the tuberculostatics gave a great chance for the surviving of the sick persons but also reduced used of the plants in the treatment of the tuberculosis.

CYTOTOXICITY EVALUATION OF *THYMUS BRACTEOSUS* VIS. EX BENTHAM (LAMIACEAE) AQUEOUS EXTRACT IN HUMAN PERIPHERAL BLOOD LYMPHOCYTES *IN VITRO*

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Thymus bracteosus Vis. ex Bentham (Lamiaceae) is endemic to the Dinaric area, with a very limited distribution in the central Balkan peninsula (Croatia, Herzegovina and Montenegro). It is well known that many aromatic medicinal plants of *Thymus* species in Balkan, may express high bioactivity and therapeutic effects. We analyzed the cytotoxicity potential of *Thymus bracteosus* Vis. ex Bentham aqueous extract in various concentrations in cultivated human lymphocytes using RT MLPA Apoptosis assay for the evaluation of relative gene expression of apoptosis-related genes and cytokinesis-blocked micronucleus cytome assay. For aqueous extract preparation, plants were collected from five localities in Herzegovina and four working solutions were made (0,01; 0,05; 0,1 and 0,2 mg/ml). The peripheral blood lymphocytes were cultivated from healthy volunteer in two series and treated with different concentrations of aqueous extract after 24 hours. Positive and negative controls were set up as well. Upon the cultivation of 72 hours, from one culture series RNA was simultaneously isolated and used for RT-MLPA R011-C1 Apoptosis assay. Other culture series was used for the microscopic slides preparations and evaluation of cytotoxicity in cytokinesis-blocked lymphocytes. Relative gene expression analysis of apoptosis-related genes showed that BBC3 (PUMA), BCL2L11, CFLAR7 and BCL2A1 genes were up-regulated in cultures treated with two higher concentrations (0,1and 0,2 mg/ml). The differences between frequencies of apoptotic and necrotic cells in comparison to control and applied concentrations were not observed, as well as the differences in values of cytotoxicity index. Our preliminary results show that there is no observed cytotoxic activity of *Thymus bracteosus* Vis. ex Bentham aqueous extract in applied concentrations *in vitro*, although there is slight up-regulation of certain apoptosis-related genes in cultures treated with highest concentrations of aqueous extract.

UPOTREBA SAMONIKLOG BILJA NA PODRUČJU KLISA

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Kao dio većeg etnobotaničkog istraživanja Dalmatinske zagore ispitali smo upotrebu samoniklog bilja stanovnika Klisa i okolnih naselja. Iako je glavni cilj bio zabilježiti upotrebu samoniklog bilja za hranu, zabilježili smo i upotrebe u druge svrhe. Za hranu i čajeve koriste se najviše: *Asparagus acutifolius* L., *Rosa* sp., *Rubus ulmifolius* Shott., *Cichorium intybus* L., *Dioscorea communis* (L.) Caddick & Wilkin, *Foeniculum vulgare* Mill., *Hypericum perforatum* L., *Sonchus* sp., *Allium ampeloprasum* L., *Celtis australis* L., *Pyrus amygdaliformis* Vill., *Cornus mas* L., *Crataegus monogyna* Jacq., *Salvia officinalis* L., and *Thymus longicaulis* C.Presl. Najveći broj vrsta se koristi kao voće, potom povrće te čaj. Voće se najviše jede sirovo, dok se povrće jede kao salata ili kuhano. Mladi izboji *A. acutifolius* su najpopularnije povrće dok su plodovi *Rosa sp.* najpopularniji čaj. Zanimljiva je upotreba korijena bljušta koji se maceriran 40 dana u rakiji koristi za mazanje bolnih mjesta te upotreba *Broussonetia papyrifera* (L.) Vent. za pranje. Od crnog jasena rade se potporni štapovi za povrće, a brnistra se koristila za vezivanje vinove loze. Za razliku od susjednih Poljica, u Klisu samoniklo bilje se obilno koristi te je tradicijsko znanje još uvijek živo.

THE USE OF WILD PLANTS IN AREA OF KLIS (CROATIA)

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As a part of an ethnobotanical study in Dalmatian hinterland (Croatia), we interviewed inhabitants of Klis and adjacent settlements regarding their use of wild plants. The focus was edible plants, yet all other uses were recorded as well. Most commonly used wild plants as food and recreational tea were *Asparagus acutifolius* L., *Rosa* sp., *Rubus ulmifolius* Shott., *Cichorium intybus* L., *Dioscorea communis* (L.) Caddick & Wilkin, *Foeniculum vulgare* Mill., *Hypericum perforatum* L., *Sonchus* sp., *Allium ampeloprasum* L., *Celtis australis* L., *Pyrus amygdaliformis* Vill., *Cornus mas* L., *Crataegus monogyna* Jacq., *Salvia officinalis* L., and *Thymus longicaulis* C.Presl. The largest number of species is used as fruit and vegetable leaves, followed by recreational teas. Fruits are mainly eaten raw, while vegetables are eaten as salad, boiled separately, or as a vegetable mix. Shoots of *A. acutifolius* are the most popular vegetable, while wild rose hips are the most popular recreational tea. An interesting feature is the use of the root of *D. communis* macerated in rakija for painful parts of the body and the use of *Broussonetia papyrifera* (L.) Vent. for washing. *Fraxinus ornus* L. is commonly used as wooden stakes in vegetable gardens and *Spartium junceum* L. was used as a tie in vineyards. Opposed to neighbouring region of Poljica traditional knowledge of wild plants use in Klis is mostly alive.

HPLC ANALIZA I ANTIAGREGACIJSKI UČINAK ETANOLNIH EKSTRAKATA LISTOVA MATIČNJAKA - *MELISSA OFFICINALIS* L.

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Matičnjak (*Melissa officinalis* L., Lamiaceae) je biljka zapadnih područja Azije i istočnog Mediterana, a kultivira se u gotovo cijeloj Europi i Sjevernoj Americi. To je višegodišnja biljka, visine 30 do 90 cm, obično s nekoliko stabljika. Listovi su dugi 2-9 cm i široki 1-5 cm, jajoliki do ovalni, nazubljenog ruba, peteljke duge 2 do 35 mm. Vrlo su specifičnog mirisa na limun. Cvjetovi su bijeli ili ružičasti. Listovi sadrže čitav niz različitih kemijskih spojeva: eterično ulje, fenolne kiseline (važan su izvor ružmarinske kiseline), flavonoide, trjeslovine itd. Eterično ulje i listovi matičnjaka rabe se u liječenju blagih nesanica te kao karminativ i spazmolitik. Cilj ovog rada bio je odrediti sadržaj ružmarinske kiseline i ispitati antiagregacijski potencijal 50%-tnih etanolnih (v/v) ekstrakata listova matičnjaka uzoraka skupljenih tijekom 2014. i 2015. godine. Sadržaj ružmarinske kiseline određen je obrnuto faznom tekućinskom kromatografijom visoke djelotvornosti spregnutom s detektorom s nizom dioda (RP-HPLC-DAD). Antiagregacijski potencijal ekstrakata matičnjaka ispitan je impedancijskom metodom na punoj krvi u testu agregacije potaknute adenozindifosfatom (ADP test). Sadržaj ružmarinske kiseline kretao se u rasponu od 1,78-4,35%. Rezultati statističke analize (jednosmjerna ANOVA s Turkeyovim *post hoc* testom) su pokazali da jedino nerazrijeđeni ekstrakti pokazuju antiagregacijski učinak u ADP testu (31,25 µg/mL). Standard ružmarinske kiseline pokazao je statistički značajno smanjenje agregacije trombocita pri koncentraciji od 90 µM. Ovim radom pokazan je antiagregacijski potencijal etanolnih ekstrakata listova matičnjaka, što se u određenoj mjeri može povezati sa sadržajem ružmarinske kiseline.

HPLC ANALYSIS AND ANTIAGGREGATORY ACTIVITY OF LEMON BALM – *MELISSA OFFICINALIS* L. LEAVES ETHANOLIC EXTRACTS

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Lemon balm (*Melissa officinalis* L., Lamiaceae) is a plant of western Asian regions and Eastern Mediterranean, and is cultivated in almost all of Europe and North America. It is a perennial herb that grows 30 to 90 cm, usually with several stems. The leaves are 2-9 cm long and 1-5 cm wide, ovate to oval, densely sawtooth, petiole is 2-35 mm long, with a specific smell of lemon. The flowers are white or pink. The leaves contain a variety of chemical compounds: essential oil, phenolic acids (an important source of rosmarinic acid), flavonoids, tannins etc. Essential oil and leaves of lemon balm are used in the treatment of mild insomnia and as a carminative and spasmolytic. The aim of this study was to determine the content of rosmarinic acid and examine antiplatelet potential of ethanol (50%, v/v) extracts of lemon balm leaves samples collected during 2014 and 2015. Rosmarinic acid content was determined by reverse phase high performance liquid chromatography coupled with a diode array detector (RP-HPLC-DAD). Antiplatelet potential of lemon balm extracts was tested by impedance method on whole blood. Aggregation was induced by adenosine diphosphate (ADP test). Rosmarinic acid content ranged from 1.78 to 4.35%. Results of statistical analysis (one-way ANOVA with *post hoc* Turkey test) showed that only the undiluted extracts have antiplatelet activity in ADP test (31.25 µg/mL). Standard of rosmarinic acid showed significant reduction of platelet aggregation at a concentration of 90 µM. This work demonstrated the antiplatelet potential of ethanol lemon balm leaves extracts, which can, to some extent, be linked to the content of rosmarinic acid.

ENDEMIČNA FLORA RIJEKE I "RIJEČNOG PRSTENA", HRVATSKA: NEKI ASPEKTI PRAKTIČNE PRIMJENE ZNANJA O ENDEMIČNOM BILJU

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Nakon što je 2015. godine objavljena botanička monografija *Endemi u hrvatskoj flori* otvorile su se mogućnosti za detaljniju obradu biljnih endema užih područnih i regionalnih flora. U radu su obrađeni podatci za 50 najvažnijih endemičnih vrsta i podvrsta te nekoliko endemičnih križanaca flore na području grada Rijeke i njene šire okolice u zapadnoj Hrvatskoj. Određeni su tipovi staništa te biljne zajednice u kojima uspijevaju endemične vrste, a provjereni su i prethodno objavljeni podatci o prisutnosti pojedinih endemičnih vrsta i podvrsta na ovom području. Tijekom višegodišnjih terenskih istraživanja otkriven je niz novih nalazišta pojedinih endemičnih svojti. Najveći broj biljnih endema zabilježen je na travnjacima. Po brojnosti endemičnih vrsta slijede petrofilna staništa (pukotine stijena, točila i obalni grebeni), a najmanji broj endemičnih svojti zabilježen je u šumama i šikarama. S obzirom na važnost travnatih staništa za održavanje bogate endemične flore posebno su istaknuti tipovi travnatih staništa izloženih snažnom i učestalom puhanju bure, koji se odlikuju velikom brojnošću nekih od najznačajnijih endema ovog područja kao što su *Genista holopetala*, *Euphorbia triflora* subsp. *triflora*, *Athamanta turbith* ssp. *haynaldii*, *Genista sericea*, *Onosma stellulata*, *Scabiosa silenifolia*, *Campanula marchesettii*, *Euphrasia illyrica*, *Satureja subspicata* ssp. *liburnica*, *Edraianthus tenuifolius*, *Knautia* spp. Neki od istraženih lokaliteta su zbog prisutnosti rijetkih i ugroženih biljnih svojti uključeni kao botanički važni u ekološku mrežu Europske unije – NATURA 2000, a veliki dio planine Obruč uvršten je u botanički važna područja Hrvatske (engl. Important Plant Areas, IPA). U radu su navedeni primjeri praktičnog korištenja znanja o endemičnom bilju, jer ono može biti od velike pomoći u svakodnevnom životu, primjerice u zaštiti prirode, planiranju različitih zahvata u prostoru, ali i kod izoliranja pojedinih čovjeku korisnih spojeva iz biljaka, u apikulturi, u turističkoj promidžbi.

ENDEMIC FLORA OF RIJEKA AND THE "RIJEKA RING", CROATIA – SOME ASPECTS OF PRACTICAL USE OF KNOWLEDGE OF ENDEMIC PLANTS

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Once the botanical monograph *Endemi u hrvatskoj flori* (Endemic Plants in Croatian Flora) was published in 2015, it became possible to have a more detailed analysis of endemic plants of a narrower territorial and regional flora. The paper covers data for fifty most important endemic species and subspecies and a few endemic hybrids of flora in the area of the city of Rijeka and its wider surroundings in western Croatia. Types of habitats and plant communities in which endemic species grow have been determined, while previously published data on the presence of specific endemic species and subspecies in this area have been verified. During a year-long field investigation, a large number of new habitats of specific endemic taxa was discovered. The highest number of endemic plants was recorded in grassland habitats. According to the number of endemic species, it is petrophilous habitats (fissures of rocks, screes and coastal cliffs) that follow, while the smallest number of endemic taxa was recorded within woods and shrubs. Regarding the importance of grassland habitats for the sustenance of rich endemic flora, it is the grassland habitats exposed to the strong and frequent blowing of *bura* (NE wind) that are of special prominence, characterized by a great number of some of the most significant endemic plants of this area, such as *Genista holopetala*, *Euphorbia triflora* subsp. *triflora*, *Athamanta turbith* ssp. *haynaldii*, *Genista sericea*, *Onosma stellulata*, *Scabiosa silenifolia*, *Campanula marchesettii*, *Euphrasia illyrica*, *Satureja subspicata* ssp. *liburnica*, *Edraianthus tenuifolius* and *Knautia* spp. Due to the presence of rare and endangered plant taxa, some of the investigated localities have been included as being important for plants into the Ecological Network of European Union – Natura 2000, while a great part of the Obruč mountain has been included into the Important Plant Areas, IPA, of Croatia. This paper identifies examples of the practical use of knowledge of endemic plants as it can be of great help in everyday life, such as in the protection of nature, in planning various interventions in space, but also in isolating some compounds from plants beneficial to man, in apiculture, as well as in the promotion of tourism.

BIOLOŠKA AKTIVNOST ETANOLNOG EKSTRAKTA I FRAKCIJA DUBROVAČKE ZEČINE (*CENTAUREA RAGUSINA* L.)

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Vrste roda *Centaurea* bogate su bioaktivnim tvarima te su dokazana njihova antioksidacijska, antibakterijska, citotoksična i druga ljekovita svojstva. Cilj rada je odrediti antioksidacijsku, antibakterijsku i citotoksičnu aktivnost etanolnog (96%) ekstrakta lista i frakcija izoliranih iz hrvatske endemične biljne vrste *Centaurea ragusina* L. sakupljene na prirodnom lokalitetu u Splitu (lokalitet Katalinić brig i Sustipan). U svrhu boljeg razumijevanja biološke aktivnosti dubrovačke zečine proučavane su interakcije ekstrakta i frakcija s dvolančanim polinukleotidima (moguće biološke mete) spektroskopijom cirkularnog dikroizma (CD spektroskopijom). Etanolni ekstrakt lista pokazao je značajnu antioksidacijsku aktivnost mjerenu DPPH i ABTS metodom dok su frakcije izolirane iz etanolnog ekstrakta pokazale slabu antioksidacijsku aktivnost. Većina testiranih frakcija i etanolni ekstrakt lista pokazali su značajnu antibakterijsku aktivnost na *Staphylococcus aureus* ATCC25923 i slabu antibakterijsku aktivnost na *Acinetobacter baumannii* DURN. Etanolni ekstrakt i frakcije CRE01_06-10 pokazuju značajnu citotoksičnu aktivnost na tumorskim staničnim linijama SCCVII, FsaR i B16-F10. Etanolni ekstrakt CRE i dio ispitivanih frakcija uzrokovali su smanjenje CD signala polinukleotida (poli A - poli U, ctDNA) i inducirane CD spektre (ICD) u području od 290 - 300 nm koji ukazuju na interakciju s tim biološkim metama. Na temelju snimljenih spektara može se zaključiti da ekstrakt CRE i frakcije CRE01_05 i CRE01_06 sadržavaju spojeve koji se vežu na RNA i DNA. U daljnjim istraživanjima, plan je izolirati spojeve iz ekstrakata i frakcija dubrovačke zečine koji bi se mogli koristiti u prevenciji bolesti uzrokovanim slobodnim radikalima, liječenju bakterijskih infekcija te u liječenju tumora.

BIOLOGICAL ACTIVITY OF ETHANOLIC EXTRACT AND FRACTIONS FROM *CENTAUREA RAGUSINA* L.

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Species of the genus *Centaurea* are rich in bioactive substances with antioxidant, antibacterial, cytotoxic and other medicinal properties. The goal of this work was to determine antioxidant, antibacterial and cytotoxic activity in ethanolic (96%) extract of leaves and isolated fractions of Croatian endemic plant species *Centaurea ragusina* L. collected at two natural habitats in Split (Katalinić brig and Sustipan). The interactions of extract and fractions with double stranded polynucleotides (possible biological targets) were studied with circular dichroism spectroscopy (CD spectroscopy) to provide a better understanding of the biological activity of *C. ragusina*. Ethanolic extract showed significant antioxidant activity measured by DPPH and ABTS method while fractions isolated from ethanolic extract showed weak antioxidant activity. Almost all tested fractions and crude ethanolic extract of leaves showed significant antibacterial activity against *Staphylococcus aureus* ATCC25923 and weak antibacterial activity against *Acinetobacter baumannii* DURN. Ethanolic extract and fractions CRE01_06-10 showed significant cytotoxic activity on tumor cell lines SCCVII, FsaR and B16-F10. Crude ethanolic extract CRE and several fractions caused decrease in the CD signal of polynucleotides and the induced CD spectra (ICD) in the range 290-300 nm, indicating the interaction with studied polynucleotides (ctDNA, poly A - poly U). Based on the recorded spectra we concluded that the compounds from CRE extract and CRE01_05 and CRE01_06 fractions, bind to RNA and DNA. In further investigations, pure compounds isolated from extracts and fractions of *C. ragusina* could find their use in the prevention of diseases caused by free radicals, treatment of bacterial infections and in the treatment of tumors.

PHENOLIC PROFILES OF THE MOSSES *POLYTRICHUM FORMOSUM* AND *PHYSCOMITRELLA CALIFORNICA*

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The bryophytes are rich source of different compounds, such as terpens, phenols (phenolic acids, flavonoids and bibenzyl derivatives), glycosides and fatty acids. Bryophytes have been rarely used in folk medicine. The available data indicates interesting chemical constituents of some bryophyte species, i.e., active and new compounds are to be found within bryophytes, especially liverworts. Bryophytes are documented to contain significant amount of phenolic compounds. Phenolic compounds exhibit several biological activities such as anti-inflammatory, immune-stimulatory, antiviral, antifungal, anticancer, antioxidant and/or antibacterial. However, knowledge on the bryophyte chemistry remains limited due to the difficulties in identification and small amount of the same species available for analyses, demanding sophisticated methods. The aim of this study was to determine phenolic profiles of two mosses, namely *Polytrichum formosum* Hedw. and *Physcomitrella californica* H.A. Crum & L.E. Anderson. To achieve the enough clean and axenic material, *in vitro* cultures were established, culture conditions optimized, and propagated for chemical analyses. Simple, low-cost, high-performance thin-layer chromatography was used as a modern tool for determination of phenolic profile of bryophytes. According to HPTLC fingerprint, several different patterns were obtained. Thus, to identify characteristic phenolic markers, highly sophisticated Orbitrap MS-MS method was applied. Thirteen phenolic compounds were detected and quantified in investigated samples. Phenolic compounds such as gallic acid, caffeic acid, vanillin and aesculin were most abundant components in *P. formosum*. Additionally, moss species *P. californica* contained low amount of quantified phenolic compounds, and gentisic and cinnamic acid, found in *P. formosum* were not identified in sample *P. californica*.

Tema simpozija

Edukacija, promocija i strukovno djelovanje

Symposium topic

Education, promotion and progress in botany

ZELENE ULICE NAŠEG GRADA (FOTOHERBARIJ)

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Herbarij je zbirka osušenih biljnih primjeraka. Svrha izrade herbarija u nastavi je učenje kroz samostalan rad na terenu pri čemu učenici primjenjuju određene metode i znanja koja su obradili na nastavi biologije. Učenici tijekom školovanja izrađuju herbarij najmanje jednom - u osnovnoj školi (6. razred), a mnogi i u srednjoj školi.

Danas je digitalizacija prisutna u svim područjima života, tako i muzeji digitaliziraju svoje zbirke npr. herbarijske zbirke mogu se pronaći u digitalnom obliku.

Primjenjujući to u učionici, u našoj školi započeli smo izradu fotoherbarija, gdje učenici fotografiraju biljke koje rastu u njihovom susjedstvu. Na stranici škole otvoren je link pod nazivom *Zelene ulice našeg grada: fotoherbarij*, gdje učenici postavljaju fotografije samoniklog bilja koje raste na ulicama i u parkovima grada. Uz fotografiju nalazi se podatak o mjestu gdje je biljka fotografirana i datum nastanka fotografije. Za sada je naglasak na samoniklom jestivom i (ili) ljekovitom bilju. Na linku se nalazi i karta grada na kojoj se može vidjeti gdje je koja biljka fotografirana.

Premda fotoherbarij ne može u potpunosti zamijeniti herbarij, fotografija biljke može zadovoljiti većinu potreba nastave biologije. Kako bi se učenici ipak upoznali s herbarijskim primjercima u školi imamo herbarij koji koristimo u nastavi. Fotoherbarij se može koristiti za praćenje rasprostranjenosti pojedinih vrsta te određivanju uzroka promjena rasprostranjenosti na nekom prostoru. Učenike bi trebalo poticati na izradu fotoherbarija u prvom redu radi očuvanja bioraznolikosti.

THE GREEN STREETS OF OUR TOWN (PHOTOHERBARIUM)

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A herbarium is a collection of plant species. The purpose of making a herbarium is to provide a practical model for student based learning where pupils can apply methods and knowledge taught during biology lessons. Pupils make a herbarium at least once during their time in Elementary school (6th grade) and often do so again whilst in secondary school.
Digitized records are replacing physical records in all walks of life. This includes the herbarium which are now commonly seen in digitized form in museums.
Applying this to the classroom, pupils can record photographs of the plant species growing in their neighbourhood in a photographic collection called a photoherbarium. Contained within the metadata of the photograph is the precise location and time that the photograph was taken. At present, the project is concentrating on edible and medicinal plant species. The website, *The green streets of our town* contains a photoherbarium where pupils can upload photographs of wild plants that grow in the streets and parks of their city. Locations where plants have been found can be conveniently displayed on a map.
Although the photoherbarium cannot completely replace the herbarium as a record of plant species, the photographed specimens would often be satisfactory for teaching purposes. The photoherbarium is of wider benefit in documenting biodiversity and the distribution of plant species across a wider area. Students should be encouraged to make photoherbarium in order to keep biodiversity.

ZNANJA DJECE MLAĐE ŠKOLSKE DOBI O ZAŠTITI I UZGOJU ŠUMA

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Sve veća urbanizacija, klimatske i brojne druge promjene u okolišu naša su svakodnevnica. Stoga su spoznaje o ulozi i važnost šuma sve veće, a time i potreba za učenjem o šumskim ekosustavima. Ključni alat u prenošenju znanja o šumama i njihovoj važnosti je tzv. šumska pedagogija. Ova relativno mlada disciplina tek dobiva svoje mjesto u našim obrazovnim programima. Najrazvijenija je u skandinavskim zemljama te u Austriji, Njemačkoj i Švicarskoj. Namijenjena je prvenstveno djeci i mladima, a služi se raznim osjetilnim metodama (potpunijem doživljavanju šume putem zvukova, zatvorenih očiju, raspoznavanjem vrste drveća po kori, listu i češeru, praćenjem životinjskih tragova i savladavanjem neravnog šumskog terena), s ciljem doživljajnog učenja o važnosti šume i šumskih ekosustava. Primjenom šumske pedagogije djeca na edukativan i zabavan način uče i razvijaju odgovoran odnos prema šumskim zajednicama. Istraživanje o tome koliko djeca u istočnoj Slavoniji znaju o uzgoju i zaštiti šuma je provedeno pomoću kvalitativnog (strukturiranog) intervjua s učenicima, prije i poslije održanog integriranog Dana šuma i terenske nastave u šumi. Intervju je proveden s učenicima prvoga i četvrtoga razreda Osnovne škole Josipa Jurja Strossmayera iz Trnave, Osječko-baranjska županija. Rezultati intervjua prije provedenih aktivnosti vezanih uz šumski ekosustav ukazali su na nedovoljno znanje o uzgoju i zaštiti šuma, dok su rezultati nakon provedenih edukativnih aktivnosti bili statistički značajno bolji. Ukupno su učenici 1. i 4. razreda nakon održanog integriranog dana i provedene terenske nastave u šumi dali 96% točnih i 4% netočnih odgovora o uzgoju i zaštiti šuma, za razliku od intervjua prije održanih aktivnosti kada su dali svega 56% točnih i čak 44% netočnih odgovora. Ovim istraživanjem potvrđeno je da su znanja djece mlađe školske dobi o uzgoju i zaštiti šume nedostatna te da bi se sadržaji o šumskim ekosustavima češće trebali obrađivati i to od početka školovanja, a kako bi učenici proširili svoj spektar znanja te bili odgajani za ekološko prihvatljiv način života. Spoznavši ovaj problem i zbog rastućeg interesa za šumskom pedagogijom, Hrvatske šume d.o.o pripremile su projekt pod nazivom „Šuma u školi, škola u šumi“ koji je započet tijekom 2013. godine i provodi se i danas. Svrha mu je djeci predškolske dobi i učenicima osnovnih škola na interdisciplinaran način približiti šumu, život u šumi i važnost gospodarenja šumama. Projekt se provodi u suradnji dječjih vrtića i osnovnih škola s ekološkim odjelima pojedinih podružnica Hrvatskih šuma. Ovako sustavno organizirana edukacija povećava svijest djece o važnosti šuma i potrebi njihova očuvanja, a istovremeno promiče ugled šumarstva kao struke i znanosti (http://portal.hrsume.hr/index.php/hr/turizam/kola-u-umi).

YOUNGER SCHOOLCHILDREN'S KNOWLEDGE ABOUT FOREST PROTECTION AND CULTIVATION

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Increasing urbanization, climate and other changes in the environment, have become part of our everyday life. Consequently, knowledge about the role and importance of forests is growing as well as the need for learning about forest ecosystems. A key tool in transferring knowledge about forests and their importance is the forest pedagogy. This relatively young discipline is still getting its place in our educational programs. It is the most developed in the Scandinavian countries and in Austria, Germany and Switzerland. It is intended primarily for children and adolescents. It uses a variety of sensory-based learning methods using own experience (a more complete experience of the forest through sounds, with eyes closed, recognising trees by bark, leaves and cones, by following animal tracks and overcoming rugged forest terrain) with the purpose to achieve an experience based learning about the importance of forests and their ecosystems. With the use of such forest pedagogy practice children acquire and develop, in an educational and joyful way, a responsible attitude towards forest communities. A research was conducted to determine how much children in Eastern Slavonia know about the forest protection and cultivation. In this research, qualitative (structured) interviews with school children were used, before and after an integrated day named “Forest and Outdoor Education in the Forest”. The interview was conducted with the first and the fourth grade children of the Josip Juraj Strossmayer Primary School in Trnava, Osijek-Baranja County. The results of interviews which had been conducted before the forest ecosystem activities indicated a lack of knowledge about forest protection and cultivation. Yet, the obtained results after the implementation of educational activities were statistically significantly better. All interviewed pupils of the first and the fourth grade who participated in the integrated out school education activity in the forest gave 96% of correct and only 4% of incorrect answers, as opposed to the interview held before the mentioned activity when they gave only 56% of correct, and even 44% of incorrect answers. This study confirmed that the knowledge of younger school age children on the forest protection and cultivation is insufficient and that the topics related to forest ecosystems should be more frequently introduced from the very beginning in the primary education, so that children can expand their knowledge and get an education supporting environmentally acceptable way of life. Having realised this problem, and due to the growing interest in Forest Pedagogy, the Croatian Forests prepared a project called "School in Forest & Forest in School" the implementation of which began in 2013 and is carried out to date. It is intended for preschool and primary school children, to bring them to forests, bring them closer to the life in forests and to learn about the importance of forest management in an

interdisciplinary way. The project is implemented in cooperation with kindergartens, primary schools and several Ecology Department branches of the Croatian Forests. This systematically organized education increases the awareness of children about the importance of forests and the need for their preservation, while promoting the forestry as a profession and science (http://portal.hrsume.hr/index.php/hr/turizam/kola-u-umi).

MEĐUNARODNA GODINA MAHUNARKI – EDUKACIJA UČENIKA OSNOVNE ŠKOLE

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Organizacija za prehranu i poljoprivredu UN-a (FAO) proglasila je 2016. međunarodnom godinom mahunarki u namjeri da se podigne svijest o svojstvima i dobrobitima prehrane bogate mahunarkama te potakne njihova konzumacija i proizvodnja. Porodica mahunarki agrikulturno je najznačajnija porodica sjemenjača, izuzev porodice trava, a njihove sjemenke i plodovi imaju veliku hranjivu vrijednost te su važni u prehrani ljudi i brojnih životinja. Od otprilike 18000 kozmopolitski rasprostranjenih vrsta unutar te porodice, u Hrvatskoj ih raste 465. S obzirom na navedeno, autori su prikazali obrađene nastavne jedinice koje obuhvaćaju gradivo biljke cvjetnjače u petom razredu osnovne škole na primjerima biljaka iz porodice Fabaceae. Osmišljene su različite varijante pokusa te su na primjerima raznih vrsta mahunarki obrađene sve nastavne jedinice: građa sjemenke, uvjeti klijanja, pokusi bubrenja sjemenki, kapilarnosti, transpiracije, oblik i građa lista, vrste stabljika, pokusi dokazivanja kloroplasta, fotosinteza, građa cvijeta i cvata te njegova uloga u spolnom razmnožavanju biljke cvjetnjače, oprašivanje, plodovi i njihovo rasprostranjivanje. Prilikom učenja građe korijena, napravljen je osvrt na mutualizam s dušikovim bakterijama koje poboljšavaju plodnost tla (zelena gnojidba). Na taj način obilježili smo godinu mahunarki i približili učenicima svijet ove značajne porodice.

INTERNATIONAL YEAR OF PULSES – EDUCATION OF PRIMARY SCHOOL PUPILS

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The Food and Agriculture Organization of the United Nations (FAO) declared 2016. the International Year of Pulses with an aim to heighten public awareness about traits and wellbeing of the nutritional benefits of pulses and to encourage their consumption and production. Family of Leguminosae (Fabaceae) is agriculturally most important family of seed plants, with an exception of grass family (Poaceae). Their seeds and fruits have high nutritional value and are very important in nutrition of humans and animals. From 18000 cosmopolitan widespread species within this family, 465 are spread in Croatia. Considering specified, authors have shown teaching units which include learning about flowering plants in fifth grade of primary school on examples of plants from family Fabaceae. Different experiments were designed and on example of pulses all teaching units were processed: seed structure, conditions of germination, experiment of seed swelling, capillarity, transpiration, form and structure of leaf, different stem structures, experiment of proving chloroplasts, photosynthesis, structure of flower and inflorescence, so as their role in sexual reproduction of flowering plants, pollination, fruits and their dispersal. While learning about root structure, there was made a review on symbiosis with certain types of bacteria which improve soil fertility (green fertilization). In this way, we marked a year of legumes and shown to pupils the world of this important family.

UČENIČKI PROJEKT "PROLJETNICE MOG ZAVIČAJA"

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Učenici 7. razreda OŠ obrađuju nastavne sadržaje botanike vezane uz biologiju stablašica. Kako bi se učenicima, kroz istraživački usmjerenu nastavu, što više približili ovi nastavni sadržaji i razvio pozitivan stav prema zaštiti biljaka u OŠ Bogumila Tonija Samobor i OŠ Ivane Brlić-Mažuranić Virovitica proveden je projekt "Proljetnice mog zavičaja". Cilj projekta je unaprjeđivanje kvalitete nastavnog procesa i uspostavljanje aktivnijeg sudjelovanja učenika u usvajanju nastavnih sadržaja botanike. Učenici su tijekom provođenja projekta upućeni na promatranje proljetnice u svom okolišu. Vodili su opažanja o vrsti proljetnica, vremenu njihova pojavljivanja, staništu, ugroženosti te jesu li su samonikle ili su presađene iz prirode. Rezultati njihovih opažanja prikupljeni su metodom ankete. Anketom je obuhvaćeno 45 učenika 7. razreda OŠ Bogumila Tonija Samobor i 45 učenika OŠ Ivane Brlić-Mažuranić Virovitica, a promatranje je provedeno od veljače do travnja 2016. godine. Učenici obje škole zabilježili su i promatrali visibabu - *Galanthus nivalis* L., jaglac - *Primula vulgaris* Huds. i mirisnu ljubičicu - *Viola odorata* L.. Samoborski učenici još su zabilježili velecvjetni kukurijek - *Helleborus niger ssp. macrantus* (Freyn) Schiffn., šafran - *Crocus sativus* L. i žabljak ljutić -*Ranunculus acris* L., a virovitički učenici zlaticu - *Ranunculus ficaria* L. i dvije vrste šumarica: bijela šumarica - *Anemone nemorosa* L. i žuta šumarica - *Anemone ranunculoides* L. Proljetnice su u oba grada najviše zastupljene na travnjacima (50% u Virovitici i 47% u Samoboru). Učenici smatraju kako su vrste najviše ugrožene košnjom (30% u Virovitici, 21% u Samoboru), prometom (9% u Virovitici i 7% u Samoboru) te smanjivanjem površina nakon rekonstrukcije ulica (7% u Virovitici i 5% u Samoboru). Većina proljetnica u Virovitici dolaze na zelenim površinama u većem dijelu grada budući da su prije presađene iz prirodnih staništa. Proljetnice su u Samoboru više zastupljene u brežuljkastom dijelu grada gdje su samonikle. Rezultati projekta prezentirani su učenicima obje škole te su učenici izradili grafikone i tablice pomoću kojih su usporedili proljetnice virovitičkog i samoborskog kraja.

STUDENT PROJECT "SPRING FLOWERS OF MY HOMETOWN"

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Educational program of the 7th grade elementary school students includes botanical topics related to cormophyta biology. To familiarize them with this subject through research oriented learning process and develop positive attitude towards plants protection a project "Spring Flowers of my Hometown" was carried out in Croatian elementary schools “OŠ Bogumila Tonija”, from Samobor and “OŠ Ivane Brlić-Mažuranić” from Virovitica. The goal of the project was to improve quality of the educational process and to initiate active participation of students in biology class. During the project the students were prompted, to monitor spring flowers in their surroundings. They recorded species of spring flower, time of their occurrence, habitat and threat as well as whether they are wildflowers or taken from nature and cultivated. Their observations were collected by a polling method. The poll included 45 students of 7th grade of the “OŠ Bogumila Tonija” Samobor and 45 students of the “OŠ Ivane Brlić-Mažuranić Virovitica”. The observations were carried out from February to April of 2016. The students of both schools recorded Snowdrop *(Galanthus nivalis* L.*)*, Primrose (*Primula vulgaris* Huds.) and Wood Violet *(Viola odorata* L.*).* Samobor students have additionally recorded Christmas Rose (*Helleborus niger ssp. macranthus* (Freyn) Schiffn), Crocus *(Crocus sativus L.)* and Meadow Buttercup *(Ranunculus acris* L.*)* while Virovitica students have in addition recorded Lesser Celandine (*Ranunculus ficaria* L.) as well as two species of Anemone, European Wood Anemone *(Anemone nemorosa* L.*)* and Yellow Woodland Anemone *(Anemone ranunculoides* L.*).* In both towns spring flowers were mostly present on grassland (50% in Virovitica and 47% in Samobor). Students estimated that plants are mostly threatened by mowing (30% in Virovitica, 21% in Samobor), traffic (9% in Virovitica and 7% in Samobor) decrease of area due to constructions of streets (7% in Virovitica and 5% in Samobor). In the major part of the city of Virovitica spring flowers occur on the green surfaces and they were replanted from natural habitats. Spring flowers in Samobor are more present in hilly part of the town where they grow as wildflowers. The project results were presented in the classrooms of both schools and student created diagrams and tables which served as a basis for the comparison of the spring flowers in the Virovitica and Samobor area.

UTJECAJ EKSPERIMENTALNOGA RADA NA SMANJENJE MISKONCEPCIJA UČENIKA U NASTAVI PRIRODE I DRUŠTVA

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Pojmom miskoncepcije obuhvaćaju se sve predodžbe učenika koje nisu u suglasju sa znanstvenim spoznajama, a mogu nastati tijekom nastavnog procesa ili postojati od ranije. Izuzetno je bitno da učitelji razredne i predmetne nastave budu svjesni postojanja učeničkih miskoncepata te da budu kompetentni za oblikovanje i provođenje različitih praktičnih aktivnosti koje će pomoći učenicima u razumijevanju traženih koncepata. Učitelji biologije često uočavaju brojne pogrešne koncepcije koje korijen imaju u razrednoj nastavi, a posebno velik broj miskoncepcija je vezan uz biljke. Stoga je neophodno s učenicima razredne nastave raditi tehnikama aktivnog učenja i koristiti istraživačko učenje koje brojni autori ističu kao najučinkovitije za prevladavanje miskoncepcija.

Sa svrhom utvrđivanja koliki utjecaj ima eksperimentalni rad u nastavi prirode i društva na smanjenje miskoncepcija vezanih uz proces klijanja sjemenke, provedeno je istraživanje na uzorku od 104 učenika četvrtih razreda osnovne škole i 98 učenika petih razreda osnovne škole. Kako su miskoncepcije vezane za proces klijanja sjemenke bile utvrđene kod učenika petoga razreda krenulo se u istraživanje postojanja tih miskoncepcija kod mlađih učenika. Učenici 4. razreda su predtestom bili podijeljeni na eksperimentalnu i kontrolnu skupinu. S eksperimentalnom skupinom su se radili eksperimenti vezani uz proces klijanja sjemenke i rast biljke. Učenici su nakon obrade nastavne teme *Život biljke* pisali pisanu provjeru znanja kojom se provjeravalo konceptualno razumijevanje procesa klijanja sjemenke. Učenici eksperimentalne skupine su bili uspješniji i pokazali su bolje razumijevanje procesa klijanja. Rezultati rada mogu biti poticaj učiteljima razredne i predmetne nastave pri planiranju eksperimentalnog rada kao oblika aktivnog učenja, kojim će se doprinijeti sprječavanju nastajanja miskoncepcija vezanih uz život biljke.

THE IMPACT OF EXPERIMENTAL WORK IN REDUCING STUDENTS' MISCONCEPTIONS IN TEACHING SCIENCE

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The notion of misconception includes all the pupils' ideas that are not in harmony with a scientific knowledge, and which can occur during the teaching process or can exist from before. It is extremely important that entry level teachers, as well as subject teachers, are aware of pupils' misconceptions and are competent in the design and implementation of various practical activities that will help pupils understand the concepts required. Biology teachers often notice many misconceptions which are rooted in entry level class teaching, with a particularly large number of misconceptions related to plants. It is therefore necessary to use active learning techniques and research learning with entry level pupils, as many authors point out to be the most effective way of overcoming misconceptions.

In order to determine what impact the experimental work in teaching science and society at reducing misunderstandings related to the process of sprouting seeds has, a research was conducted on a sample of 104 elementary school fourth graders and 98 fifth graders. As the misconceptions related to the process of germination of the seeds were detected among the fifth graders, the investigation of the existence of such misconceptions among younger pupils started. The fourth graders were divided into an experimental and a control group using a pre-test. The experimental group was doing experiments related to the process of seeds' germination and plants' growth. The pupils had to write a test after the presentation of the teaching topic *A Plant's Life,* which evaluated the conceptual understanding of the processes of seeds' germination. The pupils from the experimental group were more successful and showed a better understanding of the germination process. The work results of can be an incentive for entry level teachers, as well as subject teachers, in planning experimental work as a form of active learning, which will help prevent the emergence of misconceptions related to the plant's life.

UČENIČKI MINI PROJEKT: INVAZIVNE BILJNE VRSTE U ŠIROJ OKOLICI ŠKOLE

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U sklopu dodatne nastave iz biologije u 8. razredu 2014./2015. godine proveden je mini projekt u kojem su istražene invazivne biljne vrste u široj okolici naše škole. Tijekom projekta učenici su naučili koristiti GPS-uređaj, stručnu literaturu i on-line bazu podataka, kao i prepoznavati različite tipove staništa te bilježiti i analizirati dobivene podatke. Nakon završetka projekta izradili su prezentaciju te su predstavili svoj projekt na Županijskom natjecanju mladih biologa. Projektom je zabilježeno ukupno 20 invazivnih biljnih vrsta u široj okolici škole. Analizama je utvrđeno da su najdominantnije porodice glavočike (Asteraceae) sa 7 vrsta (35%), te porodice trave (Poaceae) i pomoćnice (Solanaceae) s po dvije vrste (10,0%). Podrijetlo im je uglavnom iz Amerike, 14 vrsta (70,0%), a u nešto manjem postotku na naše su područje pristigle iz Azije, 6 vrsta (30,0%). Kao najčešći način rasprostranjivanja plodova i sjemenki koriste vjetar (anemohorno) sa 7 vrsta (35,0%), u nešto manjem postotku koriste samostalno rasprostranjivanje (autohorno) te rasprostranjivanje životinjama (zoohorno) s po 5 vrsta (10,0%). U široj okolici naše škole smjestile su se na 10 tipova staništa, na kojima su zabilježene s ukupno 206 nalaza. Najraširenij tip staništa koje zauzimaju invazivne biljke su kuće sa stražnjim vrtovima, 110 nalaza (53,3%), slijede ih dvorišta i prednji kućni vrtovi, 31 nalaz (15,0%) te stambeni blokovi rubnog, otvorenog tipa, 25 nalaza (12,1%).
Sve zabilježene vrste pokazuju neke oblike negativnog djelovanja na okoliš ili zdravlje ljudi, (mijenjaju staništa, korovne su, otrovne ili alergene), a za njih 12 (60.0%) gotovo da ne postoji mogućnost uspješne kontrole na staništu. Ovaj mini projekt osvijestio je kod učenika postojanje ekološke problematike invazivnih vrsta u njima poznatoj i bliskoj okolici škole.

PUPILS' MINI PROJECT: INVASIVE PLANTS IN THE SURROUNDING AREA OF OUR SCHOOL

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As a part of extra-curricular biology classes, 8th- grade pupils did a mini project on invasive plants in the surrounding area of our school during the school year 2014/2015. Throughout the project pupils learnt how to use GPS device, scientific literature and on-line data base, as well as to recognize different habitats, log the data and analyse it. Their project was presented at County Competition of Young Biologists. The project presented 20 invasive plants spotted in the school surrounding area. The analyses established that the most dominant were daisy family (Asteraceae) with 7 species (35%), grass family (Poaceae) and nightshades (Solanaceae) with two species each (10.0%). The plants are mainly of American origins, 14 species (70.0%), in somewhat lower percentage there are those originating from Asia, 6 species (30.0%). The most common way of seed dissemination is wind dispersal (anemochory) which occurs at 7 species (35.0%), ballistic dispersal (autochory) occurs at a bit lower percentage and dispersal by animals (epizoochory) occurs at 5 species (10.0%). There are 10 habitat types in the surrounding area of our school marked with 206 findings. The most common habitat type covered by invasive plants are houses with backyards, 110 findings (53.3%); followed by those in front yards and gardens, 31 findings (15.0%); as well as open-type buildings at the edges, 25 findings (12.1%).
Negative effects on environment and human health of all these invasive plants have been noticed (they change habitat, are weed type plants, poisonous and allergen). Furthermore, there is almost no efficient way to control 12 plants (60.0%). The mini-project has made pupils aware of the existence of ecological issue of invasive plants in an area they are familiar with.

Tema simpozija

Flora, ekologija, vegetacija i biogeografija

Symposium topic

Flora, ecology, vegetation and biogeography

THE TERTIARY RELICT SPECIES *OSTRYA CARPINIFOLIA* SCOP. AND *PINUS NIGRA* ARNOLD ON MT FALAKRON, NORTH-EASTERN GREECE

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Mt Falakron (2232 m) is situated between Mt Rhodope and Aegean Sea, North-Eastern Greece. Basic rocks are predominantly calcareous (marbles) and soils are predominantly rendzinas. Dominating calcareous terrain is reason for especially rich flora. The climate is Transitional Mediterranean. North slopes are affected by the Temperate Continental climate, while the south slopes are affected by the Mediterranean climate. This climate mixture as calcareous base rock are a precondition for especially plant and habitat diversity. Mt Falakron can be considered as a natural museum, bringing together a lot of endemics, protected and relict plants with narrow ecological niche, which is an indication of the great conservation importance.

Ostrya carpinifolia on Mt Falakron are presented by groups of trees. They are situated on the ridge with south, west and east exposure on the south slopes, down from Apokrirono peak and up from Pyrgi village, on 1200-1300 m, on a slope with inclination 35-45°, on the black pine forest border. The age of the trees is different. Separate trees have 1 m diameter. Obviously this fragment is a remaining from a vast relict forest, destroyed by the people.

Pinus nigra takes part in relict forest situated on the west mountain parts mainly on the south slopes, but also on the north slopes of Koritsomagoula and Choros peaks from 1270 to 1650 m, where make an upper forest border. The age of the trees is different. Separate trees remaining from the old relict forest have 2 m diameter, but more trees have 30-50 cm diameter.

FLOODED FORESTS AS A TOOL FOR RESTORATION OF COASTAL AREA OF MINE PIT LAKES IN BOSNIA AND HERZEGOVINA

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Mine pit lakes, which are at a later stage of succession, have a well developed coastal vegetation. The most complex type of this vegetation are flooded forests, developed on hydromorphic soils. With the aim of analysing the diversity of the flooded forests, phytosociological survey was performed in the coastal area of 14 mine pit lakes in the territory of Bosnia and Herzegovina. The field research for this paper was carried out in 2014 (July-August). The standard method of phytosociological survey of the Zürich-Montpellier school was used (Braun-Blanquet, 1964). This method identified abiotic components of the ecosystem and floristic composition of the communities. A degree of diversity was identified within the researched communities (Shannon Index). The multivariate statistical analysis was performed by using the software package PRIMER v6. In the coastal area of the researched mine pit lakes, communities of flooded forests were identified with dominant species of *Alnus glutionsa*, *Populus alba* and *Salix alba*. Within the *Alnetea glutinosae* class, 74 plant species were identified, and within the *Populetalia albae* order Br.-Bl. 1931, 128 plant species were identified. The objective of the paper is to analyse the diversity of macrophytes within the vegetation of the flooded forests, as well as factors leading to the development of the vegetation type on the degraded surfaces of the coastal area of the mine pit lakes. The progradation of the wetland vegetation in the coastal area of these lakes provides the potential for systematic restoration. The most important factors leading to colonisation and development of the wetland vegetation in the coastal area are the inclination in the coastal area, type of geological substrate and soil, and formation method of the mine pit lake. The flooded forests provide numerous ecosystem services, and in the sustainable management and biodiversity protection system they should have a complete priority. Since the vegetation of the flooded forests here is a result of anthropogenic activities, it is necessary to plan actions for their fast progradation with the aim of preserving the wetland biodiversity and developed ecosystem services.

EFFECT OF HEAVY METALS ON PHYTOBENTHOS IN MINE PIT LAKES OF BOSNIA AND HERZEGOVINA

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Mine pit lakes are a specific type of water accumulations, formed after a drainage or exploitation process, by water filling the remaining crater or damming a watercourse with overburden material. Mine pit lakes may also be formed through subsidence after underground exploitation.

Due to nature of their formation, these lakes may contain various heavy metals that might have an adverse effect, even in small quantities, on diversity of phytobenthos. The primary effect of heavy metals on the algae is maintained on biochemical and physiological level, whereupon changes occur on ecological level. Adverse effect first cause reduction of biomass, and then reduction of diversity (Kalinowska et al., 2002).

Field research for this paper was performed during the autumn season in 2004, at six mine pit lakes in the territory of Bosnia and Herzegovina. The following heavy metals were analysed: Al, Cr, Zn, Ni and Fe. The research was based on collection of samples of cyanobacteria and algae, in line with the methodology in compliance with the standards of the European Union Water Framework Directive (WFD, 200/60/EC). The determination of cyanobacteria and algae was performed in accordance with: Hofman et al., 2013, Krammer, 2000, 2002, 2003, John et al., 2003, Lange-Bertalot, 2001, Krammer and Lange-Bertalot, 1986-1991. With the aim of analysing diversity of cyanobacteria and algae at the researched mine pit lakes, diversity within the researched samples was observed (Shannon Index). The multivariate statistical analysis was performed by using the software package PRIMER v6. The cluster and PCO analyses were used to analyse the phytobenthos composition under different ecological conditions. The objective of the paper is the analysis of the cyanobacteria and algae content in the mine pit lakes and effects of certain heavy metals on diversity of this group of organisms. The results were discussed in terms of confirmation / rejection of the hypothesis on the adverse effect of heavy metals on diversity of algae and potential for use of these water bodies in activities for conservation of wetland biodiversity.

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Herbarij ZAGR jedna je od najmlađe registriranih herbarijskih zbirki u Hrvatskoj i kao takva sastavni je dio Zavoda za poljoprivrednu botaniku Agronomskog fakulteta u Zagrebu (Hrvatska). Trenutno se procjenjuje da zbirka sadrži od 7.500 do 10.000 herbarijskih listova vaskularnih biljaka koje potječu iz mediteranskog dijela Hrvatske, Balkanskog poluotoka i ostalih područja Mediterana. U ovom trenutku ZAGR zbirka sadrži 1.275 biljnih svojti što pokriva 25% hrvatske nacionalne flore. Porodice koje su zastupljene s najvećim udjelom herbarijskih primjeraka su *Poaceae*, *Fabaceae* i *Asteraceae*. Od značajne važnosti u ZAGR zbirci je 26 tipskih primjeraka relativno nedavno opisanih novih vrsta za znanost iz Hrvatske, Albanije i Grčke. Osim toga, u ZAGR herbariju veliku važnost imaju primjerci rijetkih i endemičnih biljaka (435 herbarijskih listova) od kojih su 101 endemična svojta što čini 26% cjelokupnog broja poznatih hrvatskih endemičnih svojti. Osim toga, u zbirci su pohranjena i 1.254 herbarijska lista korovnih svojti i 31 invazivna vrsta. ZAGR zbirka sadrži preko 100 herbarijskih listova različitih primjeraka značajnih poljoprivrednih tradicionalnih i modernih kultivara rodova *Malus*, *Prunus*, *Pyrus*, *Vitis*, *Olea* i *Triticum*. Do sada je digitalizirano ukupno 1.655 herbarijskih listova koji su u cijelosti dostupni preko internetske baze podataka ZAGR Virtualni Herbarij http://herbarium.agr.hr/.

AN OVERVIEW OF ZAGR HERBARIUM OF THE FACULTY OF AGRICULTURE IN ZAGREB (CROATIA)

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ZAGR herbarium is one of the youngest registered herbaria in Croatia and it is a part of the Department of Agricultural Botany of the Faculty of Agriculture in Zagreb (Croatia). Currently the collection has estimated from 7.500 to 10.000 herbarium sheets of vascular plants from the Mediterranean part of Croatia, Balkan Peninsula and other Mediterranean areas. At the moment, the ZAGR collection has 1275 plant taxa that cover 25% of Croatian national flora. The families with the largest number of herbarium specimens are *Poaceae*, *Fabaceae* and *Asteraceae*. The particular interests of ZAGR collection are 26 type specimens of recently described new taxa to science from Croatia, Albania and Greece. The most important value in ZAGR herbarium are specimens of rare and endemic plants (435 herbarium sheets) out of which 101 belong to endemic taxa that are 26% of total recorded Croatian endemic taxa. In total 1254 sheets of weed taxa and 31 invasive species are stored in herbarium. The collection contains more than 100 sheets of different specimens of agricultural important traditional and modern cultivars of genera *Malus*, *Prunus*, *Pyrus*, *Vitis*, *Olea* and *Triticum*. Till now a total of 1655 herbarium sheets are digitalised and completely accessible online throughout ZAGR Virtual Herbarium database http://herbarium.agr.hr/.

URBANA FLORA VARAŽDINA

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Istraživanje flore grada Varaždina provedeno je tijekom četiri vegetacijske sezone (2012.-2015.) i predstavlja prvo sustavno istraživanje urbane flore ovoga grada. Ukupno je zabilježeno 758 svojti iz 111 različitih porodica. Najzastupljenije porodice su *Poaceae* (10,16%), *Asteraceae* (7,52%) i *Fabaceae* (5,67%). Među životnim oblicima dominiraju hemikriptofiti (43,21%), a među horološkim tipovima ističu se biljke euroazijskog flornog elementa (33,11%). Alohtonu floru Varaždina čini 140 svojti (18,47%), od čega je 41 svojta invazivna (5,40%). Na Crvenoj listi nalaze se 33 svojte (4,35%), a 19 svojti (2,51%) pod strogom je zakonskom zaštitom. Usporedba dobivenih podataka s podacima dobivenim istraživanjem flora ostalih gradova u Hrvatskoj pokazuje veliku podudarnost u zastupljenosti najvažnijih porodica, no udio alohtonih svojti u flori grada Varaždina puno je manji u odnosu na grad Zadar ili Šibenik te općenito na gradove srednje Europe. Uočena je i razlika u spektru životnih oblika koja se objašnjava manjim antropogenim utjecajem u odnosu na srednjeeuropske gradove, a u odnosu na dosad istraživane hrvatske gradove i različitim tipom klime. Različiti geografski smještaj hrvatskih gradova posljedica je i razlike u zastupljenosti horoloških tipova. Međutim, udio kultiviranih i adventivnih svojti u Varaždinu i ostalim dosad istraživanim hrvatskim gradovima je sličan. Dobiveni podaci ukazuju da unatoč izloženosti dugotrajnom i snažnom antropogenom utjecaju, flora Varaždina još se uvijek razvija pod prevladavajućim djelovanjem klimatskih prilika.

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The study of flora of the city of Varaždin was conducted over four vegetation seasons (2012-2015) and it represents the first systematic study of urban flora of this city. A total of 758 species from 111 different families were recorded. The most represented families are Poaceae (10.16%), Asteraceae (7.52%) and Fabaceae (5.67%). Among the life forms hemicryptophytes are dominant (43.21%), and among chorological types plants of Eurasian floral element stand out (33.11%). Non-indigenous flora of Varaždin is made up of 140 taxa (18.47%), of which 41 species are invasive (5.40%). On the Red List there are 33 species (4.35%), and 19 species (2.51%) are under strict legal protection. Comparison of the data obtained from the data gathered while exploring the flora of other towns in Croatia shows a great coincidence in the representation of the most important families, whereas the proportion of non-indigenous species in the flora of the city of Varaždin is much lower than in the city of Zadar and Šibenik, and the cities of Central Europe in general. There was a difference in the spectrum of life forms which is explained by the low human impact compared to Central European cities, and in relation to the previously studied Croatian cities and different types of climate. Different geographic location of Croatian cities is a consequence of the differences in chorological types in which we have observed a great similarity in the presence of cultivated and adventitious plants. The obtained data indicate that despite the prolonged exposure and strong anthropogenic impact, the flora of Varaždin is still evolving under the action of the prevailing climatic conditions.

INVENTARIZACIJA I KARTIRANJE VASKULARNE FLORE SPOMEN-PARKA DOTRŠČINA

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Spomen-park Dotrščina je područje pokriveno šumskom vegetacijom smješteno na jugoistočnim obroncima Medvednice, oko 6.5 km sjeveroistočno od centra grada Zagreba. Površina područja iznosi oko 5 km² i nalazi se na prosječnoj nadmorskoj visini od 250 m. Iako je unutar gradskog područja, Dotrščina dosad nije floristički istražena. S obzirom na to da se može očekivati znatan udio urbane bioraznolikosti, provedena je inventarizacija i kartiranje vaskularne flore tijekom vegetacijske sezone 2016. godine. Kartiranje je obavljeno direktnom metodom (uz pomoć navigacijskog uređaja) i indirektnom metodom (upotrebom standardne srednjoeuropske mreže za kartiranje flore približne rezolucije MTB 1/64). Određen je udio porodica i udio endemičnih, ugroženih, zaštićenih i invazivnih svojti te su analizirani životni oblici i florni elementi. S obzirom na parkovnu ulogu područja i sadržani rasadnik hortikulturnog bilja, na terenu su zabilježene i brojne kultivirane svojte. Dobiveni rezultati prilog su poznavanju urbane flore grada Zagreba i atlasu flore Hrvatske.

VASCULAR FLORA INVENTARISATION AND MAPPING IN DOTRŠČINA MEMORIAL PARK

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Memorial park Dotrščina is an area covered with forest vegetation located southeast of Medvednica Mt, approximately 6.5 km from the centre of Zagreb. The approximate surface area of the memorial park is 5 km^2 and it is elevated 250 m above sea level. Although Dotrščina is a part of Zagreb city, it has not been botanically explored yet. Since a significant part of urban biodiversity was expected, inventorying and mapping of vascular plant species was conducted during the growing season of 2016. Mapping was conducted via direct (using a navigation device) and indirect method (using the standard Middle-European grid for plant mapping with MTB 1/64 resolution). The proportions of endemic, endangered, protected and invasive species were determined, as well as the proportions of plant families. Plant life-forms and floral elements were analyzed. Since the whole area is used as a park and part of it is used as a horticultural nursery, some species belong to cultivated plants. The collected data is an addition to the urban flora of Zagreb and the atlas of Croatian flora.

FLORISTIČKI SASTAV SASTOJINA BRNISTRE (*SPARTIUM JUNCEUM*) NA FLIŠU (JUŽNA HRVATSKA)

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Brnistra, *Spartium junceum* L. (Fabaceae), je višegodišnja grmolika biljka rasprostranjena na području Mediterana i jugozapadne Europe. Prema Nacionalnoj klasifikaciji staništa Republike Hrvatske, sastojine brnistre (*Spartium junceum*) na flišnoj podlozi (D.3.3.) pripadaju mediteranskim šikarama (D.3.) Floristički sastav ovih sastojina u Hrvatskoj je potpuno nepoznat. Cilj ovog rada bio je istražiti floristički sastav sastojina brnistre na flišnoj podlozi na području Župe dubrovačke. Župa dubrovačka ima površinu od 22,81 km² (visinski raspon od 0 do 628 m) i 8460 stalnih stanovnika. Istraživanje je provedeno tijekom 2016. godine, koristeći standardnu fitocenološku metodu (Braun Blanquet 1964). Površina pojedine fitocenološke snimke iznosila je 50 m^2. Nomenklatura biljnih svojti usklađena je prema *Flora Europaea* (Tutin i sur. 1964 - 1980, 1993). Sastojine brnistre razvijaju se kao niske (2 - 4 m), guste, neprohodne grmolike formacije, najčešće izložene južnim ekspozicijama. Opća pokrovnost je 80 - 100%. Ove sastojine su pod značajnim antropogenim utjecajem (požari, sječa, ispaša, urbanizacija). Zauzimaju velike površine, često uz povremene ili stalne vodotoke i imaju relativno mali broj vrsta. U sastojinama dominira brnistra, a brijestolisna kupina (*Rubus ulmifolius* Schott) je vrsta s velikom pokrovnošću i učestalošću. Neke od svojti s najvećom učestalošću su: *Arundo plinii* Turra, *Psoralea bituminosa* L., *Dactylis glomerata* L. ssp. *hispanica* (Roth) Nyman itd. Prizemni sloj je izuzetno siromašan vrstama zbog nedostatka svjetla. U radu su prikazani prvi detaljni podatci o floističkom sastavu sastojina brnistre na istočnoj obali Jadrana. Iako ove sastojine u istraživanom području nemaju posebnu ekonomsku vrijednost, njihova uloga više je zaštitna (npr. sprječava eroziju) te doprinosi estetskoj vrijednosti krajobraza.

THE FLORISTIC COMPOSITION OF THE *SPARTIUM JUNCEUM*-STANDS ON THE FLYSCH (SOUTH CROATIA)

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Spartium junceum L. (Fabaceae), commonly known as Spanish broom, is a perennial shrub, native to the Mediterranean region and south-western Europe. According to the Croatian National Habitat Classification, stands with *Spartium junceum* on a flysch substrate (D.3.3) are classified as Mediterranean thickets (D.3). The floristic composition of these stands in Croatia is completely unknown. The aim of this study was to investigate floristic composition of stands with *Spartium junceum* on a flysch substrate in the Župa dubrovačka region. Župa dubrovačka has a surface area of 22.81 km² (altitude ranging from 0 to 628 m a.s.l.) and a population of 8460 people. The research was carried out during 2016 using the Braun Blanquet (1964) approach. The plot size was set at 50 m^2. Nomenclature of plant taxa follows *Flora Europaea* (Tutin et al. 1964-1980, 1993). The *Spartium junceum*-stands are developed as low (2-4 m), dense, impenetrable shrub formation, mostly on southern expositions with the cover of 80-100%. These stands are under significant anthropogenic influence (fires, cutting, grazing, urbanisation). They occupy large areas, often with temporary or permanent watercourses and include a relatively small number of species. These stands are characterized by the dominance of *Spartium junceum.* Among other species, elmleaf blackberry (*Rubus ulmifolius* Schott) has a relatively high cover and frequency. Some of the most frequent taxa were: *Arundo plinii* Turra, *Psoralea bituminosa* L. *Dactylis glomerata* L. ssp. *hispanica* (Roth) Nyman etc. The ground layer is extremely poor in species, due to strong shading. This study presents the first detailed data on floral composition of the stands with *Spartium junceum* on the eastern Adriatic coast. Although *Spartium junceum* stands do not have economic value in the study area, their role in local ecology (e.g. to prevent soil erosion) and the aesthetics of landscape seems to be important.

ŠTO NAM PELUDNA ZRNCA I SPORE BILJKA MOGU REĆI O FLORISTIČKOJ RAZNOLIKOSTI – PRELIMINARNI REZULTATI S PODRUČJA BLATUŠE

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Povijest vegetacijskih promjena na nekom području utvrđuje se analizom peludi (tj. izradom peludnih dijagrama), iako makrofosilni ostaci te nepeludni palinomorfi, koji se u posljednje vrijeme sve češće uključuju u analize okoliša, također imaju važnu ulogu u razumijevanju promjena klime i vegetacije. Morfološke odlike peludnih zrnaca omogućuju razlikovanje biljnih svojti od kojih potječu na razini vrste/roda ili porodice, što ih čini pogodnim sredstvom za procjenu biljne raznolikosti. Cilj ovog rada je prikazati peludni spektar biljnih vrsta utvrđenih u 4 m dugoj jezgri koja je s creta „Đon močvar“ na području Blatuše (središnja Hrvatska) uzeta tijekom 2015. g. Do sada je jezgra analizirana u polovici svoje duljine i to na način da su iz dubinski različitih slojeva jezgre, koja je nasumično uzorkovana u intervalima od po 2 cm (glinovito-pjeskoviti sediment), odnosno 5 cm (tresetni materijal), izolirana peludna zrnca. U sedimentu jezgre utvrđeno je prisustvo morfološki različitih kategorija peludi (npr. inapertuaratni, monoporatni, kolpatni, kolporatni, poratni, ulceratni i fenestrelatni tip u formi monada, pseudomonada i/ili tetrada) i spora (monoletni i triletni tip). Taksonomska kategorija pridružena je svakom tipu palinomorfa te je tako dobivena lista biljnih svojti istraživanog područja. Do sada je utvrđeno više od pedesetak biljnih svojti (uglavnom na razini roda ili porodice, a rjeđe na razini vrste), iako će daljnje istraživanje taj broj zasigurno povećati kao i donijeti neka nova zanimljiva otkrića.

WHAT CAN POLLEN AND SPORES TELL US ABOUT THE FLORA DIVERSITY – THE PRELIMINARY RESULTS FROM THE BLATUŠA AREA

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The reconstruction of the vegetation history is mainly based on pollen analysis even the macrofossils fragments and, in recent time, non-pollen palynomorphs, also have an important role in explaining climate-vegetation changes. The characteristic morphology features of pollen grains allow researchers to distinguish plants on the species/genus or family taxonomic level which makes pollen suitable for flora richness assessment. The aim of this work is to show the pollen spectra of the 4 m long core taken last year from the peat bog „Đon močvar“ on the Blatuša area (central Croatia). Results given in this work belong to different depth zones of the core, with subsampling intervals ranging from 2 cm (clay-sand sediments) to 5 cm (peat sediments). Until now, almost half of the core length was palynologically analyzed and different pollen types (e. g. inaperturate, monoporate, colpate, colporate, porate, ulcerate and fenestrelate pollen grains) in the form of monads, pseudomonads or tetrades, together with monolete and trilete spores, were observed. The taxonomic categories are added to each pollen/spore type so that a pollen-plant relation was formed. In total, we present more than fifty plant taxa 'in a broader sense' detected on the research area and further analysis will probably bring some new interesting discoveries.

INVAZIVNA FLORA ISTOČNOG DIJELA PARKA PRIRODE ŽUMBERAK – SAMOBORSKO GORJE

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Širenje invazivnih biljnih vrsta unutar onih zajednica gdje prirodno nisu bile rasprostranjene sveopći je problem, a istraživanja su pokazala da dovodi do narušavanja bioraznolikosti i nestanka pojedinih autohtonih vrsta. Za razliku od neinvazivne flore, invazivne vrste do sada nisu bile sustavno istraživane na području Parka prirode Žumberak – Samoborsko gorje, stoga je cilj ovog istraživanja bio utvrditi prisutnost invazivnih vrsta i njihovu zastupljenost u flori istočnog dijela zaštićenog područja. Istraživanje je provedeno upotrebom MTB polja veličine 1/64. Pri analizi determiniranih vrsta obrađeni su podaci o životnom obliku, mehanizmu rasprostranjivanja sjemena te načinu korištenja zemljišta na kojem se pojedine svojte pojavljuju. Kao rezultat dobivena je karta rasprostranjenosti invazivnih vrsta u istočnom dijelu Parka koja predstavlja osnovu za planiranje daljnjeg praćenja veličine populacija invazivnih vrsta.

INVASIVE FLORA IN THE EASTERN PART OF THE NATURE PARK ŽUMBERAK – SAMOBORSKO GORJE

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The invasive plant species spreading into those communities where they were not naturally widespread is considered a global problem, and studies have shown that it leads to distortions of biodiversity and the disappearance of some native species. Unlike the non-invasive flora, invasive species have not yet been systematically studied in the area of the Nature Park Žumberak – Samoborsko gorje. Therefore, the aim of this study was to determine the presence of invasive species and their representation in the flora of the eastern part of the protected area. The research was carried out using MTB 1/64 grid units. The determined species were analyzed with respect to their life form, the mechanism of seed dispersal and the type of land use where the individual taxa appear. As a result, a distribution map of the invasive species in the eastern part of the park was obtained. It represents the basis for the further monitoring planning of the population size of invasive species.

TRADICIONALNA UPOTREBA SAMONIKLOG BILJA NA PODRUČJU SAMOBORA I ŽUMBERKA

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Podaci o tradicionalnoj upotrebi samoniklog bilja u središnjoj Hrvatskoj malobrojni su i nesistematizirani, a sustavna etnobotanička istraživanja tek su se nedavno počela provoditi. U novije vrijeme tradicionalna su znanja o upotrebi biljaka pod utjecajem različitih modernih medija pa se mnoga od njih znatno mijenjaju i modificiraju. Istovremeno i nestaju u ruralnim područjima, gdje se, osobito posljednjih desetljeća, bilježi negativna populacijska dinamika i odumiranje stanovništva starije dobi koje takva znanja još primjenjuje ili bar čuva u sjećanju. Upotrebu samoniklog bilja u Samoboru i okolici temeljito je obradio M. Lang u svom etnološkom djelu s početka 20. stoljeća (1911).

Cilj istraživanja je prikupiti i istražiti tradicionalna znanja o upotrebi samoniklog bilja u samoborskom području i na Žumberku, usporediti promjene nakon jednog stoljeća i uklopiti etnobotanička znanja u socioekonomske promjene u posljednjem stoljeću te njima uzrokovane promjene vegetacijskog pokrova i kulturnog krajolika. Promjene u vegetaciji, osobito smanjivanje otvorenih površina uslijed napuštanja tradicionalne poljoprivrede, niz biljnih vrsta učinile su teže dostupnima, a neke su i nestale sa svojih prijašnjih staništa.

Iako su geografski blizu, u samoborskom kraju i na Žumberku uslijed različitog podrijetla stanovništva primjećuje se upotreba različitih biljaka i potpuno drugačije lokalno nazivlje nekih korištenih vrsta. Preliminarni rezultati pokazuju i značajne pomake u etnobotaničkom znanju među starosjedilačkim stanovništvom Samobora i okolnih sela tokom proteklog stoljeća. Neke od samoniklih biljaka upotrebljavanih prije stotinjak godina više se ne koriste ili su potpuno zaboravljene, a s druge strane primjećuje se utjecaj industrijskog društva i modernih medija koji dovode do unificiranja znanja o upotrebi biljaka, uz značajne gubitke mnogih lokalnih specifičnosti. Tim više je nužno sistematično bilježenje tradicijskih znanja i dokumentiranje tehnika upotrebe i čuvanja biljaka.

TRADITIONAL USE OF WILD PLANTS IN SAMOBOR AND ŽUMBERAK AREA

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The data available on traditional use of wild plants in central Croatia is scarce and unsystematically gathered, and it is only recently that ethnobotanical research have started being done systematically. During the recent period the traditional knowledge of wild plant usage has been influenced and modified through diverse modern media. At the same time, it has also been exposed to irreversible loss, especially in rather isolated rural areas suffering rapid depopulation and disappearance of elderly inhabitants - the ones still using, or at least keeping the knowledge. In 1911 Lang recorded information on wild plant use in folk medicine and diet of people in the Samobor area.

The aim of this research is to gather and analyse the traditional knowledge of wild plant use among the inhabitants of Samobor and Žumberak area nowadays, to observe changes which have appeared within the last century and to put the used plant species into the context of biogeographical features of the studied area. As a result of significant lifestyle changes, such as the abandonment of extensive agriculture and the traditional way of living, gradual changes of vegetation have occurred. This process leads to habitat loss, which can affect some wild plant species, including those important in traditional use.

Due to diverse historical origin of the inhabitants, it is apparent that the local people in Samobor and in Žumberak area use both different plant species and different common names for them, despite the close geographical connection of these two areas. Some wild plants recorded as useful 100 years ago are no longer in use, some of them are not even known amongst local inhabitants any more. This indicates that the traditional knowledge is disrupted on one hand, and it becomes unified under the influence of modern media on the other. Thus, due to the evident loss of traditional knowledge and many local specificities, the necessity of gathering and analysing wild plants and the way of their utilization in these areas is urgent.

ANALIZA VEGETACIJE U ŽUPI DUBROVAČKOJ (JUŽNA HRVATSKA)

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S geobotaničkog gledišta Župa dubrovačka je jedna od manje poznatih hrvatskih regija. Cilj rada bio je provesti fitocenološka istraživanja tog područja. Župa dubrovačka (površina 22.81 km², visinski raspon 0-628 m) odlikuje se složenim geomorfološkim značajkama (strmim obroncima, poljoprivrednim terasama s povremenim ili stalnim izvorima, i dr.) te različitom geološkom podlogom. Ukupna dužina obale (strmci, hridi, stjenovite i šljunčane plaže) je 11,4 km. Dubina mora u Župskom zaljevu je između 2 i 48 m. Tamo je 8300 stalnih stanovnika (popis iz 2011.), no taj se broj ljeti nekoliko puta poveća. Analiza vegetacije bila je usmjerena na opis izgleda i strukture uglavnom šumskih zajednica (s *Quercus ilex* i *Q. pubescens* te *Populus* spp. i *Salix* spp.), makije, bušika, suhih kamenjarskih travnjaka te azonalne vegetacije (psamofitske, pukotina stijena te vegetacije uz vodotoke). Analiza vegetacije izvršena je s pomoću fitocenološke metode Zürich-Montpellier škole (Braun-Blanquet 1964). Rezultati rada su prikazani kroz sintaksonomsku raznolikost odnosno sintaksonomsku shemu vegetacije. Raznolikost i struktura biljnih zajednica u Župi dubrovačkoj izravna su posljedica ekoloških čimbenika, kao što su klimatski uvjeti, podloga, nagib, nadmorska visina, itd. Drevni ljudski utjecaji posebno ispaša, požari i sječa te u novije vrijeme urbanizacija isključuje bilo kakvu mogućnost oporavka šumskih zajednica te uzrokuje fragmentaciju krajobraza.

VEGETATION ANALYSIS OF THE ŽUPA DUBROVAČKA REGION (SOUTH CROATIA): A PLANT LANDSCAPE CHARACTERISED BY ANTHROPOGENIC INFLUENCE

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Župa dubrovačka is one of the Croatian region less known from geobotanical point of view. The aim of this research is to carry out a phytosociological study of the area. Study area (surface area of 22.81 km² with an altitude ranging from 0-628 m a.s.l.) is characterized by complex geomorphological features (steep hillsides, agricultural terraces on slopes, occurrence of intermittent or permanent springs, etc.) and substrata diversity. The coast (cliffs, rocky and pebble beaches) has a total length of 11.4 km. Sea depths in Župa Bay are between 2 and 48 m. The area has 8,300 year-round inhabitants (estimated 2011), but this number increases several-fold in summer. Vegetation analyses were mainly focused on the forest community and allowed the physiognomic and structural description of the climatophilous and edaphoxerophilous forest vegetation (holm oak forests), edaphohygrophilous forest vegetation (deciduous forest communities of *Populus* spp. and *Salix* spp.), evergreen shrublands (maquis formations), garrigues, dry grasslands and azonal (psammophilous, rupicolous, riparian) vegetation. The vegetation analysis was performed using the phytosociological method of the Zürich-Montpellier sigmatist school (Braun-Blanquet 1964). Output of the phytosociological study is a syntaxonomic diversity. Setting the syntaxonomic scheme of the vegetation was our secondary objective. Finally, the plant communities of the Župa dubrovačka region are the direct result of many ecological factors, such as the nature of the substrate, climatic conditions, which vary depending on the aspect, elevation, etc. The ancient human actions especially grazing, fire and cutting, and more recently the urbanization of the coastal zone excludes any possibility of recovery of woody vegetation and is causing a severe fragmentation on the plant landscape.

RASPROSTRANJENOST SVOJTI RODA *SERAPIAS* NA OTOKU KORČULI

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U radu su prikazani rezultati istraživanja rasprostranjenosti svojti roda *Serapias* na otoku Korčuli. U dosadašnjim istraživanjima za otok Korčulu zabilježeno je pet svojti: *Serapias ionica* (E. Nelson) H. Baumann et Künkele, *S. lingua* L., *S. parviflora* Parl., *S. vomeracea* (Burm.) Briq. ssp. *vomeracea* i *S. vomeracea* (Burm.) Briq. ssp. *laxiflora* (Soò) Gölz et H. R. Reinhard. U razdoblju od 2014. do 2016. zabilježili smo tri nove svojte za otok: *Serapias cordigera* L., *S. neglecta* De Not i *S. todari* Tineo. Brojnost svojti *S. cordigera* i *S. neglecta* je vrlo mala, dok *S. todari* dolazi u većim populacijama. *S. cordigera* utvrđena u maslinicima i makiji, dok *S. todari* i *S. neglecta* naseljavaju suhe kamenjarske travnjake i maslinike. Rezultati ovog istraživanja doprinos su poznavanju korologije orhidejskih svojti na otoku Korčuli te, općenito, u Hrvatskoj.

DISTRIBUTION OF THE *SERAPIAS* SPECIES ON THE ISLAND OF KORČULA

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The paper presents results on the abundance and species distribution of the genus *Serapias* on the island of Korčula.
In the previous research done on the island of Korčula five species have been recorded: *Serapias ionica* (E. Nelson) H. Baumann et Künkele, *S. lingua* L., *S. parviflora* Parl., *S. vomeracea* (Burm.) Briq. ssp. *vomeracea* i *S. vomeracea* (Burm.) Briq. ssp. *laxiflora* (Soò) Gölz et H. R. Reinhard.
In the period from 2014 to 2016 three more species were recorded on the island: *Serapias cordigera* L., *S. neglecta* De Not i *S. todari* Tineo. The abundance of species *Serapias cordigera* L. and *S. neglecta* De Not is rare, while *S. todari* Tineo comes rather frequently.
S. cordigera was found in olive groves and maquis while *S. todari* and *S. neglecta* inhabit dry rocky grasslands and olive groves. The results of this study contribute to the knowledge of chorology of orchid species on the island of Korčula and Croatia in general.

FLORISTIČKE I EKOLOŠKE ZNAČAJKE ŠUMA HRASTA LUŽNJAKA (*QUERCUS ROBUR* L.) NA PODRUČJU EUROPE

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Hrast lužnjak (*Quercus robur* L.) gospodarski je vrlo značajna vrsta, koja zbog svoje široke ekološke niše tvori različite tipove šuma rasprostranjenih na području Europe. Cilj ovog rada bio je istražiti florističke, vegetacijske i ekološke značajke šuma hrasta lužnjaka na području Europe. U tu svrhu korišteno je 14745 fitocenoloških snimki s lužnjakom, preuzetih iz europske baze (EVA - http://euroveg.org/eva-database) i unesenih iz literature (za područja koja nisu bila sadržana u europskoj bazi). Nakon stratifikacije detaljna analiza provedena je na ukupnom broju od 3594 fitocenološke snimke. Na temelju hijerarhijske klasterske analize definirali smo pet osnovnih skupina snimki, tj. tipova lužnjakovih šuma na području Europe, koje se floristički, ekološki i geografski međusobno razlikuju. Detaljnom podjelom ih je bilo moguće razdijeliti na 17 različitih podtipova, pa su podaci promatrani i analizirani na dvije razine. Za svaku od tih pet skupina šuma, određeno je područje rasprostranjenosti, dijagnostički važne biljne vrste, provedena je DCA ordinacijska analiza flornoga sastava s pasivno projiciranim varijablama sintaksonomske pripadnosti na dijagram. Na višoj razini, između 17 različitih podtipova lužnjakovih šuma, analizirane su i uspoređene Ellenbergove indikatorske vrijednosti i provedena je korološka analiza prema fitogeografskoj pripadnosti biljnih vrsta. Dobiveni rezultati ukazuju na jasne florističke i ekološke razlike između dobivenih tipova šuma, pri čemu su se jasno odijelile atlantske i sub-atlantske skupine snimaka od kontinentalnih, unutar kojih se izdvajaju termofilne i mezofilne šume te ekstrazonalne šume u aluvijalnim riječnim područjima.

FLORISTIC AND ECOLOGICAL CHARACTERISTICS OF PEDUNCULATE OAK (*QUERCUS ROBUR* L.) FORESTS IN EUROPE

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Pedunculate oak (*Quercus robur* L.) is economically one of the most valuable hardwood tree species, which due to its wide ecological niche forms different types of forests widespread in Europe. The aim of this study was to investigate the floristic and ecological characteristics of the common oak forests in Europe. For this purpose, a data set of 14745 phytocoenological releves with common oak was used, combined from the European phytosociological data base (EVA - http://euroveg.org/eva-database) and the literature (for areas that were not included in the European data base). After the stratification, the analysis was conducted on a total of 3594 phytocoenological releves. Based on the hierarchical cluster analysis, we defined five basic groups of releves, i.e., types of pedunculate oak forests in Europe, which differ in their floristic, ecological and geographical characteristics. With fine division they could be divided into 17 different subtypes, so the data was observed and analyzed on two levels. For each of these five forests types, the area of distribution and diagnostic plant species were determined, a DCA ordination analysis of floristic composition was conducted, with variables of Syntaxonomic affiliation passively projected onto the diagram. At a finer level of 17 different forest subtypes, Ellenberg indicator values were calculated and compared after which also a chorological plant species analysis was conducted. The results show clear differences in floristical and ecological features among the groups obtained from the cluster analysis. Wherein the atlantic and sub-atlantic groups of releves could be clearly differentiated from the continental group, within which releves of thermophilous and mesic forests, as well as extrazonal forests in alluvial river areas could be distinguished.

SAMONIKLO LJEKOVITO I AROMATIČNO BILJE LIVADA JUGOISTOČNOG DIJELA SAMOBORSKOG GORJA

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Samoborsko gorje nalazi se u sklopu Parka prirode Žumberak-Samoborsko gorje, u blizini gradova Samobor i Jastrebarsko. Najviši dijelovi ovog brdskog područja obrasli su gustom šumom, a ispod tog pojasa prevladavaju livade koje su u doticaju s obradivim površinama; oranicama, voćnjacima i vinogradima. Cilj ovog rada bio je utvrditi florni sastav livada jugoistočnog dijela Samoborskog gorja te izdvojiti i opisati ljekovite i aromatične vrste. Terensko istraživanje provedeno je tijekom vegetacijske sezone 2010. na 5 lokaliteta. Rezultati ukazuju na veliko bogatstvo biljaka s ljekovitim i aromatskim svojstvima, a istraživanjem je prikupljeno i determinirano ukupno 88 svojti od kojih 59 vrsta pripada skupini ljekovitih i aromatičnih biljaka. Posebna pozornost ukazana je ljekovitim biljnim vrstama koje su uvrštene u Hrvatsku farmakopeju. Njihove droge smatraju se oficinalnim i koriste u službenoj medicini.

WILD MEDICINAL AND AROMATIC PLANTS OF THE SOUTHEASTERN SAMOBORSKO GORJE MEADOWS

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Samoborsko gorje is located within the *Žumberak-Samoborsko gorje* Nature Park, near towns of Samobor and Jastrebarsko. The highest parts of this mountain area are wooded, while beneath this area there are meadows which are in close touch with arable land - fields, orchards and vineyards. The aim of this study was to determine the flora of the *Samoborsko gorje* meadows and to isolate and describe medicinal and aromatic plants. Field research was carried out during 2010 vegetation season in five different locations. Results reflect the wealth of plants with medicinal and aromatic properties, and research is collected and determined a total of 88 species of which 59 species belong to a group of medicinal and aromatic plants. Special attention was given to medicinal plants included in Croatian Pharmacopoeia. They are considered to be officinal and are used in “official” medicine.

UMBRAULVA DANGEARDII – RIJETKO ZABILJEŽENA VRSTA U JADRANSKOM MORU

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Umbraulva dangeardii M. J. Wynne & G. Furnari 2014., (sinonimi: *Umbraulva olivascens*, *Ulva olivascens*) je do nedavno pripadala rodu *Ulva*, a u rod *Umbraulva* je izdvojena na osnovi molekularnih istraživanja i prisustva fotosintetskog pigmenta sifonaksantina. Vrsta je zabilježena u većem dijelu Sredozemnog mora, europskom dijelu Atlantskog oceana, Kanarskim otocima i na Novom Zelandu. U Jadranskom moru zabilježena je samo u Tršćanskom zaljevu i na Kornatskom otočju. Od 2014. do 2016. godine u proljetnom smo razdoblju vrstu učestalo nalazili u Splitu i Kaštelanskom zaljevu kao jednu od prevladavajućih algi najplićeg infralitorala onečišćenog područja. Iako je izgledom slična vrstama roda *Ulva* („Ulva“ morfotip), od njih se makroskopski razlikuje po specifičnoj maslinasto zelenoj boji, tankoj i nježnoj teksturi te brojnim eliptičnim perforacijama na talusu. Glavne anatomske karakteristike primjeraka iz Splita i Kaštelanskog zaljeva odgovaraju opisu primjeraka iz Atlantika i ostalog dijela Sredozemnog mora: debljina dvoslojnog talusa varira od 50 do 115 µm, površinske stanice su poligonalne do okrugle, dužine od 11 do 51 µm, sadrže jedan kloroplast s jednim do dva pirenoida. Unutar roda *Ulva* razlikovanje je vrsta problematično zbog morfološke interspecijske sličnosti i visoke razine intraspecijskih morfoloških varijacija. *Umbraulva dangeardii* ima uočljive razlike, ali i mnoge morfološke sličnosti sa svojtama roda *Ulva*. Pretpostavljamo da je *U. dangeardii* široko rasprostranjena vrsta u eutrofnim područjima Jadranskog mora, ali je kao kriptična vrsta ostala rijetko zabilježena unutar zajednice roda *Ulva*. Ovu pretpostavku trebaju potvrditi buduća terenska istraživanja.

UMBRAULVA DANGEARDII -RARELY REPORTED SPECIES IN THE ADRIATIC SEA

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Until recently*, Umbraulva dangeardii* M. J. Wynne & G. Furnari 2014, (synonyms: *Umbraulva olivascens*, *Ulva olivascens*) was classified as a member of the genus *Ulva*. It was separated in a special genus *Umbraulva* due to the molecular findings and the presence of the photosynthetic pigment siphonaxanthin. Species has been recorded over a wide area of the Mediterranean Sea, in the European part of the Atlantic Ocean, Canary Islands and in New Zealand. In the Adriatic Sea it was found only in the Gulf of Trieste and at the Kornati Islands. From 2014 to 2016 species was frequently found on our field trips in Split and Kaštela Bay during spring, as one of the most abundant alga of the shallowest infralittoral polluted areas. Although this alga is similar to species of the genus *Ulva* ("Ulva" morphotype), it can be morphologically distinguished from them by specific olive green color, thin and tender texture, and numerous elliptical perforations on the thallus. The main anatomical characteristics of specimens from Split and the Kaštela Bay correspond to the taxa described from the Atlantic and the Mediterranean: the thickness of the two-layer thallus varies from 50 to 115 μm; the surface cells are polygonal to round from 11 to 51 μm long; there is a single chloroplast with one to two pyrenoids. Differentiating the species within the genus *Ulva* is very difficult due to their morphological similarities between the species as well as the high levels of morphological variation within the species. *Umbraulva dangeardii* has notable differences but also many morphological similarities with the representatives of the genus *Ulva*. For that reasons we could conclude that the species is widespread along the Adriatic eutrophicated coastal areas, but has remained rarely observed inside the *Ulva* association due to its cryptic features. This presumption will need to be further investigated and confirmed in our future research.

LATE SEASONAL MOWING ENHANCES CENTRAL EUROPEAN *SPIRANTHES SPIRALIS* (L.) CHEVALL. (ORCHIDACEAE) POPULATION VIABILITY

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The Autumn Lady's-tresses (*Spiranthes spiralis*) is not a common species in Central Europe; the localities are scarce also in Slovenia, scattered throughout the whole country. Little was known about the species occurrence in the Nature Park Goričko (NE Slovenia), a model for a Central European traditional agricultural landscape. The study revealed that the studied population in the park is relatively dense although its habitats have been already considerably deteriorated. 2442 exemplars were recorded on 26 grassland patches applying the systematic scanning of the potential growing sites during the flowering period in 2015. *Spiranthes spiralis* population frequency (in terms of number of exemplars per grassland patch) and density, but also species' fitness (measured as a set of robust morphological traits on 427 flowering individuals) were studied in relation to patch area and vegetation height which directly reflect the time of the last seasonal mowing. We revealed that patch area is positively related with earlier mowing and that earlier mowing negatively affects *Spiranthes spiralis* density and plant fitness in general. The number of the rosette leaves was found to be the most important trait which could be used as a proxy for the general plant fitness of this orchid species because the significant positive correlation with the height of the inflorescence stalks, number of flowers, inflorescence length and the distance between the flowers was confirmed. The number of the rosette leaves shows significant negative relation to vegetation height and patch area. Late seasonal mowing which has a significant positive impact on the plant fitness enhances *Spiranthes spiralis* population viability and density.

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Kroz sustavno istraživanje vaskularne flore u proteklih 7 godina, na području grada Slatine i pripadajućih naselja inventarizirano je ukupno 816 biljnih svojti. Svi lokaliteti biljnih svojti s Crvene liste te zakonom strogo zaštićenih svojti geokodirani su GPS uređajem, a u postupku je detaljno kartirana i endemična *Cardamine waldsteinii* Dyer. Vrsta pripada porodici Brassicaceae unutar koje u hrvatskoj flori rod *Cardamine* bilježi 24 biljne svojte; njih 10 poznato je za istraženo područje Slatine. Kao ilirsko-balkanska vrsta ima područje rasprostranjenosti u Hrvatskoj, gdje se ujedno nalazi njezin središnji dio ukupnog areala, a javlja se još u Sloveniji, Mađarskoj, Bosni i Hercegovini, Srbiji i Austriji. Relativno je česta unutar svojeg areala u Hrvatskoj, a veći je broj nalaza vezan za područje planine Mala Kapela te za sjeverozapadni dio države. Nalazi s juga Hrvatske nisu poznati. Na području Slatine poznati lokaliteti odnose se na šumska područja, a značajnije populacije nalazimo u šumskim predjelima „Slatinci“, „Velika Branjevina“ i „Medinačko ražljevo“. Vrsta preferira polusjenu i vlažna šumska mjesta, obično raste u blizini potoka gdje je sastavni dio vegetacije proljetnog aspekta. U pravilu se javlja do 150 m nadmorske visine i vezana je za šumsku zajednicu *Carpino betuli-Quercetum roboris*, rjeđe za zajednicu *Carici brizoides-Alnetum glutinosae*. Mjestimično se diže i do 200 m nadmorske visine gdje se u kitnjakovim sastojinama (*Epimedio-Carpinetum betuli*) mogu pronaći izolirane jedinke na mikrolokalitetima sa zadržanom vlagom (različite udubine tla). U Slatini prve se jedinke u cvatu mogu pronaći pred kraj ožujka, a plodovi su zabilježeni krajem travnja. Trenutno je geokodirano ukupno 185 nalaza ove vrste te je pomoću njih izrađena karta distribucije u kojoj je gradijentom prikazana gustoća jedinki za istraženo područje. U Zakonu o zaštiti prirode (2013.) vrsta je deklarirana kao strogo zaštićena. Zabilježeni nalazi doprinos su poznavanju distribucije *Cardamine waldsteinii* Dyer i njezine pojavnosti unutar određenih stanišnih tipova.

DISTRIBUTION AND HABITATS OF THE ENDEMIC *CARDAMINE WALDSTEINII* DYER IN THE SLATINA AREA, CROATIA

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Through methodical research of vascular flora in the previous 7 years, a total of 816 plant taxa has been recorded in the area of Slatina and neighbouring villages. All sites containing plant taxa on the Red List and strictly protected taxa were geocoded using a GPS device, including a detailed mapping of the endemic *Cardamine waldsteinii* Dyer. It belongs to the family Brassicaceae which counts 24 taxa in the genus *Cardamine* in Croatian flora; 10 such taxa have been noted for the Slatina area. As an Illyrian Balkan species its area of distribution includes Croatia, which represents its central part of the total distribution, but also occurs in Slovenia, Hungary, Bosnia and Herzegovina, Serbia and Austria. It is relatively common within its range in Croatia where the majority of sites are found on Mt. Mala Kapela and the northwestern parts of the country. There are no known records from the southern Croatia. Known sites in the area of Slatina refer to forest habitats with dense populations growing in forest areas known as „Slatinci“, „Velika Branjevina“ and „Medinačko ražljevo“. The species prefers semi-shaded and damp woodland settings, usually growing alongside streams where it is a constituent of spring vegetation. Generally, it occurs at altitudes up to 150 m and is related to forest association *Carpino betuli-Quercetum roboris*, less often to association *Carici brizoides-Alnetum glutinosae*. Occasionally it can be found at up to 200 m in sessile oak stands (*Epimedio-Carpinetum betuli*) as isolated specimens in microlocalities with retained moisture (various ground depressions). First flowering plants in Slatina were recorded at the end of March, whereas fruit can be found at the end of April. There is currently a total of 185 geocoded points for this species which have been used to create a gradient-based distribution map in order to present species' density for the investigated area. This species is declared as strictly protected by the Regulations on the strictly protected species of Croatia (2013). The recorded findings contribute to the knowledge of distribution of *Cardamine waldsteinii* Dyer and its occurrence in certain habitat types.

MORFOLOŠKA I EKOLOŠKA KARAKTERIZACIJA NOVOOTKRIVENOG HIBRIDA *CROCUS* × *VELEBITICUS* RANDIĆ ET KREMER (*C. MALYI* × *C. VERNUS*)

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Malijev šafran (*Crocus malyi* Vis., porodica Iridaceae) je stenoendem Velebita koji je do sada zabilježen na malom broju lokaliteta na području srednjeg i južnog Velebita. Naše istraživanje je pokazalo da je Malijev šafran razmjerno česta vrsta termofilnih šuma i travnjaka, kao i drugih otvorenih, kamenitih, termofilnih staništa primorskih padina Velebita. Za razliku od njega, proljetni šafran (*C. vernus* (L.) Hill) je vrsta mezofilnih staništa i hladnijih bukovih šuma. Ove dvije vrste na mnogo mjesta rastu jedna uz drugu tvoreći hibride i vjerojatno hibridne rojeve. U ovom radu dana je morfološka i ekološka karakterizacija novootkrivenog hibrida *C.* × *velebiticus* Randić et Kremer (*C. malyi* × *C. vernus*), nothospecies nova. Neke od osnovnih makromorfoloških značajki svojte *C.* × *velebiticus* su: visina biljke 145.4 ± 48.1 mm; dužina vanjskih listića perigona 32.6 ± 6.3 mm; širina vanjskih listića perigona 9.3 ± 3.2 mm; dužina prašnika 21.2 ± 3.7 mm; dužina prašnica 14.6 ± 3 mm; dužina gomolja 13.8 ± 3.3 mm; širina gomolja 13.4 ± 4.5 mm. Boja listića i cijevi perigona je vrlo varijabilna, a tipični primjerci imaju prevladavajuću bijelu boju te s abaksijalne strane vanjskih listića perigona plavkasto-ljubičastu prugu širine 1 – 4 mm koja se proteže od osnovice do ½ ili ⅔ dužine, katkada i do vrha listića perigona. Unutrašnji listići perigona većinom u donjoj trećini s abaksijalne strane imaju izdužene ljubičaste mrlje. U ždrijelu perigona prisutna je slabo izražena žuta mrlja i dlačice. Njuška tučka je razdijeljena (najčešće u 2 – 3 razine), crvenkasto-narančasta i kod većine jedinki nadvisuje vrhove prašnika. U nekih jedinki perigon je ljubičast i nalik perigonu ljubičastih jedinki vrste *C. vernus*, ali takve hibridne jedinke, za razliku od *C. vernus*, imaju brakteole kao u vrste *C. malyi.* Prisutnost brakteola konstantna je osobina analiziranih jedinki *C.* × *velebiticus*, bez obzira na boju ili na moguće druge više ili manje varijabilne osobine. Na hibridni karakter pojedinih jedinki katkada upućuje i više ili manje izražena zakržljalost prašnika i/ili tučka. Stanište svojte *C.* × *velebiticus* su najčešće kamenjarski travnjaci s vrstama *Sesleria juncifolia*, *Carex humilis*, *Bromus erectus* s.l., većinom u blizini šumskih sastojina. Jedinke izdvojene kao holotip i izotipovi utvrđene su na kamenitom, zatravnjenom staništu šumskog požarišta u predjelu Radlovac na srednjem Velebitu, što je ujedno *locus classicus* ovog zanimljivog velebitskog hibrida.

MORPHOLOGICAL AND ECOLOGICAL CHARACTERIZATION OF THE NEWLY FOUND *CROCUS* × *VELEBITICUS* RANDIĆ ET KREMER (*C. MALYI* × *C. VERNUS*)

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Maly's crocus (*Crocus malyi* Vis., family Iridaceae) is a stenoendemic that so far has been noticed on few localities only, in the middle and south section of Mt Velebit. This research has shown that *C. malyi* is a relatively common species of rugged thermophilous forests, thermophilous grasslands and other open thermophilous habitats along the littoral slopes of Mt. Velebit. On the other hand, *C. vernus* (L.) Hill is a species of mesophytic and colder *Fagus sylvatica* L. forests. Both species grow next to each other on a number of localities forming hybrids, probably hybrid swards as well. In this work we have presented the morphological and ecological characterization of the newly found hybrid *C.* × *velebiticus* Randić et Kremer, nothospecies nova. The *C.* × *velebiticus* is characterized with several macro morphological traits: plant height 145.4 ± 48.1 mm; outer perigon leaves length and width 32.6 ± 6.3 mm and 9.3 ± 3.2 mm, respectively; stamens and anthers length 21.2 ± 3.7 mm and 14.6 ± 3 mm, respectively; corm length and width 13.8 ± 3.3 mm and 13.4 ± 4.5 mm, respectively. The perigon and perigon´s tube colours are quite variable, while typical specimens are mainly white with a blue-violet 1 to 4 mm wide stripe on the abaxial side of the outer perigon leaves. The stripe extends from the base of perigon leaves up to ½, ⅔ or throughout the perigon leaves length. The inner perigon leaves usually have violet spots on the first ⅓ of the abaxial side length. The perigon throat has a slightly developed yellowish spot and hairs. The stigma is pinnate, usually arranged in 2-3 levels, reddish-orange and in most specimens higher than anthers. The perigon colour of some specimens is violet as in *C. vernus*, but violet *C.* × *velebiticus* specimens possess bracteoles like *C. malyi*. The existence of bracteoles is a constant trait in all investigated *C.* × *velebiticus* specimens, whatever the colour or other variable traits. More or less expressed stunted growth of stamens and/or pistil in some specimens, also indicate the hybrid character of *C.* × *velebiticus*. The habitat of *C.* × *velebiticus* are usually rocky grasslands with *Sesleria juncifolia*, *Carex humilis*, and *Bromus erectus* s. l. as dominant species, and in most examples it is situated in close proximity to forest patches. The *C.* × *velebiticus* specimens chosen for holotype and isotypes were found on the stony and grassy fire site in the Radlovac area in the middle section of Mt. Velebit, a locus classicus of this hybrid.

ORNITHOGALUM SIBTHORPII GREUTER (ASPARAGACEAE) U HRVATSKOJ

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Rod *Ornithogalum* L. karakterističan je po svojoj širokoj ekološkoj valenci te jednostavnoj, ali izrazito varijabilnoj morfologiji. Centri raznolikosti su Mediteran i Južna Afrika te je ukupno do sada poznato oko 300 svojti, dok je u Europi poznato više od 40 svojti. Jedna od rano cvjetajućih proljetnih vrsta je i mediteransko-submediteranski geofit *Ornithogalum sibthorpii* Greuter, koji je rasprostranjen na Balkanskom poluotoku i Turskoj. *O. sibthorpii* nastanjuje kamenjarska i otvorena staništa, dok u submediteranu preferira otvorena staništa, putove, parkove, gažena te vlažna staništa. Lukovica je bez bulbila. Listovi su goli, žljebasti sa središnjom bijelom prugom na plojci te nadvisuju cvat. Nadzemni dio biljke je mali, cvat je do 5 cm dugačak, a podzemna stabljika može biti i do 5 cm duga, ali uglavnom ne prelazi ukupnu dužinu od 5 cm. Cvat je gronja s 2-12 cvjetova. Cvjetne stapke su jako svijene pri bazi, s koljenastim jastučićem, a prilikom dozrijevanja plodova dosežu oko 2 cm. Brakteje su kraće ili podjednako dugačke kao cvjetne stapke. Na području areala, vrsta *O. sibthorpii* je raštrkano zastupljena, ali s gustim populacijama. Prilikom uništavanja prirodnih staništa, vrsta se uspješno proširila i na antropogena staništa. Do sada nema objavljenih podataka da ova vrsta raste u Hrvatskoj, iako je poznata s krških polja susjedne Bosne i Hercegovine te je prijašnjih godina zabilježena u submediteranskoj zoni Albanije i Crne Gore. Na temelju trenutne distribucije vrste i stanišnih preferenci pretpostavka je bila da se bi ova vrsta mogla rasti i u Hrvatskoj. Kako bi potvrdili njezinu prisutnost, obavljena su terenska istraživanja u proljeće 2015. i 2016. godine te je konzultiran herbarijski materijal iz različitih zbirki. Na temelju revizije herbarijskog materijala iz GZU, K, ZA, ZAHO, ZAGR, W i WU vrsta je potvrđena za Dubrovnik, Brgat, poluotok Pelješac (Sv. Ilija i Orebić), Split i Liku (Donji Lapac). Terenskim istraživanjem vrsta je potvrđena na lokalitetima Brgat Gornji i Donji Lapac, a u travnju 2016. otkriven je i novi lokalitet u okolici Nina (Sjeverna Dalmacija). Rezultati upućuju da je *O. sibthorpii* rijetka vrsta Hrvatske flore. Daljnja istraživanja ove rano proljetne vrste su potrebna kako bi se bolje utvrdila njezina učestalost i zaštita.

ORNITHOGALUM SIBTHORPII GREUTER (ASPARAGACEAE) IN CROATIA

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The genus *Ornithogalum* L. is characterized by wide ecological valence, simple morphology, but pronounced variability. Centers of diversity are Mediterranean region and South Africa with nearly 300 taxa, and more than 40 recorded taxa in Europe. One of the early-flowering species is Mediterranean-submediterranean geophyte *Ornithogalum sibthorpii* Greuter, distributed in the Balkan Peninsula and Turkey. *O. sibthorpii* inhabits rocky places and clearings, while in submediterranean area prefers open habitats, along roads, parks and footworn surfaces close to wetlands. The bulb is without offsets. Leaves are glabrous, canaliculate with median white stripe on the abaxial side, overtop the inflorescence. Above-ground part is rather small, inflorescence is not more than 5 cm long, while below-ground scape can be up to 5 cm long, but most often overall length is approximately 5 cm. The inflorescence is corymbiform with 2-12 flowers. Pedicels are strongly refracted, with the pulvinus at the base during the fructification, cc. 2 cm long. Bracts are shorter or the same length as pedicels. Throughout the areal *O. sibthorpii* has scattered but abundant populations. Else than native populations, due to habitats change often is found in the antropogenic localities. So far, no data for this species in Croatia were published, but it is known for the karst fields in Bosnia and Herzegovina and it is recorded in previous years along the submediterranean region in Albania and Montenegro. Following present distribution data and habitat preferences, assumption was that this species might be distributed in Croatia as well. To confirm this, herbarium material was revised and field investigations during spring season of 2015 and 2016 were organized. According to herbarium revision in GZU, K, ZA, ZAHO, ZAGR, W and WU this taxon is confirmed for Dubrovnik, Brgat, Pelješac Peninsula (Mt. Vipera and Orebić), Makarska, Split and Lika (Donji Lapac). Field research confirmed the presence of *O. sibthorpii* in Brgat Gornji and in Donji Lapac. Moreover, in 2016 new localities were found in the vicinity of Nin (North Dalmatia). Results indicate that *O. sibthorpii* is rare species in Croatian flora. Further investigations of this early-spring species are needed for better knowledge of species occurrence and protection.

FLORA ZIDINA SPLITSKOG PODRUČJA

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Flora zidina splitskog područja istraživana je tijekom 2015. i 2016. godine, pokazuje veliku raznolikost svojti. Istražena flora najvećim dijelom pripada kritosjemenjačama (91,3%). Svojte su raspoređene u okviru 55 porodica. Najzastupljenije porodice su *Poaceae* (10,9%), *Asteraceae* (6,9%) i *Cichoriaceae* (6,9%). Najzastupljenija vrsta je *Parietaria judaica*, s obzirom na njenu dominantnost istražena flora pripada vegetacijskom razredu *Parietarietea judaicae.* Najzastupljeniji životni oblici su terofiti (36,4%) i hemikriptofiti (29,5%). Od flornih elemenata najveći postotak (48%) pripada mediteranskom flornom elementu. Utvrđene su četiri endemične vrste *Centaurea ragusina, Aurinia sinuata, Inula verbascifolia* i *Salvia bertolonii.* U flori zidina splitskog područja istražene su i neke invazivne vrste *Conyza canadensis, Aster squamatus* i *Ailanthus altissima*.

THE FLORA OF WALLS OF THE SPLIT AREA

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The flora of the walls of the Split area, which was was carried out during 2015 and 2016, shows a great variety of species. The examined vegetation mostly falls into the group of flowering plants or angiosperms (91,3%). Species are distributed into 55 families. The most abudant families are *Poaceae* (10,9%), *Asteraceae* (6,9%) and *Cichoriaceae* (6,9%). The most common species is *Parietaria judaica*, and considering its dominance, the examined flora belongs to *Parietarietea judaicae* vegetations class. The most abudant life-forms are therophytes (36,4%) and hemicryptophytes (29,5%). The largest percentage of flora elements (48%) falls into the category of Mediterranean flora element. Four endemic species have been established – *Centaurea ragusina, Aurinia sinuata, Inula verbascifolia* and *Salvia bertolonii*. As part of the flora found on walls of the Split area, several invasive species have also been examined, specifically *Conyza canadensis, Aster squamatus* and *Ailanthus altissima*.

EPIFITI NA PALMAMA VRSTE *PHOENIX CANARIENSIS* CHABAUD

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Epifitska flora palmi vrste *Phoenix canariensis* na splitskoj i trogirskoj rivi, te na području grada Zadra i otoka Rave istraživana je tijekom 2015. godine, te obuhvaća 105 svojti, od kojih je 61 različita svojta. Epifiti zastupljeni na svim palmama u okviru svih lokaliteta su: *Stellaria media*, *Parietaria judaica* i *Conyza canadensis*. Najzastupljenije porodice su *Poaceae* (16,39%), *Caryophyllaceae* (8,2%), te porodica *Scrophulariaceae* (6,56%). Na istraživanim područjima brojnost i pokrovnost epifita najveća je u Splitu na sjevernoj strani palmi, a najmanja u Zadru. Najčešći plod je tobolac (29,51%), pšeno (16,39). Najzastupljeniji način rasprostranjivanja je anemohorijom (65,57%), mirmekohorijom (59,02%), te ornitohorijom (45,90%). Najučestaliji životni oblici su terofiti (48,33%), hemikriptofiti (18,33%) te fanerofiti (15%). Analizom flornih elemenata utvrđeno je da je najviše općemediteranskih (21,31%) i biljaka široke rasprostranjenosti (21,31%), potom južnoeuropske-mediteranske biljke (18,03%). Najveća pH vrijednost humusa u pazušcu listova palmi utvrđena je u Zadru (5,85), potom u Trogiru (5,39) i Splitu (5,13).

THE EPIPHYTE FLORA ON THE PALMS SPECIES *PHOENIX CANARIENSIS* CHABAUD

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Research of epiphyte flora on palms species *Phoenix canariensis* Chabaud at Split, Trogir, Zadar and the island Rava was carried out during 2015. The epiphyte flora is comprised of 105 taxa, which of 61 belongs to different taxa. Epiphytes at all researched areas are: *Stellaria media*, *Parietaria judaica* i *Conyza canadensis*. The most abundant families are Poaceae (16.39%), Caryophyllaceae (8.2%), Scrophulariaceae (6.56%). Number and coverage of epiphytes on researched areas were largest in Split, on the north side of palm, the lowest in Zadar. The most common fruit is quiver (29.51%), followed by millet (16.39%). Anemochory (65.57%), mirmochory (59.02%), ornitochory (45.90) are the most common way of spreading. The most abundant life-forms among epipthyte flora are therophytes (48.33%), hemicryptophytes (18.33%), phanerophytes (15%). Performing the analysis of floral elements we assumed that general Mediterranean plants (21.31%) are the most frequent, followed by plants of widespread (21.31%), followed by Southern European-Mediterranean plants (18.03%). Maximum pH value in humus, in the axils of leaves of palm trees were identified in Zadar (5.85), Trogir (5.39) and Split (5.13).

GLYCERIA STRIATA (LAM.) HITCHC. (POACEAE) – NOVA VRSTA U HRVATSKOJ FLORI

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Sjevernoamerička vrsta trave *Glyceria striata* u Europi je prvi put zabilježena 1849. u Francuskoj. Od sredine 20. stoljeća pojavljuju se prvi nalazi i u drugim europskim državama, tako da je do danas ova alohtona vrsta zabilježena u ukupno 17 država. Vrsta je u Europu ušla neovisno u više navrata, najvjerojatnije u sjemenskoj mješavini trava iz SAD-a. *G. striata* preferira vlažna staništa, pa se pretpostavlja da su glavni vektori njenog širenja Europom ptice, vodeni tokovi i ljudska aktivnost. Prema postojećim podacima vrsta još nije zabilježena na Apeninskom i Balkanskom poluotoku. Tijekom sustavnog terenskog istraživanja aluvijalnih šuma u Dinarskoj regiji vrsta je zabilježena po prvi puta u Hrvatskoj, u lipnju 2015. Vrsta je pronađena na ukupno 4 lokaliteta u Gorskom kotaru (SZ Hrvatska), u blizini granice sa Slovenijom. Prva dva nalazišta su u blizini mjesta Gerovo, a druga dva duž toka rijeke Kupe (Sedalce i Brod na Kupi). Vrsta je rasla unutar sastojina poplavnih šuma zajednica *Lamio orvalae-Alnetum incanae* Dakskobler 2010 i *Lamio orvalae-Salicetum eleagni* Dakskobler, Šilc et Čušin ex Dakskobler 2007. Vjerojatno je u Hrvatsku stigla vodenim tokovima iz susjednih slovenskih populacija, a na barem dva lokaliteta je proširena ljudskim aktivnostima. Zbog sličnosti s vrstama *Puccinellia distans* (L.) Parl., *Catabrosa aquatica* (L.) P.Beauv. i nekim vrstama roda *Poa* zasigurno je na mnogim mjestima previđena. *G. striata* trenutno ne predstavlja ugrozu autohtonoj flori, no u Srednjoj Europi je zbog svog klonalnog rasta procijenjena kao potencijalno invazivna vrsta.

GLYCERIA STRIATA (LAM.) HITCHC. (POACEAE) – A NEWCOMMER IN CROATIA

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North-American grass species *Glyceria striata* has been recorded in Europe for the first time in 1849 in France. The first observations from other European countries appeared from mid-20th century, thus in total 17 countries reported presence of this alochtonous species so far. Independent introductions to Europe have occurred more than once, most likely through mixed grass seeds from USA. Since *G. striata* prefers wet habitats, it is assumed that birds, water flow and human activities are the main factors responsible for its spread through the continent. According to available data, the species has not yet been naturalized on the Iberian and Balkan peninsulas. During the extensive field survey of the alluvial forests of Dinaric region, the species has been found in June 2015, for the first time in Croatia. In total 4 localities have been recorded in Gorski Kotar region (NW Croatia), close to Slovenian border. The first two were near the place Gerovo, and the other two along the Kupa River (Sedalce and Brod na Kupi). The species has been found within alluvial forest stands belonging to two associations (*Lamio orvalae-Alnetum incanae* Dakskobler 2010 and *Lamio orvalae-Salicetum eleagni* Dakskobler, Šilc et Čušin ex Dakskobler 2007). *G. striata* has probably arrived to Croatia from the neighbouring Slovenian populations by water flows, and has spread at least on two localities by human activities. It is, for certain, widely overlooked and ignored, due to its similarity with the grasses *Puccinellia distans* (L.) Parl., *Catabrosa aquatica* (L.) P.Beauv., and some species of the genus *Poa*. Currently, *G. striata* does not show a risk to native floras, yet it is assessed as potentially invasive species in Central Europe due to its clonal growth.

FLORA OF ZONI PLATEAU (BARTIN)

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Küre Mountains National Park is located between the provincial borders of Bartın and Kastamonu, on Küre Mountains in the West Black Sea region. The national park was established on 07.07.2000 and has been under protection ever since. The national park covers an area of 37.753 hectares while the buffer zone around covers 134.366 hectares. The national park and its buffer zone is important for both national and international environmental interests for accommodating the best examples of wild life varieties of the "Black Sea Moist Karstic Forest" ecosystems under threat and thus has been declared as one of the 100 Forest Hot Spots under protection in Europe. Last but not least Küre Mountains National Park is located within the "North Anatolia and Caucasian Temperate Zone Forests" which is one of the first 200 ecologically significant areas declared by World Wild Fund For Nature (WWF). Küre Mountains National Park boasts of being the first national park of Turkey and the thirteenth of Europe holding PAN (Protected Area Network) Parks certificate granted to the best protected and best managed parks as well as those enabling sustainable tourism activities in and around the park. This paper studies the flora of the Zoni Plateau and its surrounding area located in Bartın zone of Küre Mountains National Park. The study focuses on and identifies all woody and herbaceous species in the area.

KARAKTERISTIKE EKOLOŠKE NIŠE HRASTA LUŽNJAKA (*QUERCUS ROBUR*) UZDUŽ RASPROSTRANJENOSTI VRSTE U EUROPI

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Hrast lužnjak (*Quercus robur*) je široko rasprostranjena i jedna od najznačajnijih europskih šumskih vrsta, kako gospodarski tako i ekološki. Cilj ovog rada bio je istražiti varijabilnost ekološke niše hrasta lužnjaka unutar cjelokupne rasprostranjenosti vrste u Europi. Kako bismo utvrdili koji okolišni čimbenici utječu na rasprostranjenost izradili smo model ekološke niše hrasta lužnjaka temeljem 239 822 točaka pojavljivanja vrste prikupljenih iz različitih izvora, te seta 14 okolišnih prediktorskih varijabli odabranih temeljem ekološke važnosti za vrstu, pritom isključujući visoko korelirane varijable. Na temelju dobivenog modela, poznatog areala vrste iz literature te postglacijalnih putova širenja definirali smo tri grupe točaka pojavljivanja uzduž gradijenta sjeveroistok - jugozapad: centar, sjeverni i južni rub areala vrste. Zatim smo istražili kako se realizirana niša vrste mijenja unutar raspoloživog ekološkog prostora okarakteriziranog s odabranim varijablama duž definiranog gradijenta. Na kraju smo usporedili širinu realizirane niše u centru distribucije u odnosu na sjeverne i južne rubove areala. Širina niše određena je kao raspon vrijednosti za svaku od najvažnijih okolišnih varijabli (odabranih temeljem doprinosa modelu) za sve točke pojavljivanja unutar tri definirane grupe. Dobiveni rezultati pokazuju razlike u karakteristikama ekološke niše hrasta lužnjaka između centralnih i rubnih sastojina.

NICHE CHARACTERISTICS OF PEDUNCULATE OAK (*QUERCUS ROBUR*) ALONG THE SPECIES DISTRIBUTION RANGE IN EUROPE

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Pedunculate oak (*Quercus robur*) is a widely distributed and one of the most valuable European hardwood tree species, both economically and ecologically. We here investigated distribution patterns and niche variation of *Q. robur* over the large geographical scale within the species entire distribution range. To explore which environmental factors influence the species occurrence we first built an ecological niche model for *Q. robur* based on 239 822 occurrence points obtained from various sources and a set of 14 environmental predictors selected based on their ecological relevance, excluding highly correlated ones. Based on the resulting model, available species distribution maps from literature and species postglacial recolonization history we defined three groups of occurrence points along the northeast-southwest gradient: species distribution centre, north and south range margin. We then explored how niche occupation (realized niche) of *Q. robur* changes within the available environmental space characterized with the selected variables along the defined gradient. Finally, we compared niche width in the distribution centre with the northern and southern range margins. Niche width was estimated using the range of values for each of the most important environmental variables (selected based on their contribution to the model) across all points occurring in the three distribution areas. We show and discuss ecological niche differences between central and marginal stands of this still ecologically intriguing species.

GEOEKOLOŠKE I FLORISTIČKE ZNAČAJKE PONIKVE SOVLJAK (VELIKA KAPELA)

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Ponikva Sovljak, smještena na području Velike Kapele 8,5 km JJZ od Ogulina, istraživana je kako bi se pomnije proučio fenomen velikih ponikava u vegetacijskom, mikroklimatskom i geomorfološkom smislu. Oblikovana je u karbonatnim naslagama djelovanjem procesa korozije, padinskih procesa i urušavanja, a njezin je postanak predisponiran izrazitim tektonskim pukotinama. Ističe se ljevkastom morfologijom i velikim dimenzijama: dubinom od 60 m i dimenzijama oboda 310 x 450 m. Cilj istraživanja bio je ustanoviti stanišne uvjete u pojedinim dijelovima ponikve ovisno o njenoj morfologiji. U vegetacijskom razdoblju 2015. godine na području ponikve provedena su mikroklimatološka mjerenja memorijskim termohigrografima, kojima su prikupljeni podaci o temperaturi zraka, vlažnosti zraka i temperaturi rosišta na različito izloženim padinama i na dnu ponikve, gdje je istovremeno popisivana i flora. Za popisane biljne svojte je napravljena taksonomska analiza, analiza ekoloških indikatorskih vrijednosti i životnih oblika prema Ellenbergu, te analiza flornih elemenata. Osim analize ukupne flore, napravljena je i analiza flore po dijelovima ponikve, pri čemu je analizirana floristička sličnost staništa korištenjem Sörensenovog indeksa. Na padinama ponikve (sjevernoj i južnoj) i na njenom dnu utvrđeni su različiti stanišni uvjeti uzrokovani geomorfologijom ponikve i mikroklimatskim uvjetima koji su se odrazili na floristički sastav. Dobiveni rezultati ukazali su i na prisutnost inverzije vegetacije kao posljedice pojave inverzije temperature zraka u ponikvi. Ukupno je zabilježeno 107 svojti biljaka, od kojih su najvećim udjelom u floističkom sastavu bile zastupljene svojte iz porodice *Lamiaceae*. Zabilježeno je 6 svojti zaštićenih Zakonom o zaštiti prirode i Pravilnikom o strogo zaštićenim vrstama, 10 ih se nalazi u Crvenoj knjizi vaskularne flore Hrvatske, a zabilježena su i 4 endema.

GEOECOLOGICAL AND FLORISTIC FEATURES OF THE SOVLJAK DOLINE (MT. VELIKA KAPELA, CROATIA)

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The Sovljak karst doline located on the Velika Kapela Mountain 8.5 km SSW from the town of Ogulin was researched in order to examine the vegetational, microclimatic and geomorphological phenomenon of large dolines more accurately. The doline was formed in carbonate beds by corrosion, slope processes and collapse, where intense tectonic fractures facilitated its formation. It stands out by its funnel-shaped morphology and large dimensions: depth of 60 m and circumference dimensions of 310 x 450 m. The aim of the research was identifying the habitat conditions in different parts of the doline, depending on its morphology. Microclimatic measurements, including air temperature, relative humidity and dew point were made in the doline in the vegetation period of 2015 at various slope expositions and at the bottom of the doline, using data loggers. Simultaneously in those parts of the doline flora inventory was also made. Registered plants underwent the taxonomic analysis, the Ellenberg's indicator values and life forms analysis and the floral elements analysis. Besides the total flora analysis, the floristic analysis for different parts of the doline was also made, using the Sörensen index for the habitat similarity analysis. Caused by the geomorphology of the doline and microclimate conditions, on the doline slopes (north and south) and at its bottom different habitat conditions were determined, which was reflected in floristic composition. The results also showed the occurrence of the vegetation inversion as a consequence of the temperature inversion in the doline. Altogether 107 plant taxa were registered, most of which belong to the family *Lamiaceae*. Among these, 6 taxa are protected by law, 10 taxa are listed on the National Red List and 4 taxa are endemic.

FLORA TOKA IZVORA RUMIN VELIKI I RUMIN MALI (DALMACIJA, HRVATSKA)

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Tijekom 2014. i 2015. godine istraživana je flora krških izvora Rumin Veliki i Rumin Mali od njihova izvora do ušća. Vodotoci izviru na zapadnim padinama uskog područja između planina Dinare i Kamešnice, te se, nakon spajanja, konačno ulijevaju u rijeku Cetinu. Istraživanjem je ukupno utvrđeno 443 svojte vaskularne flore, od čega je, prema dostupnim literaturnim podacima, 5 svojti već ranije bilo opaženo. Novoutvrđenih vrsta i podvrsta na istraživanom područje je 438. U radu je napravljena analiza flornih elemenata i životnih oblika.

FLORA ALONG THE KARST SPRINGS RUMIN VELIKI AND RUMIN MALI (DALMATIA, CROATIA)

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The area of karst springs Rumin Veliki and Rumin Mali, placed between Dinara and Kamešnica Mts, has been floristically researched during the years 2014. and 2015. The left and right banks of these two short watercourses, which are merging together and finally flow into the Cetina river, were also included in analysis and their plant diversity was observed. In total, 443 plant taxa were noticed. From that number, five taxa were already known (according to literature data) and 438 taxa were recorded for the first time. The paper contains analysis of floral elements and life forms of the researched area.

ANALIZA PORODICE COMPOSITAE IZ HERBARIJA CARLA STUDNICZKE

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U dijelu Studniczkinog herbarija pronašli smo mape u kojima se nalaze primjerci iz porodice *Compositae* čiji je dio već obrađen (Vladović i dr., 2013). Analizirani su podatci iz novih mapa i objedinjeni s otprije poznatim podatcima. Porodica *Compositae* (Ord. Compositeen) ukupno broji 1079 herbarijskih listova s 2296 herbarijskih primjeraka. Najveći dio herbarijskog materijala sakupljen je u Europi (959 herbarijskih listova). Najviše herbarijskog materijala sabrano je s područja Austrije (193 herbarijska lista). Prema pripadnosti pojedinim herbarijima ističu se herbarijski listovi iz zbirke Flora Dalmatiens (135). Na 223 herbarijske etikete nije navedeno kojoj zbirci pripadaju. U odnosu na dosada obrađeni dio herbarija navode se nove zbirke i to: E. Levier Plante neapolitane ex Aprutio, Flora Harohiva, Flora Hungarica ex herbario Vincentii Borbás, Flora Megapolitana, Flora silesiaca, Flora Steiermarks, Herb. Johannes Kunze Flora von Halle et Salle, Herbier du Pensionnat des Fréres, Kvetna Uhorska, Magyar flora Nŏgrád megye i Plante Suecicae.
Najviše herbarijskih listova sakupio je sam Studniczka (509). U odnosu na dosada obrađeni dio herbarija po prvi put se spominju slijedeći botaničari ili sakupljači biljnog materijala: Burle, Durand, Geisenheyner, Kindberg, Penzer, Rastern i Roux. Ukupno je u porodici *Compositae* (Ord. Compositeen) osim Studniczke, zabilježeno 123 sakupljača ili botaničara. Najstariji herbarijski list je iz 1855. god., a najmlađi iz 1904. god. Najveći broj herbarijskih listova, njih 613, sakupljeno je u razdoblju od 1871.-1880. god. Na 74 herbarijske etikete nije navedena godina sakupljanja.

ANALYSIS OF THE FAMILY COMPOSITAE FROM CARL STUDNICZKA'S HERBARIUM

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In the C. Studniczka's herbarium we have found new herbarium folders which contain herbarium samples from family *Compositae* (Ord. Compositeen) which one part has already been analysed (Vladović et al., 2013). We analysed the data from the new maps and integrated with already known data for the family *Compositae*. Most of the analysed herbal material (1079 herbarium sheets, with 2296 samples of herbal plants) in this part of the C. Studniczka's herbarium were collected in Europe (959 herbarium sheets). Most of the herbarium samples were collected in the area of Austria (193 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: E. Levier Plante neapolitane ex Aprutio, Flora Harohiva, Flora Hungarica ex herbario Vincentii Borbás, Flora Megapolitana, Flora silesiaca, Flora Steiermarks, Herb. Johannes Kunze Flora von Halle et Salle, Herbier du Pensionnat des Fréres, Kvetna Uhorska, Magyar flora Nŏgrád megye and Plante Suecicae. There are 223 herbarium sheets that are unmarked and therefore we do not know which herbarium collection they belong to. Apart from Studniczka, additional 123 collectors or botanists are registered. Most herbarium sheets were collected by Studniczka himself (509). Following botanist or collectors of herbal material are mentioned for the first time, in the part of the herbarium which has already been analysed, and there are: Burle, Durand, Geisenheyner, Kindberg, Penzer, Rastern and Roux. The oldest herbarium sheet dates from 1855, where as the newest ones date from 1904. The exact year of collection is missing from 74 herbarium labels.

FENOLOŠKE PROMJENE JABUKE U SJEVERNOJ HRVATSKOJ

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Vremenske prilike posljednjeg desetljeća sve manje prate poznate godišnje i sezonske hodove i sve je više ekstremnih vremenskih događaja koji ugrožavaju poljoprivrednu proizvodnju. Kako biljni svijet prvi reagira na vremenske i klimatske promjene u prirodi, praćenje i proučavanje razvojnih faza biljaka, čime se bavi fenologija, dobar su pokazatelj klimatskih promjena. Da bi se istražio utjecaj klimatskih promjena na rast i razvoj jabuke u sjevernoj Hrvatskoj, analizirani su fenološki podaci s postaje Štrigova. Proučavane su dvije sorte jabuke: jesenska stara sorta 'Bobovec' u razdoblju 1975. – 2015. i jesenska novija sorta 'Idared' u razdoblju 1987. – 2015. Za razliku od novih sorti čiji su plodovi veći, otporniji te oku ugodniji, mnogi ljubitelji jabuka složit će se da su mnoge stare sorte, iako ne tako privlačnog izgleda, daleko ukusnije. Dakako da su već pomalo i zaboravljene stoga što zbog nekih svojih karakteristika na tržištu ne mogu opstati (slabija otpornost na bolesti, skladištenje i transport). Kod jabuke se prate osam fenoloških faza: početak listanja, početak cvjetanja, puno cvjetanje, završetak cvjetanja, prvi zreli plodovi, berba, opće žućenje lišća i opće opadanje lišća. Osnovna statistička analiza pokazala je da u sjevernoj Hrvatskoj početak vegetacije sorte 'Idared' počinje početkom travnja, a sorte 'Bobovec' polovinom travnja, a završavaju polovinom studenoga za obje sorte. Zrenje plodova sorte 'Idared' počinje u prosjeku ranije (3. rujna) nego sorte 'Bobovec' (16. rujna). Stoga je i berba plodova sorte 'Idared' u drugoj polovini rujna, a sorte 'Bobovec' sredinom listopada. Primjena Mann-Kendallov rang testa za ocjenu signifikantnosti linearnog trenda i analize linearnih trendova fenofaza jabuke posljednjih desetljeća pokazale su raniji početak njihova cvjetanja oko -2 dana/10 godina i statistički značajan negativan trend punog i završetka cvjetanja od -3 do -5 dana/10 godina kao posljedicu povećanja proljetnih vrijednosti temperature zraka. Početak zrenja plodova za obje sorte počinje znatno ranije, ali ranija berba javlja se samo kod sorte 'Bobovec' (-3 dana/10 god). Kasnije opadanje lišća opaženo je samo kod sorte 'Bobovec' (2 dana/10 god). Utvrđeni raniji početak razvojnih faza jabuke od nekoliko dana u deset godina na prvi pogled ne izgleda puno. No, ako se uzme da bi u budućnosti do kraja 21. st. jabuke cvale i dozrijevale prije i do mjesec dana onda to pokazuje velik poremećaj u vegetacijskom ciklusu.

PHENOLOGICAL CHANGES IN APPLE TREES IN NORTHERN CROATIA

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In the last decade, the weather conditions are becoming increasingly less in line with the usual annual and seasonal cycles and the occurrence of extreme weather events that threaten agricultural production is more frequent. Since vegetation is the first to react to weather and climate changes in nature, monitoring and studying the developmental stages of plants, which is the focus of phenology, is a good indicator of climate change. In order to investigate the impact of climate change on the growth and development of apple trees in northern Croatia, phenological data from the meteorological station Štrigova were examined. Two cultivars of apples were analyzed: an old autumn apple cultivar 'Bobovec' in the period 1975-2015 and a newer autumn apple cultivar 'Idared' in the period 1987-2015. Unlike the new cultivars whose fruit is bigger, more resistant and nicer, many apple fans will agree that numerous old cultivars, although not as attractive, are much tastier. Of course, they have become somewhat forgotten because they cannot survive on the market (lower resistance to diseases, storage and transportation). Eight phenological phases of apple trees were observed: beginning of leaf-unfolding, beginning of flowering, full flowering, end of flowering, first ripe fruits, fruit ripe for picking, general colouring of leaves and leaf fall. Basic statistical analysis showed that in northern Croatia the vegetation of 'Idared' cultivar begins in early April and 'Bobovec' cultivar in mid-April, with an ending in mid-November for both cultivars. In general, the 'Idared' fruit ripening begins earlier (the 3rd of September) than 'Bobovec' (the 16th of September). Therefore, 'Idared' fruits are picked in the second half of September, and 'Bobovec' in mid-October. The application of Mann-Kendall rank test for assessing the significance of linear trend and the analysis of apple phenophases linear trends has shown in the last decades an earlier beginning of their flowering by approximately -2 days/decade and statistically significant negative trend in full flowering and the end of flowering by -3 to -5 days/decade as a result of an increase in spring air temperature values. The beginning of fruit ripening for both cultivars arises much earlier, but an earlier picking occurs only for 'Bobovec' (-3 days/decade). A delayed leaf fall was observed only in 'Bobovec' (2 days/decade). The determined earlier start of apple development phases by a few days in a decade does not seem significant at first glance. However, if assumed that in the future, by the end of the 21st century, apples may flower and ripe even a month earlier, then it shows a great disturbance in the vegetation cycle.

PROSTORNA I VREMENSKA RASPODJELA PELUDA AMBROZIJE U DVIJE RAZLIČITE SREDINE NA PRIMJERU ZADRA I ZAGREBA

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Rod *Ambrosia* obuhvaća 45 anemofilne biljne vrste od kojih su četiri rasprostranjene i na europskom kontinentu: *Ambrosia artemisiifolia* L. (*A. elatior* L.), *Ambrosia trifida* L., *Ambrosia psilostachya* DC i *Ambrosia tenuifolia* Spreng. Na području jugozapadne i jugoistočne Europe te u zapadnoj Aziji nativna je jedino *Ambrosia maritima* L. *A. artemisiifolia* prvi puta je registrirana 1941. godine u Slavoniji, Podravini i Posavini. Invazivno se širi kontinentalnom Hrvatskom, a posljednjih godina nalazimo je i na području Dalmacije i Istre. Ambrozija je izrazito prilagodljiva i otporna korovna biljka, s ljetno-jesenskom polinacijom, a na područjima rasprostranjenosti njena pelud predstavlja najjači alergen današnjice. Svakodnevna praćenja alergenog peluda u zraku provode se u Zadru i Zagrebu već dulji niz godina aerobiološkom volumetrijskom metodom (akreditirana metoda u Zagrebu) uporabom Burkard uređaja tipa Hirst.

Istraživanje prostorne i vremenske raspodjele peluda ambrozije provedeno je tijekom 2014. i 2015. godine. na području Zadra, predstavnika mediteranskog dijela, i na području Zagreba, predstavnika kontinentalnog dijela Hrvatske.

Dobiveni rezultati praćenja u obje istraživane godine pokazuju da prosječni udio peluda ambrozije u ukupnom peludnom spektru zraka Zadra iznosi 0,7%, a Zagreba 6,6%.

Peludni indeks, PI, (ukupna godišnja koncentracija peluda) je znatno viši u zraku Zagreba i iznosi 1867 za 2014. godinu i 1719 za 2015. PI u zraku Zadra iznosi 278 za 2014. godinu i 975 za 2015. godinu. Viši prosječni dnevni maksimumi zabilježeni su tijekom 2015. godine u oba istraživana gradska područja. U Zagrebu je zabilježen prosječni dnevni maksimum od 293 peludnih zrnaca/m^3 zraka, dok je u Zadru zabilježeno 133 peludnih zrnaca/m^3 zraka. Polinacijska sezona je dulja u Zagrebu. Za prikaz dvosatnih raspodjela koncentracije peluda tijekom dana korišten je intradiurnalni indeks (IDI). Vidljiva je razlika dnevne dinamike polinacije u oba istraživana područja.

Sukladno prostornoj i vremenskoj raspodjeli peluda ambrozije, višoj ukupnoj i dnevnoj koncentraciji, duljoj polinacijskoj sezoni s većim brojem dana visokog alergijskog rizika, utjecaj na kvalitetu svakodnevnog življenja alergičara je izraženiji u Zagrebu nego u Zadru.

SPATIAL AND TEMPORAL DISTRIBUTION OF RAGWEED POLLEN IN THE EXAMPLE OF ZADAR AND ZAGREB

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The genus *Ambrosia* includes 45 anemophilic plant species of which four are widespread on the European continent: *Ambrosia artemisiifolia* L. (*A. elatior* L.), *Ambrosia trifida* L., *Ambrosia psilostachya* DC and *Ambrosia tenuifolia* Spreng. In the southwestern and south-eastern Europe and in western Asia the only native one is *Ambrosia maritima* L. *A. artemisiifolia* was first registered in 1941 in Slavonia, Podravina and Posavina. It spreads invasive in continental Croatia, but in the recent years it is also recorded in Dalmatia and Istria. *Ambrosia* is extremely adjustable and resistant weed, with summer-autumn pollination and pollen with the strongest allergenic potential in the area of its distribution. Daily airborne pollen monitoring is conducted in Zagreb and Zadar for many years now using volumetric method (which is validated in Zagreb by Croatian Accreditation Agency) and Burkard volumetric samplers (type Hirst).
Spatial and temporal distribution of ragweed pollen was conducted in 2014 and 2015 in Zadar (Mediterranean part of Croatia) and Zagreb (continental part of Croatia).
The results of monitoring for both years show that the average share of ragweed pollen in the total pollen spectrum of Zadar is 0.7% and 6.6% in Zagreb.
Pollen index, PI, (total pollen count) is much higher in Zagreb and counts 1867 in year 2014 and 1719 in 2015. PI in Zadar is 278 in 2014 and 975 in 2015. Average daily maximum was higher in 2015 for both cities. Zagreb recorded average daily maximum of 293 pollen grains/m^3 of air, while in Zadar that count was 133 pollen grains/m^3 of air. Pollination season lasts longer in Zagreb. Diurnal pollen distribution (calculated with IDI- intradiurnal index) show difference in daily dynamic of pollen for both research areas.
Considering spatial and temporal distribution of ragweed pollen, higher total daily concentration and longer pollination season with more days of high allergic risk, impact on the quality of everyday life for allergic people is higher in Zagreb than in Zadar.

RAZNOLIKOST BILJNIH SVOJTI I STANIŠTA PLANINE MATOKIT (VRGORAC) - NOVA NALAZIŠTA ENDEMA

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Tijekom florističkog istraživanja i kartiranja staništa (2010. - 2015.) planine Matokit u okolici Vrgorca ukupno je inventarizirano 605 biljnih svojti i desetak vegetacijskih zajednica u raznim stadijima. Planina Matokit pripada submediteranskoj zoni s izraženim utjecajem planinske klime, a vegetacijski je raščlanjena prema nadmorskoj visini. S južne, teško pristupačne strane gusto je prekrivena makijom crnike (sveza *Quercion ilicis* Br.-Bl. (1931) 1936) i gustim sastojinama *Juniperus communis* L. koje se uzdižu i do 600 m n.v. Sa sjeverne strane Matokit je prekriven šumskom vegetacijom koja pripada svezi primorskih termofilnih šuma i šikara *Ostryo-Carpinion orientalis* Ht. (1954) 1959. Otvorene površine travnjaka u različitim stadijima sukcesije, protežu se hrptom u smjeru istok – zapad, a kombinacija su sveze istočnojadranskih kamenjarskih pašnjaka mediteransko litoralnog pojasa (*Chrysopogoni-Saturejon* Ht. et H-ić 1934) i sveze travnjaka epimediteransko-montanog pojasa (*Saturejon subspicatae* H-ić 1975). Na vršnim dijelovima oko 900 - 1000 m n.v. prisutna je as. *Seslerio juncifoliae-Caricetum humilis* Ht. 1930. Zanimljivo je da se zbog velikog utjecaja mediteranske klime iz sveze vegetacije vapnenačkih stijena *Centaureo-Portenschlagiellion* Trinajstić 1980, na 1000 m n.v. pojavljuje as. *Campanulo pyramidali-Moltkietum petraeae* H-ić 1963. Na planini Matokit zabilježeno je 25 endema u širem smislu i 5 stenoendema. Gotovo sva nalazišta endema predstavljaju nove lokalitete za područje planine Matokit. Najbrojnije vrste endema pripadaju porodicama *Fabaceae, Brassicaceae* i *Apiaceae*. Posebno zanimljive endemične svojte koje nisu uključene u knjizi *Endemi u hrvatskoj flori* su novo zabilježena vrsta za Hrvatsku floru *Cardamine fialae* Fritsch i nedavno opisana vrsta *Erysimum croaticum* Polatschek. Također zabilježen je križanac između dviju endemičnih vrsta perunika *Iris illyrica* Tomm. x *Iris pseudopalida* Trinajstić. Zabilježene su i neke, u Hrvatskoj usko rasprostranjene svojte kao što su *Thymus bracteosus* Vis. ex Benth. i *Linaria microsepala* A.Kern., a svojti *Vicia ochroleuca* Ten. ssp. *dinara* (K. Malý) Rohlena, Matokit predstavlja najjužniji zabilježeni lokalitet u Hrvatskoj. Svi herbarijski primjerci su digitalizirani i dostupni u ZAGR virtualnom herbariju (http://herbarium.agr.hr/).

PLANT AND HABITAT DIVERSITY OF MATOKIT MT. (VRGORAC) – NEW FINDINGS OF ENDEMIC TAXA

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During the floristic research and habitat mapping (2010-2015) of Matokit Mt. around Vrgorac, a total of 605 plant taxa and more than ten vegetation communities in various stages were found. Matokit Mt. belongs to the Submediterranean zone with a high influence of the mountain climate and the vegetation is vertically divided according to altitude. Southern side is difficult to access and is densely covered with maquis of alliance *Quercion ilicis* Br.-Bl. (1931) 1936, and large stands of *Juniperus communis* L. rising up to 600 m a.s.l. On the northern side Matokit Mt. is covered with forest vegetation that belongs to the thermophilous coastal forest and scrub *Ostryo-Carpinion orientalis* Ht. (1954) 1959. Open grasslands in various stages of succession, stretching along the mountain ridge east – west side, are combination of rocky pastures of eastern Mediterranean littoral zone (*Chrysopogoni-Saturejon* Ht. et H-ić 1934) and grasslands of epimediterranean-montane belt (*Saturejon subspicatae* H-ić 1975). At the peak mountain areas around 900-1000 m a.s.l. As. *Seslerio juncifoliae-Caricetum humilis* Ht. 1930 is developed. Because of the great influence of the Mediterranean climate, the alliance of limestone rocks *Centaureo-Portenschlagiellion* Trinajstić 1980 appears at 1000 m a .s l., specifically as. *Campanulo pyramidali-Moltkietum petraeae* H-ić 1963. On the Matokit Mt. we recorded 25 endemic species in the wider sense and 5 stenoendemics. Almost all the sites of endemic species represent new sites for Matokit Mt. area. The most numerous family of endemic species belong to *Fabaceae, Brassicaceae* and *Apiaceae* family. Especially interesting endemic species in the flora of Matokit Mt. that are not included in the book *Endemic species in the Croatian flora* are: *Cardamine fialae* Fritsch newly recorded species for Croatian flora and recently described species *Erysimum croaticum* Polatschek. Also hybrid populations between two endemic species (*Iris illyrica* Tomm. x *Iris pseudopalida* Trinajstić) were found. Some narrowly distributed species of Croatian flora were also found: *Thymus bracteosus* Vis. ex Benth. and *Linaria microsepala* A.Kern. Matokit Mt. represents the southernmost site for species *Vicia ochroleuca* Ten. ssp. *dinara* (K. Malý) Röhl. in Croatian flora. All herbarium specimens are digitized and available in ZAGR Virtual herbarium (http://herbarium.agr.hr/).

ISTRAŽIVANJE BOTANIČKI VRIJEDNIH VRSTA NA PODRUČJU PLIŠ-MALIŠĆAK-TURJAK-LAPJAK

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Područje Pliš – Mališćak – Turjak – Lapjak nalazi se u južnom dijelu Parka prirode Papuk sjeverno od naselja Velika i Radovanci. Dominantna šumska zajednica na tom području su šume hrasta medunca i crnog jasena koje su se razvile na strmim obroncima s pojedinačnim otvorenim travnjačkim staništima. Istraživanja su obuhvatila obilazak terena te bilježenje GPS točki na kojima su evidentirane biljne svojte značajne za ovaj tip staništa, a koje su u nekoj od kategorija zaštite. Zabilježeno je 29 GPS točaka kojima je obuhvaćeno 19 botanički značajnih svojti od kojih se ističu *Pulsatilla grandis* Wender, *Fritillaria orientalis* Adams (*F. tenella* Bieb.), *Epipactis helleborine* (L.) Crantz, *Ophrys insectifera* L. i *Platanthera bifolia* (L.) Rich. Određen je stupanj istraženosti, brojnost te procjena veličine populacije. U cilju očuvanja vrsta koje se nalaze na travnjačkim površinama u različitim stadijima sukcesije potrebno je provoditi uklanjanje drvenaste i grmolike vegetacije koja nadire na travnjačku površinu. Selektivnim krčenjem posebice borovice (*Juniperus communis* L.) potrebno je očuvati povoljni omjer između travnjaka i šikare, uključujući i sprječavanje procesa sukcesije. Kao hitna mjera, na mjestima malih travnjačkih površina potrebno je redovito odstraniti izraslo grmoliko raslinje i malo drveće pri čemu je moguće ostaviti pokoji grm radi očuvanja veće biološke raznolikosti. Da bi se došlo do bolje evidencije pojedinih svojti na istraživanim lokalitetima potrebno je vršiti kontinuirana istraživanja, posebice svojti koje su manje brojnošću.

RESEARCH OF BOTANICAL VALUABLE SPECIES IN THE AREA PLIŠ-MALIŠĆAK-TURJAK-LAPJAK

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Area Pliš - Mališćak - Turjak - Lapjak is located in the southern part of the Nature Park Papuk, north of the villages of Velika and Radovanci. Dominant forest communities in the area are forests of oak and black ash that have developed on the steep slopes of individual open grassland habitats. The research included field investigations and recording of GPS points that where characteristic plant species for this type of habitat were spotted, and which are in one of the categories of protection. We recorded 29 GPS points which included 19 botanical taxa. Some of the most significant ones are: *Pulsatilla grandis* Wender, *Fritillaria orientalis* Adams (*F. tenella* Bieb.), *Epipactis helleborine* (L.) Crantz, *Ophrys insectifera* L. and *Platanthera bifolia* (L.) Rich. There has been some level of research, quantity and estimate of population size. In order to preserve species that are found in the grassland areas at different stages of succession, it is necessary to carry out the removal of woody and bushy vegetation encroaching the grassland. Selective clearing, particularly of juniper (*Juniperus communis* L.), is necessary to preserve the favourable ratio between the grass and shrubs, including the prevention of the succession process. As an emergency measure, areas with small grassy areas should regularly have the grown bushy undergrowth and small trees removed, while it is possible to leave the occasional shrub to preserve greater biodiversity. In order to achieve better records of some species at studied sites, it is necessary to carry out continuous research, particularly of the species that are smaller in numbers.

BENTIČKE DIJATOMEJE – POKAZATELJI EKOLOŠKOG STANJA KRŠKIH JEZERA

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Fitobentos je jedan od bioloških elemenata kakvoće prema Okvirnoj Direktivi o vodama (ODV) te predstavlja ključnu komponentu u ocjeni ekološkog stanja jezerskih ekosustava. Unatoč tome, fitobentičke i perifitonske zajednice nekoliko su desetaka puta slabije istražene od odgovarajućih fitoplanktonskih zajednica jezera (Cantonati i Lowe 2014). Dijatomeje, kao značajne predstavnike fitobentosa, odlikuju kratak životni ciklus, široka rasprostranjenost te osjetljivost na vrlo male okolišne promjene, što omogućava jednostavno praćenje stanja sustava i otkrivanje uzroka promjena u sustavu. Rasprostranjenost i sastav dijatomejske zajednice izrazito su ovisni o dubini i vrsti podloge, količini dostupne svjetlosti i zasjenjivanju. Obalni pojas jezera nastanjuju vrste koje su prilagođene na visoku osvijetljenost, veće temperaturne oscilacije i stalna kolebanja razine vode. U dubokoj zoni, gdje često prevladavaju uvjeti slabijeg prodora svjetlosti, jak učinak zasjenjivanja od strane fitoplanktona te smanjena koncentracija kisika i procesi bakterijske razgradnje, razvija se sastavom drugačija dijatomejska zajednica. Zbog svoje očuvanosti i stupnja zaštite Plitvička jezera, specifična hidrogeološka krška pojava sastavljena od 16 baražnih jezera, referentan su sustav za određivanje kakvoće vode i praćenje promjena fitobentoske zajednice krških jezera. Cilj je istraživanja prema sastavu i brojnosti fitobentoskih dijatomeja odrediti ekološko stanje jezera Kozjak i Prošće. Uzorci fitobentosa u oba jezera prikupljani su tijekom 2015. i 2016. godine s najdublje točke i s obalnog područja. Usporedno su uzimani i uzorci za kemijsku analizu vode. Nakon čišćenja i izrade trajnih preparata dijatomeje su određivane i brojane do 400 ljuštura na svakom preparatu. Kakvoća vode istraživanih jezera određena je na temelju dijatomejskih indeksa: Hrvatski saprobni indeks - SI_{HRIS}, Hrvatski trofički indeks dijatomeja - TID_{RH} i indeks organskog opterećenja - IPS. Odnos zastupljenosti dijatomeja i koncentracije hranjivih soli obrađen je multivarijatnom analizom kanoničke korespondencije (CCA), kako bi se odredio utjecaj kemijskih i fizikalnih čimbenika na sastav dijatomejskih zajednica.

BENTHIC DIATOMS – INDICATORS OF ECOLOGICAL STATUS OF KARSTIC LAKES

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Phytobenthos, one of biological quality elements according to the Water Framework Directive (WFD), is a key component in the evaluation of the ecological status of lake ecosystems. Nevertheless, studies on phytobenthic and periphytic communities in lakes are vastly outnumbered when compared with the corresponding phytoplanktic communities (Cantonati & Lowe 2014). Diatoms, as the most important representatives of phytobenthos, are characterized by having a short life cycle, widespread distribution and a distinct sensitivity to the slightest environmental changes. These features enable a relatively easy monitoring of an ecosystem and detection of changes in the ecological status. Distribution and composition of diatom communities are mainly conditioned by the lake depth and substrate type, the amount of available light and shading effect. The shallow littoral strip of the lake is inhabited by species adapted to high irradiance, large temperature oscillations and constant fluctuations in the water level. In the lake's deep zone, where conditions are often dominated by low light availability, strong effect of shading by phytoplankton and attenuated oxygen concentration with bacterial degradation processes, a distinct diatom community is present. Plitvice Lakes, a specific hydrogeological phenomenon composed of 16 cascading lakes, constitutes a referent lake ecosystem for the water quality evaluation and monitoring of the phytobenthic community. The purpose of this study was to compare differences in the composition and abundance of diatom communities and to determine the ecological status of lakes Kozjak and Prošće. Benthic samples, along with the samples for chemical analysis of water, were collected during 2015 and 2016, from the deepest point and from the shallow littoral point on both lakes. After cleaning of samples and preparation of permanent slides diatoms were identified, measured and counted to 400 frustules on each slide. Water quality of the investigated lakes was determined using several multimetric diatom indices: Croatian saprobic index - SI_{HRIS}, Croatian trophic diatom index - TID_{RH}, Pollution Sensitivity Index - IPS. The relationship between samples and nutrient concentrations was tested using multivariate analysis of canonical correspondence (CCA) to investigate the influence of chemical and physical factors on the composition of the community.

Nastavnička sekcija

Education section

PRIMJENA HERBARA U NASTAVI BIOLOGIJE

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Nastava botanike učenicima je često suhoparna i zamorna. Jedan od načina kako je učiniti zanimljivijom može biti izrada herbara. Prilikom izrade učenici razvijaju niz kompetencija viših razina (determiniranje, provjeravanje i kategoriziranje biljnih svojti, stvaranje vlastite zbirke i dr.), opažaju biljke u njihovom prirodnom okruženju i upoznaju se s raznolikošću biljnoga svijeta. Herbar može poslužiti kao izvrstan nastavni materijal učenicima i nastavniku prilikom obrade sadržaja iz botanike svih uzrasta. Ovisno o pravilima izrade koje postavi nastavnik učenicima, herbar se može primijeniti u nastavi nižih i viših razreda osnovne škole, kao i u srednjim školama svih profila gdje se radi nastava iz botanike. Iskustva korištenja herbara u nastavi pokazuju da učenike treba detaljno usmjeriti kako bi im se olakšala izrada herbara te im jasno obrazložiti načine i kriterije vrednovanja njihovog rada (izgled prešanih biljaka, točnost podataka na etiketama, poštivanje prethodno zadanih pravila izrade i sl.). Primjena herbara u nastavi može imati svoje pozitivne (praktični rad, približavanje botanike učenicima, zabava i dr.) i negativne strane (vrijeme potrebno za izradu i kasnije vrednovanje, stres i frustracije, nezadovoljstvo učenika rezultatima i dr.).

ODGOJNE MOGUĆNOSTI ŠKOLSKIH VRTOVA I MOGUĆNOST REALIZACIJE DIJELA NASTAVE U ŠKOLSKOM VRTU

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Osnovna škola ne treba biti samo mjesto nastave, ona mora biti i prostor življenja, učenja i iskustva. Idealno mjesto za obradu brojnih nastavnh sadržaja je školski vrt. U školskom vrtu mogu se realizirati svi nastavni predmeti, a takva nastava temelji se na vlastitim iskustvima. Stručnjaci su u svojim istraživanjima došli do zaključka da školski vrtovi potiču intelektualni, emocionalni i društveni angažman kod učenika. Rad u vrtu razvija kod učenika brigu za druga živa bića, svijest o okolišu. Djeca rado sudjeluju u nastavi koja se odvija u školskom vrtu, spontanija su, dolaze brže do zaključka. Kroz istraživačku nastavu učenici lakše usvajaju znanja.U školskim vrtovima također se može vrlo kvalitetno organizirati i slobodno vrijeme.

KLJUČNI KORACI U EVOLUCIJI KOPNENIH BILJAKA

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Velika anoksija koja se prije nekih 500 milijuna godina dogodila u svjetskim morima vjerojatni je otponac koji je pokrenuo izlazak biljnog života iz vode. Kopnene biljke su, pak, trajno mijenjale lice Zemlje tvoreći svijet kakav nam je danas poznat. U ovom se predavanju ističu ključni događaji u evoluciji biljaka te ih se pokušava dovesti u kontekst blizak i razumljiv učenicima srednjih škola. Pretke kopnenih biljaka nalazimo kod zelenih alga, iako je još uvijek donekle nejasno s kojom skupinom unutar njih su najsrodnije. No, na temelju fosiliziranih spora iz ordovicija, starih oko 470 milijuna godina, možemo zaključiti da su prve kopnene biljke bile uvelike nalik današnjim mahovinama jetrenjačama – bez složenijih tkiva i vrlo ovisne o vodi iz okoliša. Osnovni izazovi – selekcijski pritisci – s kojima su se morale suočiti bili su kako doći do vode, te kako tu vodu dovesti u sve one dijelove koji nisu u izravnom kontaktu s tlom. Sljedeći veliki izazov je bio kako omogućiti spajanje gameta, oplodnju, van vodenog okoliša. Prvi izazov, primanje i provođenje vode, počeo se rješavati prije nekih 430 milijuna godina, u siluru, pojavom prvih potpuno izoliranih provodnih elementa. Oni su omogućili znatno uspješniju kolonizaciju kopnenih staništa i prvu veliku diversifikaciju biljnog svijeta – devonsku eksploziju. Pritom se događao još jedan važan proces, stvaranje tla. Naime, prije pojave kopnenih biljaka nije bilo ni tla. Postojala je samo litološka podloga, a biljke su u simbiozi s gljivama pospješile njeno trošenje i miješanjem s odumrlim biljnim dijelovima stvorile prvo rastresito, humozno tlo. No, sve su te biljke za oplodnju još uvijek trebale vodu iz okoliša. One su bile papratnjače. Tu potrebu za vodom zadržali su i njihovi današnji srodnici. Problem prijenosa spolnih stanica zrakom riješen je tako da su upakirane u nepropusne paketiće koji ih zaštićene prenose zrakom. Ti paketići su peludna zrna i ona nose muške spolne stanice. Time se u evolucijskoj povijesti bilja po prvi puta javila mogućnost prijenosa genetičkog materijala zrakom. S druge strane, jajna stanica ostaje na matičnoj biljci ovijena s nekoliko zaštitnih ovoja, a od čitave te strukture nakon oplodnje nastaje sjemenka, jedno od najrevolucionarnijih dostignuća u evoluciji biljaka. Pojava sjemenke omogućila je da nova biljka doslovno nastaje na majčinskoj biljci upakirana u zaštitne omotače i opskrbljena hranjivim tvarima. Sjemenka je omogućila dotad nedostižne načine rasprostranjivanja biljaka. Time su prije nekih 350 milijuna godina rođene golosjemenjače, iako se pojava prvih sjemenki veže uz neke starije skupine otprije 385 milijuna godina. Prije otprilike 300 milijuna godina Zemlju pogađa globalno ledeno doba. Klima postpuno postaje suša i hladnija, tropske šume i močvare se povlače, a time se gube i odgovarajuća staništa za dotad dominantne papratnjače. No, golosjemenjače, preadaptirane za život u takvim uvjetima, uspješno osvajaju nova staništa i globalno se šire. Mezozoik postaje dobom golosjemenjača. Do sljedeće i zasad posljednje „revolucije u evoluciji“ biljaka dolazi u kredi, prije oko 140 milijuna godina pojavom kritosjemenjača ili

cvjetnica. One su zadržale evolucijske novitete golosjemenjača, peludno zrno i sjemeni zametak, no njega su ovile novim zaštitnim slojem i smjestile ga u cvijet. Pojava cvijeta, odnosno njegovih boja, mirisa i hrane koju nudi omogućila je da raznošenje peludi ne bude više ovisno o nasumičnosti vjetra, nego je ciljno povjereno kukcima. Time je stvoreno jedno od najuspješnijih partnerstva u evoluciji života na Zemlji, omogućivši da cvjetnice postanu najbrojnija skupina biljaka, a kukci najbrojnija skupina životinja. Zaštitni ovoj oko sjemenke omogućio je pojavu novog organa – ploda – koji je neslućeno povećao mogućnosti rasprostranjivanja sjemenki. Time je nastao biljni svijet kakav danas znamo i koji je temelj egzistencije svih ostalih kopnenih organizama i ljudske civilizacije.

CIJANOBAKTERIJE I NJIHOVA ULOGA U EVOLUCIJI FOTOSINTETSKIH ORGANIZAMA

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Zemlja je nastala prije 5 milijardi godina zajedno sa 149.6 x 10^6 kilometara udaljenim Suncem. U procesu nastajanja niza objekata i planeta Sunčevog sustava, jedino se Zemlja našla na udaljenosti koja je omogućila sva tri agregatna stanja vode, a time i stvaranje života. Zemlja je dinamični sustav u kojem se energija neprestano izmjenjuje i zahvaljujući tome stvarali su se oceani, planine, kontinenti, ali i prije nekoliko milijardi godina atmosfera. Niz promjena stvorile su iz, kako se za sada čini, HCN i H_2S uz pomoć UV zračenja, prekrusore nukleinskih kiselina (RNA). Procesi i reakcije koji su doveli do stvaranja nukleinskih kiselina također su doveli istovremeno i do nastajanja aminokiselina i lipida, kao početnih dijelova života. Nastali su jednostanični organizmi koje mi danas nazivamo prokariotima. Neki od prokariotskih organizama prije 3,5 milijarde godina uz pomoć ključne molekule, proteina D1, kao srca fotosintetske reakcije, u procesu fotosinteze, počeli su proizvoditi kisik. Kisik koji je dospijevao u okolinu u početcima se trošio za niz oksidacijskih procesa, a u konačnici za nastajanje atmosfere. Prokariotski fotosintetski organizmi su više od milijardu godina postepeno mijenjali atmosferu čineći je prikladnom za novi korak u evoluciji i život na Zemljinoj površini. Tragovi prokariotskih autotrofnih organizama pronađeni su u fosilnim nalazima iz prekambrijskog razdoblja i danas ih nazivamo Cijanobakterijama. Na Zemlji su prije 3,8 milijardi godina nastali i eukariotski organizmi. Razlika u strukturi stanice između prokariota i eukariota predstavlja najveću evolucijsku nezavisnost u živom svijetu danas i mnogo je veća od same činjenice postojanja ili nepostojanja jezgrine membrane. Prokarioti su naizgled jednostavniji u strukturi, ali ne i nužno u kemijskim procesima. Pogled kroz elektronski mikroskop otkriva nam mnogobrojne strukture koje su omogućile ovim organizmima da milijarde godina žive na Zemlji gotovo nepromijenjeni. Usporedbama morfologije cijanobakterija iz prekambrijskog razdoblja i danas otkriva nam nevjerojatnu činjenicu da su gotovo morfološki istovjetne. Osim što imaju jednu od ključnih uloga u stvaranju živog svijeta na Zemlji imaju i jedinstvenu ulogu nastajanju eukariotskih fotosintetskih organizama. U procesu koju nazivamo endosimbioza prije 1,5 milijardi godina od cijanobakterija nastao je plastid i od proteobakterija mitohondrij. Oba organela u evoluciji su izmjenom svojih biokemijskih reakcija i smanjenjem genoma kodirali svoje proteine u jezgri eukariotske stanice, odnosno postali trajno njeni sastavni dio. Teorija endosimbioze upravo tvrdi da je slijedom priliva prokariotskih gena u eukariotsku jezgru, epizodno došlo do stvaranja novih fotosinteskih eukariotskih organizama. Uslijedili su procesi primarne, sekundarne i tercijarne endosimbioze i evolucijskog razvoja svih danas poznatih algi i biljka na Zemlji.

INTERSPECIJSKE ASOCIJACIJE GLJIVA

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Gljive ulaze u čitav spektar međuodnosa s mnogim drugim živim organizmima; raznolikost simbiotskih odnosa u koje ulaze, posljedica su izuzetno dugotrajne koevolucije glavnih evolucijskih linija gljiva s algama, biljkama i životinjama. Unatoč tome, ove simbioze su vrlo često marginalizirane. Lišajevi su najčešći i najvidljiviji primjer simbiotskog odnosa gljiva i drugih organizama. Ovaj tradicionalni primjer mutualizma u kojemu oba partnera, i gljiva i alga, imaju korist ipak nije tako jednostavan kako se na prvi pogled čini. Novije spoznaje dovode u pitanje koliko je značajan doprinos gljive zajednici i njezin odnos prema fikobiontu, ponajviše zato jer je alga u potpunosti sposobna za samostalan život, dok mikobiont nije. Drugi česti primjer simbiotskog odnosa u koje ulaze gljive su mikorize – asocijacija hifa gljiva i korijenja biljaka. Ovaj tip partnerskog odnosa gljiva i biljaka može pokrivati čitav spektar simbioza – od potpuno mutualističkog gdje i biljka i gljiva imaju koristi od asocijacije, preko djelomično parazitskog u kojem prehrana biljke u određenom periodu života u potpunosti ovisi o gljivi, do potpuno parazitskog odnosa, u kojem biljke svoje nutritivne zahtjeve u potpunosti pokrivaju parazitiranjem na gljivi. Jedan od najvažnijih primjera simbiotskog odnosa biljaka i gljiva je ipak pravi parazitiam, u kojem gljiva svoje nutritivne zahtjeve pokriva na štetu biljke domaćina. Posljedice parazitiranja gljiva na biljkama često su vrlo jasno vidljive s obzirom da mogu uzrokovati drastično uništenje tkiva domaćina, odnosno, smanjenje prinosa agronomski značajnih biljaka. Naravno, među fitoparazitskim gljivama također imamo čitav niz prijelaza, od saprotrofnih koje mogu biti fakultativno nekrotrofne do pravih biotrofnih parazita. Osim fitoparazitskih gljiva, važno mjesto u ekosustavima zauzimaju i zoopatogene, mikopatogene i fikopatogene gljive. I dok one u prirodi zauzimaju specifične niše, njihova upotreba u biološkoj kontroli određenih štetnih vrsta je od posebnog interesa za čovjeka. Tako se određene mikoparazitske gljive mnogu koristiti za sprečavanje razvoja drugih bolesti uzrokovanih gljivama na poljoprivredno važnim kulturama, dok se zooparazitske gljive mogu upotrebljavati za kontrolu poljoprivrednih štetnika (kukaca i oblića). Simbiotski odnosi gljiva i životinja također su vrlo zanimljivi, no često zanemareni i previđeni. Jedan od najpoznatijih primjera je simbioza s mravima ili termitima, koji uzgajaju gljivične vrtove. Ovaj zanimljivi i jedinstveni odnos kukaca koji se brave poljoprivredom samo pokazuje fleksibilnost živih organima i kompleksnost interakcija u koje ulaze. Kada je riječ o odnosu čovjeka s gljivama, raspon simbiotskih odnosa je iznimno velik: uzgoj gljiva za ljudsku konzumaciju, korištenje u farmaceutskoj i prehrambenoj industriji, patogeni koji mogu uzrokovati vrlo teške infekcije, posebno kod imunokompriomitiranih osoba. Kompleksnost interakcija gljiva s drugim organizmima odraz je snage evolucijskih procesa kao i izdržljivosti ove vrlo važne skupine organizama koja je diskretno, ali kontinuirano, prisutna među mnogo većim i „glasnijim“ bićima.

ŠTO RADIMO KRIVO: POGREŠNE PREDODŽBE O PROCESU FOTOSINTEZE

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Razna istraživanja pokazuju da učenici često pogrešno tumače mnoge, osobito one teže shvatljive pojmove iz nastavnog programa prirode i biologije. To otežava daljnje školovanje jer se pogrešne predodžbe i koncepti teško ispravljaju. U nastavnim materijalima i udžbenicima koje koriste studenti i nastavnici biologije često nailazimo na pogrešno tumačenje činjenica o složenim procesima osobito onima vezanim uz biljke. Mnoge pogrešne predodžbe posljedica su pojednostavljivanja složenijih pojmova, poopćavanja te korištenja pogrešnih i pojednostavljenih naziva. Proces fotosinteze vrlo je složen i teško pojmljiv proces koji često pokušavamo pojednostavljeno prikazati studentima i učenicima pa dolazi do pogrešnog razumijevanja i/ili nerazumijevanja. Tako na primjer možemo čuti da se u biljaka fotosinteza odvija danju, a stanično disanje noću, da je za proces fotosinteze potreban samo ugljikov dioksid, voda, svjetlost i klorofil. Korištenje povijesnog naziva „reakcije u tami“ za sekundarne reakcije fotosinteze može navesti učenike i studente na krivi zaključak da se fiksacija ugljikovog dioksida odvija noću. Stoga je važno utvrditi koje su to predodžbe o procesu fotosinteze najčešće pogrešne te s njima upoznati nastavnike kako bi se spriječio njihov nastanak.

Stručna ekskurzija

Excursion

POSTKONGRESNA STRUČNA EKSKURZIJA U NACIONALNI PARK “KRKA”

Nacionalni park “Krka” nalazi se u sjevernoj Dalmaciji, površine je 109 km^2 i obuhvaća gotov čitav tok rijeke Krke i donji tok njene pritoke Čikole. Iako su pojedini dijelovi toka Krke bili i ranije zaštićeni, čitavo područje proglašeno je nacionalnim parkom tek 1985. Temeljni fenomen rijeke Krke - sedrene barijere i ostali krški oblici, čine osnovu njene krajobrazne i biološke raznolikosti. Osim geomorfoloških i hidroloških vrijednosti, ovo područje karakterizira i izuzetno floristično bogatsvo, zbog čega je NP Krka i važno botaničko područje (IPA) u Hrvatskoj. Fitogeografski, Park pripada submediteranskoj zoni koju karakteriziraju listopadne šume hrasta medunca sveze *Ostryo-Carrpinion orientalis*, a koja je uslijed ljudskog djelovanja tijekom stoljeća značajno degradirana u niske šume, šikare, suhe travnjake i kamenjarske pašnjake. No u posljednjih nekoliko desetljeća, napuštanjem tradicionalne ispaše i sječe zbog jake depopulacije, ovaj je proces preokrenut u smjeru progresivne vegetacijske sukcesije. Početkom 19. stoljeća prva botanička istraživanja ovog područja provodi Roberto Visiani, no prvo sustavno istraživanje provedeno je tek u periodu od 1989. do 1991. godine. Kontinuirano floristično kartiranje u posljednjih 10 godina rezultiralo je s ukupno 1180 biljnih svojti, što čini preko 20 % hrvatske flore. Ovo veliko floristično bogatstvo posljedica je fitogeografskog položaja, velike raznolikosti staništa i dugotrajnih utjecaja čovjeka na floru i vegetaciju područja.

Voditelji ekskurzije: Vedran Šegota, Nina Vuković i Antun Alegro
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POST CONGRESS EXCURSION TO THE NATIONAL PARK “KRKA”

Krka National Park in Northern Dalmatia, with an area of 109 km^2 embraces almost the whole course of the Krka River, and lower course of the Čikola tributary. After initial protection of several course segments, the whole area was finally proclaimed a national park in 1985. The key phenomena of the Krka River are the travertine waterfalls and other karst formations, which are forming the backbone of landscape and biological diversity. Beside great geomorphological and hydrological values, this area exhibits exceptional floristical richness and was accordingly identified as important plant area (IPA) in Croatia. Regarding phytogeographical position, the area belongs to the sub-Mediterranean zone, mainly characterised by deciduous forests dominated by downy oak (all. *Ostryo-Carrpinion orientalis*), during the centuries largely degraded by human impact into low forest, shrubberies, dry grasslands and rocky pastures. On the contrary, abandonment of traditional pasturage and wood cutting caused by strong depopulation in the last decades has inverted this process, in the direction of progressive vegetation succession. The flora of this area has been studied from as early as the 19th century by Roberto Visiani, however, the first comprehensive research was done in the period between 1989 and 1991. Continuous floristic field studies in last 10 years revealed a species list of 1180 taxa, representing more than 20 % of the total Croatian flora. This great floristic richness is the result of the Parks phytogeographical position, diversity of habitats and long-lasting anthropogenic influence on the flora and vegetation of the area.

The excursion will be guided by: Vedran Šegota, Nina Vuković & Antun Alegro
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