

TREĆI HRVATSKI BOTANIČKI KONGRES
Third Croatian Botanical Congress

2010

KNJIGA SAŽETAKA
BOOK OF ABSTRACTS

TREĆI HRVATSKI BOTANIČKI KONGRES
Third Croatian Botanical Congress

S MEĐUNARODNIM SUDJELOVANJEM
with international participation

MURTER, 24.-26. RUJNA 2010.
Murter, Croatia, September 24th-26th 2010

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PREDGOVOR

Zadovoljstvo mi je pozdraviti vas u kompleksu turističkog naselja Lovišća–Ježera na otoku Murteru, mjestu gdje će se održati Treći hrvatski botanički kongres s međunarodnim sudjelovanjem. Nama koji smo bili uključeni u organizaciju Kongresa posebice je drago što sudjelujete u radu te vam želimo uspješna izlaganja i ugodan boravak na otoku gdje se miris smija i slavuje miješa s mirisom mora.

Kongres organizira Hrvatsko botaničko društvo s ciljem promicanja suradnje i razmjene znanstvenih i stručnih informacija s područja botanike i srodnih struka. Uz unapređivanje botanike kao znanosti sudionici ovoga skupa doprinjet će unapređenju botaničkih spoznaja na popularnoj, stručnoj i nastavnoj razini. Očekujem da će dostignuća i spoznaje ovog Kongresa imati svoje uporište u promicanju i zaštiti biološke raznolikosti, a primjenjena botanika u provođenju projekata održivog razvoja hrvatskog gospodarstva.

Ovo je prvi put da se botanički kongres održava u maloj sredini i na malom otoku te mi je posebice drago što ovaj kongres ne zaostaje, ni po broju sudionika ni po broju priopćenja za prethodnim koja su održana u Zagrebu.

Program Kongresa sastoji se od dva plenarna izlaganja, 39 usmenih i 71 postersko izlaganje u okviru deset tema te jednog okruglog stola.

U izradi priloga sudjelovalo je oko 250 znanstvenika i stručnjaka, a njih stotinjak će izložiti svoje znanstvene i stručne spoznaje na čemu im zahvaljujem. Ovaj broj je nadmašio sva naša očekivanja u vrijeme kad smo započeli s organizacijom Kongresa. Osim hrvatskih znanstvenika raduje me sudjelovanje kolega iz Albanije, Austrije, Bosne i Hercegovine, Češke, Francuske, Italije, Kanade, Mađarske, Makedonije, Malezije, Poljske, SAD-a, Slovenije, Srbije, Švicarske, Turske i Velike Britanije.

U ime Organizacijskog odbora Trećeg hrvatskog botaničkog kongresa zahvaljujem svima koji su svojim znanjem i radom te financijskom pomoći omogućili da se ovaj Kongres održi.

Svoju zahvalu dugujem i pokroviteljima te sponzorima bez čije potpore ovog Kongresa ne bi bilo.

Još jednom želim vam ugodan boravak u turističkom naselju Lovišća. Za potpuni doživljaj pobrinut će se orkestar cvrčaka koji će u krošnjama borova svirati Odu radosti i potaknuti vas na biološku raznolikost vaših promišljanja.

U ime Organizacijskog odbora Trećeg hrvatskog botaničkog kongresa,

Dr. sc. Marija Pandža, predsjednica

PREFACE

It is my great pleasure to welcome you all here in the Lovišća-Jezera tourist resort on the island of Murter, a place where the Third Croatian Botanical Congress will be held. Both, the Organizing and the Scientific Committee members are delighted to have you all here with us this weekend. We are sure you will also enjoy a great time here on this island where the scents of *Helichrysum italicum* and *Salvia officinalis* mix up with the scent of the sea.

This Congress was organized by the Croatian Botanical Society, in order to promote cooperation and exchange of scientific information in the field of botany and related scientific branches. It will contribute not only to botany as a science but to the botanic finds on popular, scientific and teaching levels as well. I also expect the accomplishments and the results of this Congress to have their effects in the promotion and protection of biological diversity and realization of sustainable development projects in Croatian economy resulting from the applied botany.

This is the first Croatian botanical congress organized in such a small place, this small island. Therefore, we are very happy to say that it completely equals the previous two held in Zagreb, both regarding the number of participants and their presentations.

The Program of the Congress consists of two plenary sessions, 39 oral and 71 poster presentations within ten themes and one round table. All the presentations have been prepared by some 250 scientists and experts and about a hundred of them will present their latest scientific work. This was all beyond our expectations at the time we started preparations for the Congress. Apart from Croatian scientists and experts, we are pleased to welcome our dear guests from Albania, Austria, Bosnia and Herzegovina, Canada, Czech Republic, France, Hungary, Italy, Macedonia, Malaysia, Poland, Serbia, Slovenia, Switzerland, Turkey, UK and USA.

On behalf of the Organizing Committee of the Third Croatian Botanical Congress and my own, I wish to thank all those who contributed either financially or by their work and knowledge and made this Congress possible.

Once again, I hope you will enjoy this place. A famous cricket orchestra in the Aleppo-pine trees will enhance the atmosphere. They are going to play Beethoven's *Ode to Joy* for you and help you make the Congress a memorable event!

On behalf of the Organizing Committee of the Third Croatian Botanical Congress,

Marija Pandža, PhD, President

ORGANIZACIJA

Hrvatsko botaničko društvo

ORGANIZATION

Croatian Botanical Society

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Ivan Klarin, Tisno

**PROGRAM
PROGRAMME**

**USMENA IZLAGANJA
ORAL PRESENTATIONS**



PETAK, 24. RUJNA 2010. / FRIDAY, SEPTEMBER 24, 2010

9:00 – 9:15 Otvorenje / Opening Ceremony

**PLENARNA PREDAVANJA
PLENARY**

Moderator / Chair: S. Kovačić

9:15 – 10:00

G. M. Schneeweiss

PHYLOGENY AND EVOLUTION OF THE NON-PHOTOSYNTHETIC *OROBAN-*
CHE (*OROBANCHACEAE*) AND RELATED GENERA

10:00 – 10:45

M. Weber

UNUSUAL POLLEN FEATURES

10:45 – 11:15 Stanka / Coffee break

**TAKSONOMSKA ISTRAŽIVANJA
TAXONOMIC RESEARCH**

Moderatori / Chairs: B. Mitić, A. Alegro

11:15 – 11:30

S. Bogdanović, I. Rešetnik, Z. Liber, S. Brullo

NOVA HAZMOFITSKA SVOJTA IZ *CAMPANULA* SER. *GARGANICAE* TRINAJ-
STIĆ (*CAMPANULACEAE*) S OTOKA VISA (HRVATSKA) / A NEW CHASMOP-
HYTIC TAXON OF THE *CAMPANULA* SER. *GARGANICAE* TRINAJSTIĆ (*CAMPA-*
NULACEAE) FROM THE ISLAND OF VIS (CROATIA)

11:30 – 11:45

S. Stefanović, Z. Liber, T. Nikolić, B. Surina, S. Kovačić, D. Lakušić

MOLECULAR PHYLOGENY OF *CAMPANULA PYRAMIDALIS* COMPLEX (*CAM-*
PANULACEAE): TAXONOMIC AND BIOGEOGRAPHIC IMPLICATIONS

11:45 – 12:00

W. M. M. Eddie, S. Kovačić

TOWARDS A RESOLUTION OF THE “*CAMPANULA* PROBLEM”

12:00 – 12:15

M. Kaligarič, B. Bohanec, B. Simonovik, N. Šajna, M. Regvar

ON THE VARIABILITY OF GLASSWORTS (*SALICORNIA* L.) FROM THE GULF
OF TRIESTE (NORTHERN ADRIATIC)



12:15 – 12:30

N. Hristovski, V. Milosavljević, N. Randelović
THE NEW SPECIES OF THE GENUS *CROCUS* L. - *CROCUS JABLANICENSIS*

MOLEKULARNA BOTANIKA I FIZIOLOGIJA BILJA
PHYSIOLOGY AND MOLECULAR BIOLOGY OF PLANTS

Moderator / Chair: Ž. Škvorc

12:30 – 12:45

J. Antunović, S. Mlinarić, H. Lepeduš, A. Lalić, J. Kovačević, V. Cesar
BIOKEMIJSKI ODGOVORI KLIJANACA JEČMA NA STRES IZAZVAN SUŠOM
/ BIOCHEMICAL RESPONSES OF BARLEY SEEDLINGS INDUCED BY DROU-
GHT STRESS

12:45 – 13:00

K. Sever, Ž. Škvorc, D. Krstonošić, I. Alešković, M. Temunović, I. Seletković, N.
Potočić, J. Franjić
SADRŽAJ KLOROFILA I SEZONSKA DINAMIKA DUŠIKA U LISTOVIMA HRA-
STA LUŽNJAKA (*QUERCUS ROBUR* L.) / CHLOROPHYLL CONTENT AND SEA-
SONAL DYNAMIC OF NITROGEN IN LEAVES OF PEDUNCULATE OAK (*QUER-
CUS ROBUR* L.)

13:00 – 14:45 Ručak / Lunch

PRIMIENJENA BOTANIKA I ZAŠTITA PRIRODE
NATURE CONSERVATION AND APPLIED BOTANY

Moderator / Chair: N. Jasprica

14:45 – 15:00

B. Dorbić, N. Gačina, M. Krnčević, Ž. Krnčević, M. Srpak
POVEZANOST PČELARSTVA I HORTIKULTURE KROŽ ODRŽIVI RAZVOJ SRI-
ME KOD ŠIBENIKA / CONNECTION BETWEEN BEEKEEPING AND HORTI-
CULTURE THROUGHOUT SUSTAINABLE DEVELOPMENT OF SRIMA NEAR
ŠIBENIK

15:00 – 15:15

M. Rogošić
PARK ŠUMA "PREDOLAC – ŠIBANICA" / FOREST IN THE PROTECTED AREA
"PREDOLAC – ŠIBANICA"



15:15 – 15:30

Antun Car

LJEKOVITE BILJKE U DUBROVAČKIM SAMOSTANIMA / MEDICINAL PLANTS
IN THE MONASTERIES IN DUBROVNIK

15:30 – 15.45

V. Lupis, N. Jasprica, D. Šoljan

PRIKAZI BILJA U BAROKNOJ UMJETNOSTI PELJEŠCA / PLANTS IN THE BA-
ROQUE ART ON THE PELJEŠAC PENINSULA

FLORISTIČKA ISTRAŽIVANJA I BIORAZNOLIKOST FLORISTIC RESEARCH AND BIODIVERSITY

Moderatori / Chairs: S. Buzjak, M. Vrbek

15:45 – 16:00

S. Brana

OPHIOGLOSSUM AZORICUM C. PRESL (*OPHIOGLOSSACEAE*), NOVA SVOJTA
U FLORI HRVATSKE / *OPHIOGLOSSUM AZORICUM* C. PRESL (*OPHIOGLOSSA-
CEAE*), A NEW TAXON IN CROATIAN FLORA

16:00 – 16:15

I. Ljubičić, M. Britvec, I. Vitasović Kosić

SAMONIKLA VASKULARNA FLORA KAMENJARSKIH PAŠNJAKA NA OTOKU
PAGU / NATIVE VASCULAR FLORA OF ROCKY PASTURES ON THE ISLAND
OF PAG

16:15 – 16:30

N. Šajna, T. Kavar, J. Šutar-Vozlić, M. Kaligarić

RARITY AND PERSISTENCE OF ENDEMIC *HLADNIKIA PASTINACIFOLIA*
RCHB. (*APIACEAE*)

16:30 – 16:45

V. Krpina, M. Milović, M. Pandža, D. Tafra

VASKULARNA FLORA VRGADSKIH OTOČIČA / VASCULAR FLORA OF THE
VRGADA ISLETS

16:45 – 17:00

J. Vangjeli, A. Proko

BIODIVERSITY OF VASCULAR PLANTS IN ALBANIA



17:00 – 18:30

**POSTERSKA IZLAGANJA UZ PRIGODAN KOKTEL DOBRODOŠLICE/
POSTER PRESENTATIONS DURING COCKTAIL RECEPTION**

**BOTANIKA I OBRAZOVANJE
BOTANY AND EDUCATION**

Moderator / Chair: M. Pandža

18:30 – 18:45

D. Crnčec

RAZVOJ I STJECANJE TEMELJNIH ODGOJNO-OBRAZOVNIH POSTIGNUĆA (KOMPETENCIJA) KROZ IZVANNASTAVNU AKTIVNOST VOĆARSKE GRUPE U SKLOPU ŠKOLSKOG VRTA I VOĆNJAKA / DEVELOPMENT AND ACQUISITION OF EDUCATIONAL ACHIEVEMENTS (COMPETENCIES) THROUGH THE EXTRA-CURRICULAR ACTIVITY „FRUIT GROWING“ WITHIN THE PROJECT SCHOOL GARDEN AND ORCHARD

18:45 – 19:00

S. Milin, M. Pandža, D. Barić, M. Ivanac-Maštruko

PRIMJENA FENOLOŠKIH MOTRENJA U NASTAVI / APPLICATION OF PHENOLOGICAL OBSERVATIONS IN TEACHING

19:00 – 20:00

Okrugli stol / Round table - B. Juretić: BOTANIČKI VRTOVI I ARBORETUMI / BOTANICAL GARDENS AND ARBORETA

20:00 Večera / Dinner



SUBOTA, 25. RUJNA 2010. / SATURDAY, SEPTEMBER 25, 2010

**BIOLOGIJA ALGI, GLJIVA I LIŠAJEVA
BIOLOGY OF ALGAE, FUNGI AND LICHENS**

Moderatori / Chairs: A. Plenković-Moraj, Z. Ljubešić

9:00 – 9:15

Ana Car, A. Witkowski, S. Dobosz, N. Jasprica
DIJATOMEJE RODA *MASTOGLOIA* THWAITES EX W. SMITH NA STANIŠTIMA
ALGI *CAULERPA RACEMOSA* I *CAULERPA TAXIFOLIA* U JADRANSKOM MORU
/ DIATOMS OF THE GENUS *MASTOGLOIA* THWAITES EX W. SMITH
FROM AREAS AFFECTED BY *CAULERPA RACEMOSA* AND *CAULERPA TAXI-
FOLIA* (ADRIATIC SEA COAST, CROATIA)

9:15 – 9:30

M. Čalić, M. Carić
PROLJETNO CVJETANJE TOKSIČNOG DINOFLAGELATA *PROROCENTRUM
MINIMUM* U MALOSTONSKOM ZALJEVU (JUŽNI JADRAN) / SPRING BLOOM
OF TOXIC DINOFLAGELATE *PROROCENTRUM MINIMUM* IN MALI STON BAY
(SOUTH ADRIATIC)

9:30 – 9:45

Z. Ljubešić, D. Viličić, I. Cetinić, B. Jones, C. Lee, M. Marini
HETEROGENA RASPODJELA FITOPLANKTONA U SLOJU DUBOKOG MAK-
SIMUMA KLOROFILA U JABUČKOJ KOTLINI (SREDNJI JADRAN) / PATCHY
DISTRIBUTION OF PHYTOPLANKTON WITHIN THE DEEP CHLOROPHYLL
MAKSIMUM IN JABUKA PIT (MIDDLE ADRIATIC)

9:45 – 10:00

S. Bosak, T. Šilović, D. Viličić
SEZONSKA VARIJABILNOST UDJELA RAZLIČITIH VELIČINSKIH KATEGORI-
JA U BIOMASI FITOPLANKTONA: USPOREDBA DVA SUSTAVA NA ISTOČNOJ
OBALI JADRANSKOG MORA / SEASONAL VARIABILITY OF SIZE FRACTIO-
NATED PHYTOPLANKTON BIOMASS: A COMPARATIVE STUDY IN TWO EA-
STERN ADRIATIC SEA COASTAL SYSTEMS

10:00 – 10:15

E. Hrustić, M. Carić
AKTIVNOST ALKALNE FOSFATAZE U STRATIFICIRANIM ESTUARIJIMA KRKE
I ZRMANJE (ZIMSKI ASPEKT 2004.) / ALKALINE PHOSPHATASE ACTIVITY IN
STRATIFIED KRKA AND ZRMANJA ESTUARIES (WINTER ASPECT 2004)

10:15 – 10:45 Stanka za kavu / Coffee break



Moderatori / Chairs: T. Miličević, B. Antolić

10:45 – 11:00

B. Antolić, A. Špan, A. Žuljević, V. Nikolić

TAKSONOMSKI SASTAV, DUBINSKA RASPROSTRANJENOST I FITOGEOGRAFSKE ZNAČAJKE MORSKE BENTOSKE MAKROFLORE NA ŠIREM PODRUČJU ŠIBENIKA (SREDNJI JADRAN, HRVATSKA) / TAXONOMIC COMPOSITION, DEPTH DISTRIBUTION AND PHYTOGEOGRAPHIC CHARACTERISTICS OF MARINE BENTHIC MACROFLORA OF THE WIDER ŠIBENIK AREA (MIDDLE ADRIATIC SEA, CROATIA)

11:00 – 11:15

V. Nikolić, M. Despalatović, A. Žuljević, B. Antolić

MORSKA CVJETNICA *POSIDONIA OCEANICA* KAO BIOINDIKATOR STANJA PRIOBALNIH VODA U SREDNJEM JADRANSKOM MORU / SEAGRASS *POSIDONIA OCEANICA* AS BIOINDICATOR OF WATER QUALITY IN THE CENTRAL ADRIATIC SEA

11:15 – 11:30

T. Miličević, A. Ivanović, D. Ivić, J. Kaliterna, M. Milović

OSJETLJIVOST HRVATSKIH ENDEMIČNIH SVOJTI *IRIS* NA FITOPATOGENU GLJIVU *CLADOSPORIUM IRIDIS* / SUSCEPTIBILITY OF CROATIAN ENDEMIC *IRIS* TAXA TO PYTOPATHOGENIC FUNGUS *CLADOSPORIUM IRIDIS*

11:30 – 11:45

M. Ježić, Lj. Krstin, D. Rigling, M. Ćurković-Perica

POPULACIJSKA STRUKTURA GLJIVE MJEŠINARKE *CRYPHONECTRIA PARASITICA* (MURRILL) BARR. U HRVATSKOJ I SLOVENIJI / POPULATION STRUCTURE OF ASCOMYCETE *CRYPHONECTRIA PARASITICA* (MURRILL) BARR. IN CROATIA AND SLOVENIA

11:45 – 12:00

S. Ozimec

EPIFITSKI I TERIKOLNI LIŠAJEVI GORSKOGA KOTARA / EPIPHYTIC AND TERRICOLOUS LICHENS OF GORSKI KOTAR

12:00 – 14:00 Ručak / Lunch



BILJNA EKOLOGIJA
PLANT ECOLOGY

Moderatori / Chairs: J. Topić, M. Kaligarić

14:00 - 14:15

S. Redžić

THE VEGETATION DIVERSITY PATTERNS OF THE WESTERN BALKANS

14.15 - 14:30

A. Alegro, V. Šegota, Z. Sedlar, V. Hršak

GUBITAK TRAVNJAČKIH STANIŠTA U SREDOZEMNOM PODRUČJU HRVATSKE – PRIMJER NA VISINSKOM GRADIJENTU OD PRIOBALNOG DO PRETPANINSKOG POJASA / LOSS OF GRASSLAND HABITATS IN MEDITERRANEAN PARTS OF CROATIA – AN EXAMPLE ON ALTITUDINAL GRADIENT FROM LITTORAL TO SUBALPINE BELT

14:30 – 14:45

B. Surina, Ž. Modrić Surina

VEGETACIJA SNJEŽNIH TOČILA I BLOKOVA U HRVATSKOJ – EKOLOGIJA I UGROŽENOST / SNOWBED VEGETATION IN CROATIA: PHYTOSOCIOLOGY, ECOLOGY AND CONSERVATION STATUS

14:45 – 15:00

A. Lengyel, A. Dénes, D. Purger, Z. Stančić, W. Willner, J. Csiky

SUBMEDITERRANEAN RELATIONS OF SOUTH HUNGARIAN MESIC MEADOWS

15:00 – 15:15

J. Topić, Lj. Ilijanić

RASPROSTRANJENOST I EKOLOŠKE ZNAČAJKE STANIŠTA ENDEMIČNE VELEBITSKE DJETELINE (*TRIFOLIUM VELEBITICUM* DEGEN) / DISTRIBUTION AND ECOLOGICAL CHARACTERISTICS ON THE HABITATS OF ENDEMIC CLOVER *TRIFOLIUM VELEBITICUM* DEGEN

15:15 – 15:45 Stanka za kavu / Coffee break

15:45 – 16:00

S. Škornik, K. Hartman, M. Kaligarić

RELATION OF DRY GRASSLANDS CSR FUNCTIONAL SIGNATURES AND CONTRASTING GEOLOGICAL SUBSTRATES



16:00 - 16:15

S. D. Jelaska

RAZNOLIKOST I DINAMIKA STANIŠTA PARKA PRIRODE „VRANSKO JEZERO”
/ DIVERSITY AND DYNAMICS OF “VRANSKO JEZERO” NATURE PARK HABITATS

16:15 – 16:30

Ž. Modrić Surina, J. Topić

VEGETACIJSKE, EKOLOŠKE I HIDROLOŠKE ZNAČAJKE CRETA NA TRSTENIKU (GORSKI KOTAR, HRVATSKA) / PHYTOSOCIOLOGY, ECOLOGY AND HYDROLOGY OF THE TRSTENIK MIRE (GORSKI KOTAR, CROATIA)

16:30 – 16:45

J. Vukelić, D. Baričević, I. Šapić

FITOCENOLOŠKE ZNAČAJKE ŠUMA BIJELE JOHE (*ALNUS INCANA* /L./ MOENCH) U GORSKOME KOTARU / PHYTOCOENOLOGICAL CHARACTERISTICS OF FORESTS OF GREY ALDER (*ALNUS INCANA* /L./ MOENCH) IN GORSKI KOTAR

16:45 – 17:00

M. Ruščić, I. Carev, I. Marić Zerdun

FLORA I VEGETACIJA PRIRODNOG REZERVATA PANTAN / FLORA AND VEGETATION OF PANTAN PROTECTED AREA

17:00-17:15

G. Lukač, N. Andačić, Z. Marasović

ORNITOHORNE BILJNE OAZE U KANJONIMA VELIKE I MALE PAKLENICE, U NACIONALNOM PARKU PAKLENICA / ORNITHOCHORES PLANTS OASIS FROM TWO CANYONS, VELIKA AND MALA PAKLENICA IN PAKLENICA NATIONAL PARK

17:15 – 18:15

ZAKLJUČCI I PREPORUKE KONGRESA / CONCLUSIONS AND RECOMMENDATIONS (S. KOVAČIĆ, N. JASPRICA, T. NIKOLIĆ, B. JURETIĆ, M. PANDŽA)



NEDJELJA, 26. RUJNA 2010. / SUNDAY, SEPTEMBER 26, 2010

**STRUČNI IZLET U PARK PRIRODE “VRANSKO JEZERO”
VISIT TO THE LAKE VRANA NATURE PARK**

9:00 – 14:00

Polazak sudionika autobusom ispred turističkog naselja Lovišće-Jezera (vožnja traje oko 30 minuta). Cijena stručnog izleta uračunata je u iznos kotizacije. Povratak u Jezera se očekuje oko 14 sati.

09:00 – 14:00

Participants depart by coach in front of the Lovišće-Jezera holiday village (the drive takes about half an hour). This tour is included in the registration fee. The return to Jezera is expected around 14:00 hrs.

POSTERSKO IZLAGANJE
POSTER PRESENTATION



BIOLOGIJA ALGI, GLJIVA I LIŠAJEVA BIOLOGY OF ALGAE, FUNGI AND LICHENS

D. Hafner, N. Jasprica, A. Lončar
CYANOBACTERIA OF THE KARSTIC SPRINGS IN HERZEGOVINA (BOSNIA
AND HERZEGOVINA)

A. Ivanković, D. Hafner
PHYTOPLANKTON AND PHYTOBENTHOS OF BLIDINJE LAKE (BOSNIA AND
HERZEGOVINA)

M. Maslač, A. Partl
ISTRAŽIVANJE LIHENOFLORE NACIONALNOG PARKA „KORNATI“ / LICHE-
NOLOGICAL RESEARCH IN NATIONAL PARK „KORNATI“, CROATIA

A. Plenković-Moraj, É. Ács, K. T. Kiss, K. Kralj Borojević, P. Žutinić, M. Gligo-
ra Udovič
VERTIKALNA DISTRIBUCIJA FITOPLANKTONA VISOVAČKOG JEZERA, NP
KRKA / VERTICAL DISTRIBUTION OF PHYTOPLANKTON IN LAKE VISOVAC,
NP KRKA

S. Bosak, D. Omanović, J. Dautović, H. Mihanović, G. Olujić, L. Šupraha, M.
Ahel, D. Viličić
RASPODJELA FITOPLANKTONA, ORGANSKE TVARI I METALA U TRAGOVIMA
U ESTUARIJU RIJEKE KRKE / DISTRIBUTION OF PHYTOPLANKTON, ORGA-
NIC MATTER AND TRACE METALS IN THE KRKA RIVER ESTUARY

T. Žuna Pfeiffer, M. Mihaljević
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GUBITAK TRAVNJAČKIH STANIŠTA U SREDOZEMNOM PODRUČJU HRVATSKE – PRIMJER NA VISINSKOM GRADIJENTU OD PRIOBALNOG DO PRETPLANINSKOG POJASA

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Promjene u načinu života i privredi većine sredozemnih zemalja uključuju napuštanje tradicionalnog stočarstva i poljoprivrede. Te promjene posljedično su uzrokovale i promjene travnjačke vegetacije, odnosno njenu sukcesiju prema klimazonalnoj vegetaciji, koja je gotovo redovito šumska vegetacija. U cilju praćenja tih promjena, istraživani su travnjaci i njihovi ostaci iz svih visinskih pojasa. Pojas vazdazelene vegetacije (sveza *Quercion ilicis*) istraživan je na otoku Molatu, dok su južne padine Velebita i područje oko Danila i Pokrovnika (Šibensko zaleđe) odabrani za istraživanje pojasa listopadne vegetacije (sveze *Quercion pubescentis* i *Fagion sylvaticae*). Najveći gubitak bioraznolikosti, uzrokovan sukcesijom travnjaka u makije, uočen je pojasu vazdazelene vegetacije. Odnos bogatstva vrsta na travnjacima i u zatvorenoj makiji kreće se oko 6:1, s gotovo potpunim nestankom zeljastih vrsta, osobito terofita. Stvarni gubitak bioraznolikosti je i veći, uzme li se u obzir da su endemične vrste većinom zeljaste biljke otvorenih staništa. Gotovo isti proces zbiva se i u pojasevima zimzelene vegetacije, no razmjerno je sporiji i ne završava u tako gustim i tamnim gušticama. Stoga se može održati veći broj vrsta, no opća fizionomija krajolika je vrlo izmijenjena. Osim uobičajenih drvenastih vrsta, karakterističnih za svezu *Quercion pubescentis*, u velikoj množini može se javiti vrsta *Juniperus oxycedrus* i stvoriti vrlo guste vazdazelene šikare, koje su po gubitku bioraznolikosti slične onima iz vazdazelenog pojasa. U tom su pojasu travnjaci korišteni kao pašnjaci bili rasprostranjeni na velikim površinama. Izrazita degradacija tla, strmi položaji i izloženost vjetru usporavaju njihovu sukcesiju. Nasuprot tome, travnjaci korišteni kao livade razvijeni su nad dubljim tlima i zaravnjenim položajima zaštićenim od vjetra, što je omogućilo njihovu znatno bržu sukcesiju, osobito ukoliko je dominantna drvenasta vrsta *Pinus nigra*. Pojas iznad 1200 m n.m. pripada svezi *Fagion*. Tanak sloj tla, izloženost vjetru i razmjerno kraći vegetacijski period onemogućuju jednako brzu sukcesiju kao u nižim pojasevima, no ovdje se ona zbiva rastom niskih pužavih grmova vrsta *Arctostaphylos uva-ursi*, *Juniperus nana* i *J. sabina*, koji također mijenjaju sastav travnjaka, iako se njihova opća fiziognomija može činiti nepromijenjenom. Sukcesija i promjena staništa, koje vode do gubitka travnjaka, pripadaju među glavne procese u vegetacijskoj dinamici svih visinskih pojaseva sredozemnog dijela Hrvatske. Iako se u svakom pojasu taj proces zbiva različitom brzinom i uključuje različite vrste, vodi do gubitka bioraznolikosti na razini vrsta, staništa i krajolika.



LOSS OF GRASSLAND HABITATS IN MEDITERRANEAN PARTS OF CROATIA – AN EXAMPLE ON ALTITUDINAL GRADIENT FROM LITTORAL TO SUBALPINE BELT

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Change in lifestyles and economy in majority of Mediterranean countries includes abandonment of traditional cattle-breeding and agriculture. This causes change of grassland habitats and their succession to climazonal vegetation, which is almost regularly forest vegetation. To trace these changes, grasslands and their remnants from all altitudinal belts were researched. Evergreen vegetation belt (alliance *Quercion ilicis*) was researched on the island of Molat, while southern slopes of the Mt. Velebit and area of Danilo and Pokrovnik (in the hinterland of the town Šibenik) as representatives of different altitudinal belts of deciduous vegetation (alliances *Quercion pubescentis* and *Fagion sylvaticae*). Eumediterranean belt of evergreen vegetation has the largest loss of biodiversity caused by succession of grassland vegetation toward macchias. Ratio of species richness on grasslands and closed macchias is app. 6:1, with almost complete loss of herbaceous species, especially therophytes. The real loss of biodiversity is even larger when it is considered that majority of endemic species are herbaceous species of the open habitats. The very same process occurs in the vegetation belts of deciduous zone, but it is relatively slower and, it does not result in so dense and dark shrublands. Therefore, maintenance of larger number of species is allowed, but the general physiognomy of landscape is strongly changed. Beside the common tree species characteristic for alliance *Quercion pubescentis*, *Juniperus oxycedrus* can occur with very high abundance and form very dense evergreen shrubberies, which have biodiversity loss similar to those in evergreen belt. In this zone grasslands used as pastures were spread on large areas. Very strong degradation of soil, steep slopes and exposition to wind has slowed the succession. On the other side, grasslands used as meadows are developed on deeper soils and almost flat terrains protected from wind. Such position allows more rapid succession especially when main tree species is *Pinus nigra*. The belt above 1200 m a.s.l. belongs to the alliance *Fagion*. Thin layer of soil, strong influence of wind and relatively shorter growing season do not allow as much as rapid succession as in lower altitudes, but here it occurs by grow of dense, procumbent shrubs *Arctostaphylos uva-ursi*, *Juniperus nana* and *J. sabina*, which also change composition of grassland communities although the general physiognomy seems unchanged. The processes of succession and habitat change which lead to loss of open grasslands are main processes in vegetation dynamics in all vegetation belts in Mediterranean parts of Croatia. Although this process in each belt has different velocity and different species are included, it leads to loss of biodiversity on species, habitat and landscape level.



TAKSONOMSKI SASTAV, DUBINSKA RASPROSTRANJENOST I FITOGEOGRAFSKE ZNAČAJKE MORSKE BENTOSKE MAKROFLORE NA ŠIREM PODRUČJU ŠIBENIKA (SREDNJI JADRAN, HRVATSKA)

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Popis bentoskih morskih makroalga i morskih cvjetnica na širem području Šibenika (Prokljansko jezero, Šibenski zaljev, Šibenski kanal i južna obala otoka Zlarina kao referentna postaja) koji donosimo u ovome radu temelji se na našim istraživanjima obavljenim od 1973. do 2006. godine. Materijal je sakupljan uzduž dubinskih transekata i na dodatnim postajama pomoću autonomnih ronilaca, a na dubinama većim od 30 m pomoću trokutaste dredže. Bentoska flora istraživanog područja prikazana je pomoću brojčane i postotne zastupljenosti glavnih sistematskih odjeljaka bentoskih alga (Rhodophyta, Heterokontophyta i Chlorophyta) i morskih cvjetnica (Magnoliophyta), fitogeografske pripadnosti pojedinim flornim elementima te njihove dubinske rasprostranjenosti. Popis sadrži ukupno 287 svojti bentoskih alga i tri vrste morskih cvjetnica. Najviše su zastupljene svojte iz odjeljka Rhodophyta (170 svojti ili 58,6%), a slijede ih svojte iz odjeljaka Chlorophyta (59 svojti ili 20,3%) i Heterokontophyta (58 svojti ili 20,0%). Određene su tri vrste morskih cvjetnica (*Posidonia oceanica*, *Cymodocea nodosa* i *Zostera noltii*) koje čine oko 1% ukupnog broja svojti zabilježenih u bentoskoj flori šireg područja Šibenika. Prema vrijednostima kvocijenata R/P (Feldmann 1937) i R+C/P (Cheney 1977) bentoska flora šireg područja Šibenika ima suptropski karakter. U fitogeografskom sastavu brojem i postotkom prevladavaju atlantski (63 svojte ili 22,0%), subkozmodolitski (61 svojta ili 21,1%), mediteranski (53 svojte ili 18,3%), kozmoplitski (38 svojti ili 13,1%) i indo-atlantski (37 svojti ili 12,8%) florni elementi, koji ukupno obuhvaćaju 252 svojte ili 87,3% svih dosad određenih svojti bentoskih alga i morskih cvjetnica (290) u podmorju šireg područja Šibenika. Od endemičnih jadranskih svojti zabilježene su samo dvije (*Feldmannia irregularis* var. *lebeliides* i *Fucus virsoides*). U odnosu na zastupljenost bentoske flore na pojedinoj biotomskoj stepenici, najveći je broj svojti zabilježen u gornjem infralitoralu (211), manje u srednjem (154) i donjem infralitoralu (129), te manje u eulitoralu (57).



**TAXONOMIC COMPOSITION, DEPTH DISTRIBUTION
AND PHYTOGEOGRAPHIC CHARACTERISTICS OF
MARINE BENTHIC MACROFLORA OF THE WIDER
ŠIBENIK AREA
(MIDDLE ADRIATIC SEA, CROATIA)**

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Here, we give a review of taxonomic composition, depth distribution, and phyto-geographic characteristics of benthic marine macroflora on the wider Šibenik area (Prokljan Lake, Šibenik Bay, Šibenik Channel and the southern coast of Zlarin Island as a reference station). It is based on our researches from 1974 to 2006. Material was collected along the depth transect and at additional stations by scuba diving, and at depths greater than 30m, using a triangular dredge. The list contains 290 taxa belonging to the Rhodophyta (170 taxa - 58.6%), the Chlorophyta (59 taxa - 20.3%), the Heterokontophyta (58 taxa - 20.0%) and the Magnoliophyta (3 taxa - 1.0%). The established ratio between the number of Rhodophyta and Heterokontophyta (R/P index; Feldmann 1937) was 2.93, and relation between the number of Rhodophyta + Chlorophyta and Heterokontophyta (R+C/P index; Cheney 1977) was 3.95. Both quotients show a subtropical character of benthic macroalgal flora in the surveyed area. With regard to its origin, the benthic flora of wider Šibenik area is not homogenous. It comprises floral elements from several phytogeographic regions. Predominant by number and percentage are taxa of Atlantic (63 taxa - 22.0%), subcosmopolitan (61 taxa - 21.1%), Mediterranean (53 taxa - 18.3%), Cosmopolitan (38 taxa - 13.1%) and Indo-Atlantic (37 taxa - 12.8%) floral elements. Other phytogeographic regions contribute to Šibenik marine algal flora by only 38 taxa - 22.7% of total 290 taxa recorded. Only 2 taxa are included in Adriatic endemic category (*Feldmannia irregularis* var. *lebelioides* and *Fucus virsoides*). The analysis of benthic flora in relation to littoral bionomical zones reveals that the highest number of algal taxa is recorded in the upper infralittoral zone (211), and the lowest (except of the supralittoral) in the eulittoral zone (57).



BIOKEMIJSKI ODGOVORI KLIJANACA JEČMA NA STRES IZAZVAN SUŠOM

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Ječam je jedna od najvažnijih žitarica širom svijeta. Okolišni stresovi, kao što je nedostatak vode, uzrokuju ozbiljne probleme za rast i prinos biljaka. U svrhu unaprjeđenja procesa oplemenjivanja važno je razumjeti odgovore biljke na takav tip stresa. Cilj ovog preliminarnog istraživanja bio je ispitati fiziološke odgovore desetodnevnih klijanaca ječma, koji su prestankom zalijevanja bili izloženi suši tijekom sljedećeg desetodnevog razdoblja. Klijanci kultivara Bravo rasli su u plastičnim posudama, u smjesi zemlje i pijeska u omjeru 3:1, u kontroliranim uvjetima u uzgojnoj komori (svjetlo/tama: 16/8 h pri temperaturi od 22/19°C, intenzitet svjetlosti 60-70 $\mu\text{mol fotona m}^{-2}\text{s}^{-1}$). Za analize su korišteni prvi listovi klijanaca kontrolnih biljaka i biljaka izloženih stresu, a svi prikazani rezultati uspoređeni su s kontrolom. Poznato je da su stanične membrane, posebno membrane kloroplasta, osjetljive na oštećenja uzrokovana oslobađanjem reaktivnih kisikovih jedinki (ROS). U obrani biljaka protiv oksidativnog stresa važnu ulogu imaju antioksidativni enzimi. Pokazali smo da suša uzrokuje značajno povećanje produkcije vodikova peroksida (H_2O_2) te povećanu razinu lipidne peroksidacije (TBARS) tijekom trajanja eksperimenta. Svakodnevno su mjerne aktivnosti katalaze (CAT), superoksid dismutaze (SOD) te gvajakol peroksidaze (GPOD). Aktivnost superoksid dismutaze smanjivala se od petog dana tretmana nadalje, dok su aktivnosti katalaze i gvajakol peroksidaze tijekom tretmana rasle. Rezultati su pokazali da je povećanje sadržaja vodikovog peroksida, kao i povećana razina lipidne peroksidacije, u listovima ječma bila praćena različitim dinamikom aktivnosti glavnih enzima antioksidativnog sustava tijekom desetodnevne izloženosti suši. Buduća će istraživanja biti usmjerena na reakcije različitih hrvatskih kultivara ječma na stres uzrokovan sušom.



BIOCHEMICAL RESPONSES OF BARLEY SEEDLINGS INDUCED BY DROUGHT STRESS

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Barley is one of the most important crops all over the world. Environmental stresses such as water deficit causes a serious problems for plant growth and productivity. It is important to understand responses to drought stress in order to improve breeding processes. The aim of this preliminary report was to investigate physiological response of 10 days old seedlings exposed to 10 days long water deficit induced by withholding water. *Hordeum vulgare* cv. Bravo was used in this study. Seedlings were grown in plastic pots containing mixture of commercial soil and sand (3:1) in controlled conditions of growth chamber (light/dark regime of 16/8 at 22/19°C, irradiance 60-70 $\mu\text{mol photons m}^{-2}\text{s}^{-1}$). First seedling leaves of control and stressed plants were used for analyses and all of reported results were compared to control ones. It is well known that cell membranes, particularly chloroplast membranes are sensitive to oxidative damage caused by ROS (Reactive Oxygen Species). Antioxidative enzymes play an important role in plant defence against oxidative stress. Here we revealed that drought stress caused significant increase of hydrogen peroxide (H_2O_2) content and enhanced level of lipid peroxidation (TBARS) during the experimental period. Activities of catalase (CAT), superoxide dismutase (SOD) and guaiacol peroxidase (GPOD) were measured every day during drought treatment. The activity of SOD was decreased on the fifth day of treatment and further on. Activities of CAT and GPOD were increased during applied drought stress. Our results revealed that increase in H_2O_2 and TBARS levels in barley leaves were accompanied with different dynamics of main antioxidative enzymes activity exposed to 10-days drought stress. Further investigations will be focused on reactions of different Croatian barley cultivars to drought stress.



UČKA KAO MODEL ZA PRAĆENJE UTJECAJA KLIMATSKIH PROMJENA NA FLORU – PRELIMINARNO ISTRAŽIVANJE

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Podatke o flori prikupljene tijekom kartiranja sjevernog dijela Parka prirode „Učka” analizirali smo s obzirom na areal vrsta i životne oblike, koristeći MTB 1/64 kvadrante kao osnovne prostorne jedinice. Naš je cilj bio utvrditi može li se na Učki, osim vertikalnog (visinskog) gradijenta, potvrditi i postojanje horizontalnog (geografska širina) gradijenta, s obzirom na smjer pružanja te planine. Za udjele pojedinih životnih oblika te središta rasprostranjenosti izračunali smo Pearsonove koeficijente korelacije s nadmorskom visinom, te geografskim koordinatama. Za sve životne oblike, osim za terofite, ustanovljene su korelacije jednakoga smjera (pozitivnog ili negativnog) s nadmorskom visinom i geografskom širinom, pri čemu kao statistički značajne valja istaći smanjenje fanerofita s porastom nadmorske visine ($r=-0,8$; $p<0,05$), odnosno geografske širine ($r=-0,63$; $p<0,05$) kao i povećanje udjela geofita u istim uvjetima ($r=0,75$; $p<0,05$, $r=0,69$; $p<0,05$). Analizom rasprostranjenosti utvrđena je manja pravilnost u smjeru korelacija s visinom i geografskom širinom, no visoke, statistički značajne korelacije utvrđene su za biljke kontinentalne i subatlantske rasprostranjenosti, pri čemu su prve pozitivno ($r=0,74$; $p<0,05$, $r=0,74$; $p<0,05$), a potomje negativno ($r=-0,88$; $p<0,05$, $r=-0,75$; $p<0,05$) korelirane s porastom nadmorske visine i geografske širine. Dobiveni rezultati potvrđuju postojanje horizontalnog gradijenta na Učki, čime upućuju na potrebu daljnjeg istraživanja, koje će obuhvatiti i južni dio planine, te na odabir indikatorskih vrsta kod kojih bi praćenje rasprostranjenosti moglo ukazati na postojanje utjecaja klimatskih promjena na floru.



UČKA MT. AS A MODEL FOR MONITORING OF CLIMATE CHANGE IMPACT ON FLORA – PRELIMINARY RESEARCH

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We have analysed data gathered during the flora mapping of northern part of Učka Nature Park with respect to their areal and life forms, using MTB 1/64 quadrants as a basic spatial units. We wanted to test whether on Učka Mt. beside vertical (elevational) gradient, horizontal (latitudinal) gradient exists as well, especially because of north-south orientation of Učka Mt. For shares of particular life forms and areals we have calculated Pearsons correlation coefficients with elevation, latitude and longitude. With the exception of therophytes, for all life forms correlations of same directions (positive or negative) have been established with elevation and latitude. Among them, those for phanerophytes which share decrease with increase of elevation ($r=-0.8$; $p<0.05$) and latitude ($r=-0.63$; $p<0.05$) should be emphasized, as well as those positive ones for geophytes ($r=0.75$; $p<0.05$, $r=0.69$, $p<0.05$). At areal level, less regularity in direction of correlation with elevation and latitude was observed. However, high statistically significant correlation was established for species of continental and subatlantic distribution, with former being positively ($r=0.74$; $p<0.05$, $r=0.74$; $p<0.05$) and latter negatively ($r=-0.88$; $p<0.05$, $r=-0.75$; $p<0.05$) correlated with the increase of elevation and latitude. Obtained results have confirmed existence of the horizontal gradient on Učka Mt., that rise necessity of expanding research to the southern parts of mountain, as well as selection of indicator species whose monitoring could reveal existence of climate change impact on flora.



TERMOPHILOUS ELEMENTS IN FLORA OF PREKMURJE REGION (NE SLOVENIA)

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The vascular flora of Prekmurje region (NE Slovenija) has been investigated with emphasis on thermophilous elements. The result of field research represents the list of taxa which is partially supplemented with data from other sources. Altogether 1250 taxa have been recorded, as to that, 103 taxa were described for the first time for Prekmurje region and 15 taxa were described for the first time for the sub-Pannonic region (according to the phytogeographic division of Slovenia). The horological spectrum reveals the prevalence of Eurasian (26.8%), European (15.2%) and central-European elements (8.72%), but there is also a large number of cosmopolites (9.92%), circumpolar (10.56%) and continental elements (2.08%) and even some sub-Atlantic elements (0.48%) are also present in this region. Surprisingly low is the share of Illyrian (0.24%), central-Alpine (0.88%), Pannonian (0.08%) and Eastern elements (0%). This is showing to a still perceived influence of the Alps and Central-European flora but almost none of the Dinaric and very little of the Pannonic macroregion. Also high is the share of alien species (9.04%) and cultivated species (7.12%). Special attention was paid on sub-Mediterranean and other thermophilous species. Their share in Prekmurje is surprisingly high (8.88%) and some new species (e.g. *Spergularia marina*, *Arenaria leptoclados* and *Cerastium dubium*) were found in recent times only; the influence of global warming is not excluded as a possible reason. Increased international transit transport from the Mediterranean parts of Europe into continental regions is also a possible explanation for the occurrence of those species. Other interesting species that occur in dry and semi-ruderal places are: *Petrorhagia prolifera*, *Papaver argemone*, *Vicia pannonica*, *Kickxia elatine*, *Geranium purpureum*, *Crepis setosa*, *Vulpia bromoides*, *Aira elegantissima*, *A. caryophyllea*, *Setaria verticilliformis* and *Bothriochloa ischaemum*. Specific and important dry and warm habitats in northern parts of Prekmurje (Goričko) are semi-dry acid meadows with many interesting thermophilous species like *Moenchia mantica* agg., *Sanguisorba muricata*, *Potentilla rupestris*, *Rosa micrantha*, *Saxifraga bulbifera*, *Euphorbia verrucosa*, *Verbascum phoeniceum*, *Muscari comosum*, *Allium carinatum*, *Festuca rupicola* and *Koeleria macrantha*.



SADRŽAJ DUŠIKA I SAHAROZE U PODANCIMA VRSTE *POSIDONIA OCEANICA* (L.) DELILE NA PODRUČJU SPLITSKO-DALMATINSKE ŽUPANIJE

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Istraživanje je provedeno na uzorcima morske cvjetnice *Posidonia oceanica*, prikupljenima na šest postaja u Splitsko-dalmatinskoj županiji. Određen je sadržaj dušika i saharoze u podancima (rizomima) te vrste, kako bi se procijenila razina poremećaja u morskom okolišu. Povećanje antropogenog pritiska vodi do povišenog sadržaja dušika u morskoj vodi, što je izravno povezano sa sadržajem dušika u tkivima vrste *P. oceanica* te uzrokuje smanjivanje sadržaja prirodnih ugljikohidrata, osobito saharoze. Rezultati provedenog istraživanja potvrđuju ovaj obrazac i u skladu su s drugim istraživanjima s područja Sredozemnog mora te pokazuju da je vrsta *P. oceanica* dobar bioindikator obogaćenja morskog okoliša dušikom.



NITROGEN AND SUCROSE CONTENT IN *POSIDONIA OCEANICA* (L.) DELILE RHIZOMES FROM THE SPLIT-DALMATIA COUNTY

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The study was conducted on samples of the marine phanerogam *Posidonia oceanica* collected from 6 stations in the Split-Dalmatia District. Nitrogen and sucrose content was determined in the rhizomes in order to evaluate the disturbance level in the marine environment. It has already been shown that the increase in anthropogenic pressure leads to higher nitrogen content in sea water which correlates directly with nitrogen content in *P. oceanica* tissues. This results in lower content of carbohydrate reserves, especially sucrose. The results of our study confirm this trend and are in accordance with other research in the Mediterranean; proving *P. oceanica* is a good bioindicator of nitrogen pollution in the marine environment.



**NOVA HAZMOFITSKA SVOJTA RODA *CAMPANULA*,
SER. *GARGANICAE* TRINAJSTIĆ (*CAMPANULACEAE*)
S OTOKA VISA (HRVATSKA)**

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Zapadni Balkan i područje oko Jadrana prostor su iznimnog florističkog bogatstva, koji između ostalog obuhvaća oko 85 vrsta i podvrsta roda *Campanula* L. Među njima je morfološki i filogenetski dobro izdvojena okojadranska skupina od devet svojti zvončića, koja pripada rodu *Campanula* sect. *Campanula* subsect. *Elatines* (Wohlfarth) Trinajstić ser. *Garganicae* Trinajstić. Za vrijeme florističkih istraživanja otoka Visa, otkrivena je nova svojta koja pripada rodu *Campanula* ser. *Garganicae*. Nova svojta raste kao član endemične hazmofitske vegetacije stjenjača *Centaureo-Campanuleta* Trinajstić 1980. Morfološki gledano, zbog zvonastog vjenčića, nova svojta slična je vrsti *Campanula portenschlagiana* Schult., a zbog oblika listova, dlakavosti i tipa dlaka slična je jonskim vrstama *C. acarnanica* Damboldt i *C. cephallica* Feer. U ovome su istraživanju upotrijebljene jezgrene ITS i kloroplastne *trnL-trnF* DNA sekvence kako bi dale odgovor o filogenetskom položaju nove svojte unutar ser. *Garganicae*. Prethodno nepoznata svojta s otoka Visa identificirana je kao filogenetski i morfološki odvojena od svih do sada poznatih svojti unutar ser. *Garganicae* te pokazuje bliže filogenetske odnose s vrstama *C. debarensis* Rech. f. i *C. cephallica* Feer.



**A NEW CHASMOPHYTIC TAXON OF THE
CAMPANULA SER. GARGANICAE TRINAJSTIĆ
(CAMPANULACEAE) FROM THE ISLAND OF VIS
(CROATIA)**

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The amphi-Adriatic and Western Balkan region is floristically extremely rich, among other, comprising at least 85 species and subspecies of the genus *Campanula* L. Among them, morphologically and phylogenetically well separated is the amphi-Adriatic group of nine taxa belonging to the *Campanula* sect. *Campanula* subsect. *Elatines* (Wohlfarth) Trinajstić ser. *Garganicae* Trinajstić. In the course of floristic researches on the island of Vis, a new taxon belonging to the *Campanula* ser. *Garganicae* was discovered. This new taxon grows as a member of the endemic chasmophytic vegetation of the *Centaureo-Campanuletalia* Trinajstić 1980. From the morphological point of view, the new taxon, because of the campanulate corolla is similar to the species *Campanula portenschlagiana* Schult., whereas regarding the shape of leaves, type of hairs and indumentum it is similar to the Ionian species *C. acarnanica* Damboldt and *C. cephallica* Feer. We used nuclear ITS and plastid *trnL-trnF* DNA sequence data to address the question of the phylogenetic position of this new taxon inside the ser. *Garganicae*. The previously unrecognized entity from the island of Vis was identified as a phylogenetically and morphologically separate taxon from all other taxa within the ser. *Garganicae* and showed closer relationships with *C. debarensis* Rech. f. and *C. cephallica* Feer.



KOMERCIJALNO SAKUPLJANJE ZAŠTIĆENIH SAMONIKLIH BILJAKA U HRVATSKOJ

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Komercijalno sakupljanje zaštićenih samoniklih biljaka u Hrvatskoj regulirano je Pravilnikom o sakupljanju zaštićenih samoniklih biljaka u svrhu prerade, trgovine i drugog prometa (Narodne novine 154/08). Po zahtjevu fizičke ili pravne osobe, Ministarstvo kulture izdaje dopuštenje koje sadrži količine i biljne dijelove zaštićenih samoniklih biljnih svojti koje se dopuštaju za sakupljanje, uz uvjete pod kojima se sakupljanje mora obavljati. Po isteku dopuštenja, stranaka mora predati izvještaj u kojem se navode količine sakupljenih biljnih svojti i županije u kojima su sakupljene. U našem istraživanju analizirali smo sve zahtjeve, dopuštenja i izvještaje od 2005. do 2009. godine. Stranke koji podnose zahtjeve su pojedinci, ali i tvrtke. Analizirane su zatražene količine zaštićenih samoniklih biljnih svojti iz zahtjeva, kao i sakupljene količine prema izvještajima. Prema rezultatima analiza, biljne vrste koje se sakupljaju u najvećim količinama su *Helichrysum italicum* (nadzemni dijelovi), *Laurus nobilis* (listovi), *Rosa canina* (plod) te *Vitex agnus-castus* (listovi i cvjetovi). Količine smilja (*Helichrysum italicum*) zatražene za sakupljanje, u svrhu destilacije i produkcije esencijalnih ulja, veće su od traženih količina svih ostalih biljnih vrsta. Druge biljne vrste od posebnog interesa sakupljačima su *Calluna vulgaris*, *Dryopteris filix-mas*, *Galanthus nivalis*, *Hypericum perforatum* i *Ruscus hypoglossum*, no one se sakupljaju u znatno manjim količinama.



COMMERCIAL COLLECTING OF PROTECTED WILD PLANTS IN CROATIA

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Commercial collecting of protected wild plants in Croatia is regulated by the Ordinance on the Collecting of Protected Wild Plants for the Purpose of Processing, Trading and Other Types of Traffic (Official Gazette 154/08). Upon a request of the natural or legal person, the Ministry of Culture issues a permit which includes the quantities and plant parts of protected wild plant taxa approved for collecting, together with the conditions under which collecting has to be done. Upon the expiry of the permit, the party has to submit a report stating the quantities of collected plant taxa and counties of their collection. In our research we have analysed all requests, permits and reports from year 2005 up to year 2009. Parties that submit requests are individuals as well as companies. Analyses of the quantities of each protected wild plant taxa requested for collecting, as well as reported collected quantities have been done. According to the analyses, the plant species that are being collected in largest quantities are *Helichrysum italicum* (above-ground parts), *Laurus nobilis* (leaves), *Rosa canina* (fruit) and *Vitex agnus-castus* (leaves and flowers). The quantity of *Helichrysum italicum* being requested for collection to be used for distillation and production of essential oil is greater than requested quantities of all other plant species. Some other plant species of special interest for collectors are *Calluna vulgaris*, *Dryopteris filix-mas*, *Galanthus nivalis*, *Hypericum perforatum*, *Ruscus hypoglossum*, but these species are being collected in substantially smaller quantities.



RASPODJELA FITOPLANKTONA, ORGANSKE TVARI I METALA U TRAGOVIMA U ESTUARIJU RIJEKE KRKE

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Visokostratificirani estuarij rijeke Krke smješten je u središnjem dijelu istočne obale Jadranskog mora. Prijašnja istraživanja pokazala su da oštri vertikalni gradijent saliniteta (haloklina) većim dijelom godine dijeli vodeni stupac po dubini na bočati sloj iznad i morski sloj ispod halokline. U prijelaznom sloju dolazi do ugibanja slatkovodnog fitoplanktona, što ima za posljedicu akumulaciju organske tvari i povećanu količinu nutrijenata te dolazi i do akumulacije metala. Terenska istraživanja provedena su u travnju i lipnju 2010. na četiri postaje duž estuarija. Vertikalna raspodjela saliniteta, temperature, kisika i fluorescencije klorofila *a* određena je pomoću CTD sonde. Uzorci za analizu ostalih parametara uzimani su Niskinovim crpcem volumena 5 l na različitim dubinama, odabranima na temelju vertikalnog profila saliniteta i fluorescencije klorofila *a* prethodno izmjerenih sondom. Kvalitativni i kvantitativni sastav fitoplanktona određen je korištenjem svjetlosnog inverznog mikroskopa, te analizom karakterističnih pigmenata čija je koncentracija izmjerena tekućinskom kromatografijom s visokom moći razlučivanja (HPLC). Otopljeni i partikularni organski ugljik analiziran je metodom visokotemperaturne katalitičke oksidacije (HTCO). Tragovi metala određeni su voltametrijom s anodnim/katodnim otapanjem na elektrodi s visećom živinom kapi, metodom dodatka standarda. U ovom radu bit će prezentirani rezultati istraživanja koliko biomasa pojedinih fitoplanktonskih skupina korelira s distribucijom veličinskih frakcija organske tvari i metala u tragovima.



DISTRIBUTION OF PHYTOPLANKTON, ORGANIC MATTER AND TRACE METALS IN THE KRKA RIVER ESTUARY

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The estuary of the karstic Krka River is a salt-wedge, highly stratified estuary located in the central part of the eastern Adriatic coast. Previous investigations showed that during most of the year the sharp vertical salinity gradient (halocline) divides the water column into two distinct parts: upper freshwater layer and lower marine layer. Freshwater phytoplankton decomposition represents the main source of biogenic organic matter which accumulates at the interface between fresh- and brackish water. Accumulation of organic carbon at the interface is encompassed by accumulation of nutrients and trace metals. Sampling was conducted during April and June 2010, at four stations along the estuary. Vertical distribution of salinity, temperature, oxygen and chlorophyll *a* fluorescence was obtained using a conductivity, temperature and depth (CTD) profiler. Sampling was performed using 5L Niskin sampler at various depths, according to the vertical salinity and chlorophyll *a* fluorescence profiles obtained previously with CTD profiler. Qualitative and quantitative phytoplankton composition was determined by light inverted microscope and phytoplankton pigment analysis by high performance liquid chromatography (HPLC). Dissolved and particulate organic carbon analyses were performed by high temperature catalytic oxidation (HTCO) method. Trace metal concentrations were determined by anodic/cathodic stripping voltammetry on static mercury drop electrode using standard addition method. Data will be presented showing the extent to which biomass of different phytoplankton groups correlates with distribution of organic matter size fractions and trace metals.



SEZONSKA VARIJABILNOST UDJELA RAZLIČITIH VELIČINSKIH KATEGORIJA U BIOMASI FITOPLANKTONA: USPOREDBA DVAJU SUSTAVA NA ISTOČNOJ OBALI JADRANSKOG MORA

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Sezonska dinamika fitoplanktona analizirana je tijekom 2008. i 2009. godine u dva poluzatvorena zaljeva, smještena na sjevernom i južnom dijelu istočne obale Jadranskog mora: u zaljevu Boke kotorske i Limskom kanalu. Za oba obalna krška sustava karakterističan je povećan unos nutrijenata, zahvaljujući znatnim količinama precipitacije tijekom većeg dijela godine i dotoku slatke vode porijeklom iz brojnih površinskih i potpovršinskih izvora (vrulja). Svrha rada bila je utvrditi razlike u udjelima pojedinih veličinskih kategorija fitoplanktona u ukupnoj biomasi. Za analizu pikoplanktona (0,2-2 μm), korišten je protočni citometar, dok su nanoplankton (2-20 μm) i mikrop plankton (20-200 μm) analizirani inverznim svjetlosnim mikroskopom. Proljetno i kasnozimsko razdoblje karakterizirano je dominacijom mikrofitoplanktona i do 90 % u ukupnoj biomasi fitoplanktona u oba sustava. Nasuprot tome, tijekom ljeta u ukupnoj biomasi najzastupljenije su pikoplanktonske cijanobakterije roda *Synechococcus* i do 90% u oba sustava. U jesenskom razdoblju cijanobakterije su u Kotorskom zaljevu i dalje najzastupljenije s 60%, dok je u Limskom kanalu dominirao mikrofitoplankton sa 70%. Nanoplankton je slabo zastupljen u biomasi oba sustava, osim u proljetnom razdoblju, kad je zabilježen veći doprinos kokolitoforida i autotrofnih flagelata.



SEASONAL VARIABILITY OF SIZE FRACTIONATED PHYTOPLANKTON BIOMASS: A COMPARATIVE STUDY IN TWO EASTERN ADRIATIC SEA COASTAL SYSTEMS

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Seasonal dynamics of phytoplankton taxonomic composition and biomass was analysed during 2008/2009 in two semi-enclosed bays: Lim Bay and Boka Kotorska Bay located in the northeastern and southeastern coastal area of Adriatic Sea, respectively. Both coastal carstic systems are characterized by increased nutrient input due to considerable precipitation quantities and strong freshwater inflow from numerous streams and submarine karstic springs (*vručjas*). The scope of this work was to determine differences between two systems in terms of phytoplankton size fraction biomass distribution: picoplankton (0.2–2 μm), nanoplankton (2–20 μm) and microplankton (20–200 μm). The smallest size fraction was investigated by means of flow cytometry and larger fractions by means of inverted light microscope. In both systems, spring and late winter period was characterized by microphytoplankton domination up to 90% of total phytoplankton biomass. In summer the most prominent were picoplanktonic cyanobacteria *Synechococcus* sp. which contributed up to 90% of total biomass in both systems. In Kotor Bay cyanobacteria contributed up to 60% in autumn while in Lim bay microphytoplankton dominated in 70% of total biomass. Contribution of nanoplanktonic cells was rather low in both systems, except in the spring when the larger contribution of coccolithophorids and autorophic flagellates was recorded.



**OPHIOGLOSSUM AZORICUM C. PRESL
(OPHIOGLOSSACEAE), NOVA SVOJTA
U FLORI HRVATSKE**

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Istraživanjem rodovskih zajednica (*genus communities*) jednolista (rod *Ophioglossum*, *Ophioglossaceae*) u Istri, kod nekih populacija uočene su morfološke, ekološke i fenološke razlike u odnosu na otprije poznate vrste *Ophioglossum lusitanicum* L. i *Ophioglossum vulgatum* L. Te populacije determinirane su kao populacije vrste *Ophioglossum azoricum* C. Presl. U radu se razmatra taksonomija, morfologija, fenologija i rasprostranjenost te nove svojte te daje ključ za razlikovanje sve tri vrste roda *Ophioglossum* u flori Hrvatske.



**OPHIOGLOSSUM AZORICUM C. PRESL
(OPHIOGLOSSACEAE), A NEW TAXON
IN CROATIAN FLORA**

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By researching genus communities of Adders tongue (*Ophioglossum*, *Ophioglossaceae*) in Istria, in some of the populations, morphological, ecological and phenological differences have been noted compared to the earlier known species *Ophioglossum lusitanicum* L. and *Ophioglossum vulgatum* L. These populations have been determined as *Ophioglossum azoricum* C. Presl. This work examines taxonomy, morphology, phenology, and distribution of the new taxon, and also gives the key to distinguishing all three species of *Ophioglossum* in Croatia's flora.



FLORISTIČKA RAZNOLIKOST BAŠKIH OŠTARIJA

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Baške Oštarije su jedan od najatraktivnijih cestovnih prijelaza u vršnom dijelu Velebita. Područje su izravnoga dodira submediteranske i planinske klime. Izložene su čestim i snažnim udarima bure, a zbog miješanja različito zagrijanih zračnih masa imaju veliki broj dana s maglom. Posebnost i izuzetna vrijednost Oštarijskoga polja je da kroz njega protječe potok Ljubica. Zbog toga istočni dio Oštarijskoga polja čine vlažne gorske livade i košanice, te niski ili prijelazni cretovi. Vlažne livade uz potok Ljubica i cret uz isti prepoznati su i kao važna područja za divlje svojte i stanišne tipove u preliminarnoj Nacionalnoj ekološkoj mreži (potencijalna Natura 2000 područja) unutar granica zaštićenoga područja Parka prirode Velebit. U Baškim Oštarijama su pronađena staništa vrste *Pulsatilla grandis* Wender., koja se nalazi na listi Dodatka I. Direktive o zaštiti prirodnih staništa i divlje faune i flore. Sjevernu i južnu stranu Oštarijskoga polja pokriva primorska bukova šuma (*Seslerio autumnali-Fagetum* M. Wraber ex Borhidi 1963) koja se s okolnih obronaka spušta sve do livada u zaravni. Zapadni, prošireni dio Oštarijskoga polja, tvore suhe livade i krški manje ili više kamenjarski travnjaci šaša crljenka i bodljikave zečine (*Carici humili-Centaureetum rupestris* Ht. 1931) ili pak sveze dlakave murave (*Scorzonerion villosae* H-ić 1949). Južne strane kamenih glavica Badnja i Basače prelaze u stjenovite kamenjare i primorska točila. Rad je obuhvatio uzorkovanje koje se sastojalo od terenskih istraživanja na geokodiranim lokalitetima i površinama MTB 64 osnovnih polja za kartiranje flore. Terenske aktivnosti su provedene i provode se u razdoblju 2008.-2010. u svim dijelovima vegetacijske sezone i na svim tipovima staništa. Biljni materijal se herbarizira, determinira i nomenklaturno usklađuje prema Nikolić (2008), a alohtona flora prema Richardson et al. (2000), Pyšek et al. (2004) i *Flora Croatica Database*. Zabilježena je značajna brojnost vrsta iz porodica *Fagaceae*, *Orchidaceae*, *Ranunculaceae*, *Rosaceae*, *Apiaceae*, *Oleaceae*, *Caryophyllaceae*, *Gentianaceae*, *Boraginaceae*, *Lamiaceae*, *Brassicaceae*, *Solanaceae*, *Plantaginaceae*, *Caprifoliaceae*, *Fabaceae*, *Asteraceae*, *Liliaceae*, *Poaceae*, *Typhaceae* i *Cyperaceae*.



FLORISTIC DIVERSITY OF BAŠKE OŠTARIJE

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Baške Oštarije is one of the most attractive road crossings in the top regions of Velebit. It is an area where the submediterranean and mountain climates are in direct contact, exposed to frequent and severe bora winds. On account of air masses of different temperatures mixing, it has a very high number of days with fog. What is special and exceptionally valuable about the area is that the stream Ljubica goes through it. Because of it, the eastern part of the valleys of Baške Oštarije consists of moist mountain meadows and low or transient fens. The moist meadows and the fen near the stream Ljubica have been recognized as important areas for wild species and habitat types in the preliminary National ecological network (potential Natura 2000 areas) within the Velebit Nature Park. In Baške Oštarije, habitats were discovered of the species *Pulsatilla grandis* Wender, listed in Annex I of the Directive on the protection of natural habitats and wild fauna and flora. The northern and southern parts of the fields of Baške Oštarije are covered with beech forests (*Seslerio autumnali-Fagetum* M. Wraber ex Borhidi 1963) which reach all the way from the slopes to the meadows in the plateau. The western extended area is mainly dry meadows and karst, more or less stony grasslands (ass. *Carici humili-Centaureetum rupestris* Ht. 1931 or alliance *Scorzonerion villosae* H-ić 1949). The southern parts of the stone crests Badanj and Basača are rocky areas with littoral vegetation. This paper includes samples from field research on geo-coded localities and surfaces of 64 primary fields for floral mapping. The field activities have been carried out in the 2008-2010 period in all areas of the vegetation season and in all habitat types. The plant material is herborized, determined and harmonised in nomenclature according to Nikolić (2008), and the allochthonous flora according to Richardson et al. (2000) and Pyšek et al. (2004) as well as the Flora Croatica Database. A great number of species from the following families was recorded – *Fagaceae*, *Orchidaceae*, *Ranunculaceae*, *Rosaceae*, *Apiaceae*, *Oleaceae*, *Caryophyllaceae*, *Gentianaceae*, *Boraginaceae*, *Lamiaceae*, *Brassicaceae*, *Solanaceae*, *Plantaginaceae*, *Caprifoliaceae*, *Fabaceae*, *Asteraceae*, *Liliaceae*, *Poaceae*, *Typhaceae* and *Cyperaceae*.



GEOEKOLOŠKE ZNAČAJKE URUŠNE PONIKVE JAPAGE NA ŽUMBERKU

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Japage je urušna ponikva smještena u zapadnom dijelu Žumberka. Oblikovana je u tektonski razlomljenim karbonatnim naslagama gornjokredne starosti (vapnenci i breče). Osim okršavanja, koje je uočljivo u dva speleološka objekta, danas na njen razvoj navije utječu padinski procesi (urušavanje, kliženje i osipanje). Duljina osi oboda ponikve Japage u smjeru S-J je 64 m, a u smjeru I-Z je 63 m. Svojim dimenzijama ističe se kao najveća takva pojava na području Žumberka. Dubina između najniže točke oboda i dna je 15 m. Najveća visinska razlika je 37,7 m. Volumen ponikve je 54 000 m³. Mjerenjima mikroklimatskih parametara u Japagama (od 2007. do 2009. godine) dokazana je temperaturna inverzija u toplom dijelu godine. Vrijednosti relativne vlažnosti zraka povišene su na dnu, a prema rubovima oboda ponikve se smanjuju. U vegetacijskom razdoblju između 2007. i 2008. godine na području Japaga istraživana je i flora. Popisivane su biljke koje rastu na različitim dubinama i ekspozicijama, a dio njih je ucrtan na profilima SJ i IZ. Zabilježene biljke podvrgnute su analizi ekoloških indikatorskih vrijednosti i životnih oblika. Ukupno je zabilježeno 58 svojti biljaka. Devet svojti (31%) od ukupnog broja zabilježenih zaštićeno je Zakonom o zaštiti prirode, a tri svojte nalaze se u „Crvenoj knjizi vaskularne flore Hrvatske”, kao gotovo ugrožene (NT). Od životnih oblika prevladavaju hemikriptofiti i geofiti, što odgovara umjerenom klimatskom pojasu, kojemu Japage i pripadaju. Od vrsta, svojom nazočnošću prevladavale su paprati i to osobito u donjem dijelu ponikve i na dnu, gdje je smanjena osvjetljenost i povećana vlažnost zraka i tla u odnosu na rub ponikve. Analizom ekoloških indikatorskih vrijednosti florističkog sastava ponikve, zaključili smo da je tlo u Japagama umjereno vlažno, uglavnom slabo kiselo do alkalno, te da se radi o sjenovitom staništu na kojem prevladavaju biljke široke rasprostranjenosti, koje mogu rasti u brdskom, planinskom i subalpinskom području.



GEOECOLOGICAL FEATURES OF THE COLLAPSED DOLINE JAPAGE ON ŽUMBERAK (CROATIA)

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Japage is a collapsed doline located in the western part of Žumberak, formed in tectonically crushed Upper Cretaceous carbonate layers (limestone and breccia). Apart from karstification, which is evident in two speleological features, its development is today mostly affected by the slope processes (collapsing, landsliding and soil creeping). The length of the peripheral axis of the collapsed doline Japage is 64 m in the N-S direction, and 63 m in the E-W direction. In terms of dimensions, it is the largest such phenomenon on the territory of Žumberak. The depth between the lowest point of the periphery and the bottom is 15 m. The highest altitude difference is 37.7 m. The dolines volume is 54.000 m³. The measurement of microclimatic parameters in Japage (carried out from 2007 to 2009) proved temperature inversion during the warm part of the year. The relative air humidity is higher at the bottom, and lower towards the margins of the dolines rim. During the vegetation period in 2007 and 2008, the flora of Japage doline was also researched. Plants growing at various depths and expositions were registered, and a part of them was recorded in the profiles N-S and E-W. The listed plants underwent the analysis of ecological indicator values and life forms. Altogether 58 plant taxa were registered. Nine of them, i.e. 31% of the total number of the recorded taxa are protected by the Nature Protection Act, and three are listed in the Red Book of Vascular Flora of Croatia as near threatened (NT). The life form analysis showed the predominance of hemi-cryptophytes and geophytes, corresponding to the moderate climate zone Japage belongs to. Ferns were the predominant species, particularly in the lower part of the doline and at its bottom, which has less sunlight and higher air humidity and soil moisture compared to the dolines upper marginal parts. Based on the analysis of ecological indicator values of the dolines floristic composition, we came to the conclusion that the soil in Japage is moderately moist, mostly low acidic to alkaline. It is a shadowy habitat predominated by widespread plants that can grow in colline, mountainous and sub-alpine areas.



DIJATOMEJE RODA *MASTOGLOIA* THWAITES EX W. SMITH NA STANIŠTIMA ALGI *CAULERPA RACEMOSA* I *CAULERPA TAXIFOLIA* U JADRANSKOM MORU

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Rod *Mastogloia* Thwaites ex W. Smith uključuje brojne vrste koje žive kao epifiti na morskim cvjetnicama i algama, a zajedno s ostalim birafidnim (*Diploneis*, *Amphora*) i monorafidnim (*Cocconeis*, *Achnanthes*) rodovima dijatomeja doprinose ukupnoj raznolikosti bentoskih zajednica. Istraživanje je sastavni dio projekta o egzotičnim algama roda *Caulerpa* na istočnoj obali Jadrana. Uzorci su sakupljeni mjesečno, tijekom 2009. i 2010. godine, na staništima alga vrsta *Caulerpa racemosa* (uvala Gonoturska na otoku Mljetu i Orsula kraj Dubrovnik) i *Caulerpa taxifolia* (Stari Grad na otoku Hvaru). Uzorci su analizirani skenirajućim elektronskim mikroskopom Hitachi S-3500 i S-550 te svjetlosnim mikroskopom Nikon E600 uz povećanje 1000x. Vrste roda *Mastogloia* imaju promjenjivu strukturu areola. U uzorcima je nađeno više od 25 vrsta, od toga su česte *M. binotata* (Grunow) Cleve, *M. fimbriata* (Brightwell) Cleve, *M. splendida* (Gregory) Cleve, *M. crucicula* (Grunow) Cleve, *M. erythraea* Grunow, *M. corsicana* Grunow, *M. inaequalis* Cleve, *M. cuneata* (Meister) Simonsen, *M. ovulum* Hustedt, *M. pusilla* Grunow, *M. ovata* Grunow, *M. paradoxa* Grunow, *M. decipiens* Hustedt, *M. ignorata* Hustedt, *M. cyclops* Voigt, *M. pseudolatecostata* Yohn et Gibson i *M. pumila* (Grunow) Cleve. Rezultati istraživanja doprinose su poznavanju taksonomiji i ekologiji roda *Mastogloia* u Jadranskom moru.



**DIATOMS OF THE GENUS *MASTOGLOIA* THWAITES
EX W. SMITH FROM AREAS AFFECTED BY
CAULERPA RACEMOSA AND *CAULERPA TAXIFOLIA*
(ADRIATIC SEA COAST, CROATIA)**

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The genus *Mastogloia* Thwaites ex W. Smith includes a number of species living as epiphytes on seaweeds and seagrasses, and together with other biraphid (i.e. *Diploneis*, *Amphora*) and monoraphid genera (i.e. *Cocconeis*, *Achnanthes*), genus *Mastogloia* is highly biodiversified and quantitatively significant in the benthic communities. The present study is being developed in the framework of a research project dealing with exotic seaweeds *Caulerpa racemosa* and *Caulerpa taxifolia* in the Croatian part of southern Adriatic Sea. Studied samples were taken monthly during 2009 and 2010 in the areas of *Caulerpa racemosa* (Gonoturska Bay on Island of Mljet and location Orsula near Dubrovnik) and *Caulerpa taxifolia* (Stari Grad, Island of Hvar) at the depth from 5m to 15m. Processed material (hydrogen peroxide treated) was studied by means of Scanning Electron Microscope Hitachi S-3500 and S-5500. SEM studies were supplemented by light microscope (LM) observations. Diatom analysis was performed on permanent slides with Nikon E600 microscope under magnification of x1000. *Mastogloia* species are very distinctive with extremely variable areola structure. More than 25 species have been found, including: *M. binotata* (Grunow) Cleve, *M. fimbriata* (Brightwell) Cleve, *M. splendida* (Gregory) Cleve, *M. crucicula* (Grunow) Cleve, *M. erythraea* Grunow, *M. corsicana* Grunow, *M. inaequalis* Cleve, *M. cuneata* (Meister) Simonsen, *M. ovulum* Hustedt, *M. pusilla* Grunow, *M. ovata* Grunow, *M. paradoxa* Grunow, *M. decipiens* Hustedt, *M. ignorata* Hustedt, *M. cyclops* Voigt, *M. pseudolatecostata* Yohn et Gibson, and *M. pumila* (Grunow) Cleve. Results of this project will fill up the gap in our knowledge of communities and assemblages of *Mastogloia* species on Adriatic Sea coast.



LJEKOVITE BILJKE U DUBROVAČKIM SAMOSTANIMA

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Samostansko ljekarništvo posebice je cvalo od VI. do IX. stoljeća, utemeljeno na radovima Kasiodora i njegovim prijevodima grčkih medicinskih knjiga. Osnova je bila Dioskorova „Knjiga o bilju”, zatim djela Hipokrata i Galena. „Učini ovaj božanski i provjereni lijek. Uzmi perunike i miloduha te tucanjem dobro usitni u prah, zatim metni da uzavre u pjenušavu medu pa neka ujutro to uzme onaj koji kašlje”, recept je zadarskog liječnika Federika Grisogona iz XVI. stoljeća. Biljke su kroz stoljeća činile važni dio procesa liječenja, a mnoge su u narodnoj tradiciji ostale i danas. U dubrovačkim samostanima liječilo se uglavnom ljekovitim biljkama uzgojenim u dijelu vrta zvanom „herbarijum”, što je bilo propisano još od doba Karla Velikoga. Već su u Bibliji spominjane biljke od značenja u procesu liječenja ili očuvanja zdravlja, kao što su smokva (*Ficus carica*), šipak (*Punica granatum*), maslina (*Olea europaea*) ili vinova loza (*Vitis vinifera*). Posebno se ističu dvije biljke, mirta (*Myrtus communis*), bogata vitaminom C, te rutvica (*Ruta graveolens*), koja u narodu i danas ima mnogostruku primjenu. Današnja uporaba bilja svedena je uglavnom na kozmetičku primjenu: biljke se u izvornom obliku rijetko koriste u samom liječenju. U narodu je, međutim, još uvijek prisutna uporaba biljaka sa svrhom ublažavanja mnogobrojnih zdravstvenih tegoba, kad se prvo pokušava pomoći biljem pa tek onda proizvodima moćne farmaceutske industrije. Neke od biljaka, koje i danas nalazimo u uporabi narodne medicine, služile su kao sastavni dio recepture samostanskih ljekarnika.



MEDICINAL PLANTS IN THE MONASTERIES IN DUBROVNIK

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Monastic apothecary work blossomed between the 6th and the 9th centuries, based on Kasiodors work and his translations of the Greeks medicine books. The basic book was Dioskurids book of the herbs, works of Galen and Hipocrates. "Make this godlike and proved medicine. Take Iris and Hyssop, powder them, put them to boil in the foamy honey and let somebody who coughs take one spoon in the morning" – this was a recipe of the Zadars doctor Federiko Grisogono from the 16th century. For centuries, the herbs were very important part of the healing, and many of them still have part in todays traditional medicine. In Dubrovniks monasteries monks treated people with the medicinal plants grown in the gardens part known as "herbarium" what was ordered from the time of Charles the Great. Since the Biblical times we could find the plants important in the process of healing or health protection like Wild Figs (*Ficus carica*), Pomegranate (*Punica granatum*), Olive (*Olea europaea*) or Common Grape Vine (*Vitis vinifera*). Specially two plants were emphasized: Myrtle (*Myrtus communis*), enriched with the vitamin C, and Rue (*Ruta graveolens*) which is even today used in the traditional medicine. Nowadays, the herbs are mostly used in the cosmetic industry. A lot of common people still very often use herbs for medical problems before turning to their medical doctors. Among the herbs used today, many of them took part in the old monastic apothecarys recipes.



RAZVOJ I STJECANJE TEMELJNIH ODGOJNO- OBRAZOVNIH POSTIGNUĆA (KOMPETENCIJA) KROZ IZVANNASTAVNU AKTIVNOST VOĆARSKE GRUPE U SKLOPU ŠKOLSKOG VRTA I VOĆNJAKA

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Razvijanje temeljnih kompetencija učenika odvija se kroz redovitu nastavu, ali i kroz izvannastavne aktivnosti. Cilj ovog rada jest promotriti neke od osnovnih dokumenata Ministarstva znanosti, obrazovanja i športa kroz prizmu prilagođavanja promjenama suvremenog društva, odnosno pomaku u kurikulumu s prenošenja znanja na razvoj kompetencija. Posebno se ističu očekivana odgojno-obrazovna postignuća izvannastavnih aktivnosti s osvrtom na aktivnosti voćarske grupe u sklopu školskog vrta i voćnjaka. S obzirom da se obrazovanje u školi ostvaruje na temelju nacionalnog kurikuluma, nastavnih planova i programa te školskog kurikuluma, u radu su navedeni osnovni ciljevi nacionalnog kurikuluma s osvrtom na školski kurikulum temeljen na odredbama Zakona o odgoju i obrazovanju u osnovnim i srednjim školama te ciljevima, svrhom i organizacijskim obilježjima izvannastavnih aktivnosti. U drugom dijelu rada se na temelju iskustva iz zadnje dvije godine u provedbi i rezultatima izvannastavne aktivnosti voćarske grupe u osnovnoj školi Sveti Martin na Muri (Međimurska županija) pobliže promatra aspekt stjecanja kompetencija učenika, posebice socijalne, poduzetničke i prirodoznanstvene, te daje okvir mogućnosti vrednovanja novih sadržaja utemeljenih na korelacijsko-integracijskim mogućnostima interdisciplinarnih izvannastavnih aktivnosti kao temelju suvremenog nastavnog procesa.



**DEVELOPMENT AND ACQUISITION OF
EDUCATIONAL ACHIEVEMENTS (COMPETENCIES)
THROUGH THE EXTRA-CURRICULAR ACTIVITY
„FRUIT GROWING” WITHIN THE PROJECT SCHOOL
GARDEN AND ORCHARD**

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Students develop their basic competencies through regular curricular activities, but also through extra-curricular ones. The aim of this paper is to consider some of the basic documents of the Ministry of science, education and sports through the prism of adaptation to the changes of modern society, that is, to the shift in the curriculum from knowledge transfer to development of competencies. A special consideration has been given to the expected educational achievements of extra-curricular activities, and the activities of the „fruit growing”, within the project school garden and orchard, have been reviewed. Considering that education at school is based on national curriculum, plans and programmes and school curriculum, this paper cites the basic aims of the national curriculum with a glance at the school curriculum based on provisions of the Law of education in primary and secondary schools and aims, purpose and organizational features of the extra-curricular activities. The second part of the paper aims to observe more closely and based on the experience in execution and results of the extra-curricular activity „fruit growing” at the Primary school Sveti Martin na Muri (Međimurje county) from the last two years, the aspect of students acquisition of the competencies, especially social, entrepreneurial and scientific, and provides a framework for the possibility to evaluate new contents based on correlative-integrative possibilities of the interdisciplinary extra-curricular activities as a base of contemporary teaching process.



INTERDISCIPLINARNE RADIONICE S TEMOM ZAŠTITE PRIRODE: HERBARIJ MORSKIH ALGI

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Uvažavajući teme i metode istraživanja znanstvenika koji su pridonijeli stvaranju muzejskih zbirki Prirodoslovnog muzeja Dubrovnik (PMD), s posebnim osvrtom na zbirku morskih algi nastalu tijekom 19. st, osmišljen je interdisciplinarni edukativni program s temom zaštite prirode – Izrada herbarija morskih algi. Na temelju preliminarnih radionica i istraživanja interesa učenika osnovnoškolskog uzrasta definiran je program koji se sastoji od edukacije u prostoru Muzeja, terenskog rada i obrade prikupljenog materijala. Tijekom radionica, od postavljanja istraživanja na terenu, do uspostavljanja nove muzejske zbirke morskih algi, obrađuju se sljedeće teme: zakonske obveze istraživanja u zaštićenim područjima, korištenje ronilačke opreme, fotografija kao muzejska dokumentacija i alge kao indikatori onečišćenja mora. Herbarij morskih algi izrađuje se metodama koje su se jednako primjenjivale u 19. stoljeću. Uz determinaciju vrsta, obrada prikupljenog materijala uključuje i odabir vrste papira za herbarij, s naglaskom na reciklaži postojećeg dostupnog materijala, pisanje olovkom, korištenje povećala, metode herbariziranja i na koncu interdisciplinarnu tj., kreativnu primjenu rezultata. Uspoređivanjem podataka postojeće zbirke morskih algi PMD-a iz 19. stoljeća i prikupljenih podataka trenutnog stanja na terenu detaljnije se obrađuje tema biološke raznolikosti, te se ukazuje na važnost kontinuiteta znanstvenog rada kao i na metode rada u prirodoslovlju s osvrtom na očuvanje i pravilno upravljanje prirodnim vrijednostima. Iskustvenim učenjem, koristeći jednostavne metode, istovremeno povezujući naslijeđene vrijednosti i suvremene znanstvene spoznaje, ostvaruje se program s nizom interdisciplinarnih pedagoških radionica čime se pridonosi edukaciji učenika o muzeologiji, zaštiti prirode i okoliša u svrhu poticanja komunikacije i entuzijazma za znanost, te poticanja kreativnog i odgovornog pristupa izazovima svakodnevnog života.



INTERDISCIPLINARY WORKSHOPS ON THEME OF NATURE PROTECTION: MARINE ALGAE HERBARIUM

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Taking into account the themes and the methods of the scientists whose research contributed to the forming of museum collections of the Dubrovnik Natural History Museum, with the particular attention on the collection of the marine algae created during the 19th century, conceived is an interdisciplinary educational programme on the theme of nature protection – Making of marine algae herbarium. On the bases of the preliminary workshops and the research of primary school pupils interests, defined is a programme that consists of the following workshops: museum education, field work and the processing of the collected materials aimed at establishing a new Museum collection of marine algae. In these workshops the following themes are elaborated: legislation concerning research in protected areas, the use of diving equipment, the application of photography as the museum documentation and algae as indicators of the marine pollution. The marine algae herbarium is made using the same methods used in the 19th century. Apart from the species determination, the processing of the collected material also includes the following: the selection of the herbarium paper with the attention on the recycling of the existing available material, pencil writing, the use of the magnifying glass, the methods of herbarisation, and finally the interdisciplinary – creative application of the results. Comparing the data of the Dubrovnik Natural History Museums existing collection of the marine algae from the 19th century, and the collected data of the current field condition, the theme of biodiversity is elaborated in great detail. At the same time, emphasis is put on the importance of continuity of the scientific research and the methods of the natural history work, such as the conservation and the management of the natural values. The programme, conceived as a series of the interdisciplinary educational workshops, relies on the experience-based learning, the use of simple methods and relating of the inherited values and the contemporary understandings. Whilst encouraging communication and enthusiasm for science, and creative and responsible approach to the challenges of the everyday life, the purpose of the programme is to contribute to pupils education about museum studies and the nature and the environment protection.



MAPPING THE VASCULAR FLORA OF PÉCS (HUNGARY): DIVERSITY, CHANGES, NATURALNESS

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This study presents the preliminary results of a flora mapping project conducted in the city of Pécs (South Hungary). For such purpose, this is the first attempt in Hungary to use finer grid scales than the usual resolution of many national floristic investigations. The city has an area of 163 km² and approx. 157.000 inhabitants. For mapping floristic records, the authors used the system of Niklfeld (1971) modified by Király (2003). According to these methods seven Central European Flora-mapping and 12 Hungarian Flora-mapping quadrats covered the area of Pécs. However, this resolution insufficiently reflected the most important floristic patterns. Therefore we divide the Central European Flora Quadrats into 64 parts and conducted flora censuses in 100 rectangles, each of 2.2 km². Only species spreading naturally (i.e. native, archeophyte and spontaneously naturalized neophyte plants) were censused. The resulting database includes approx. 1750 species with actual and archive records. In the last two years 1300 taxa was recorded in Pécs, which means approx. 200 new species in the flora of the city (e.g. *Corispermum nitidum*, *Epipogium aphyllum*, *Senecio inaequidens*, *Thelypteris palustris*). The average actual species richness of the quadrats was ca. 300. According to the published and herbarium data the number of neophytes increased fourfold in the last 70 years. Degree of naturalness found to be positively correlated with altitude of the grid cells.



PROLJETNO CVJETANJE TOKSIČNOG DINOFLAGELATA *PROROCENTRUM MINIMUM* U MALOSTONSKOM ZALJEVU (JUŽNI JADRAN)

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Malostonski zaljev je tradicionalno važno područje za uzgoj školjkaša na istočnoj obali Jadranskoga mora. Hidrografske prilike u zaljevu su pod utjecajem specifičnih krških podmorskih izvora (vrulja) i dotoka rijeke Neretve. Ovo istraživanje je dio kompleksnog hidrografskog i biološkog istraživanja u Malostonskom zaljevu, provedenom tijekom 2002. Prvi put objavljujemo cvjetanje toksičnih dinoflagelata u tom zaljevu. Uzorci za analizu fitoplanktona i hidrografskih parametara sakupljeni su svaki tjedan u proljetnom razdoblju (ožujak-svibanj) na 13 metara dubokoj postaji Usko. Uzorci su uzimani od površine do dna na svakih metar dubine. Sredinom travnja i početkom svibnja u Malostonskom zaljevu su zabilježena dva relativno intenzivna cvjetanja fitoplanktona. Abundancija mikrofitoplanktona u proljeće 2002. bila je od $2,8 \times 10^3$ do $3,2 \times 10^5$ stanica L^{-1} . Najveća abundancija mikrofitoplanktona (zabilježena 17. travnja na tri metra dubine) uvjetovana je razvojem malog toksičnog dinoflagelata *Prorocentrum minimum*, čiji je relativni udio u abundanciji mikrofitoplanktona bio 95,1%. Cvjetanje ove vrste je ponovno zabilježeno 2. svibnja na površini ($2,1 \times 10^5$ stanica L^{-1}), s relativnim udjelom u ukupnoj abundanciji mikrofitoplanktona od 96,3%. Tijekom razdoblja istraživanja temperatura je varirala od 12,2 do 19,8°C, a salinitet od 31,6 do 38,6. Cvjetanja *Prorocentrum minimum* zabilježena su u uvjetima povišene temperature ($>16^\circ C$) i sniženog saliniteta (34-36). Abundancije *Prorocentrum minimum* u proljeće 2002. najveće su od kada se obavljaju ekološka istraživanja u Malostonskom zaljevu. Poznavanje ekologije i distribucije vrste *Prorocentrum minimum* u obalnom području južnog Jadrana važna je polazišna točka za detektiranje i praćenje eventualnih prirodnih i antropogenih poremećaja.



SPRING BLOOM OF TOXIC DINOFLAGELATE *PROROCENTRUM MINIMUM* IN MALI STON BAY (SOUTH ADRIATIC)

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Mali Ston Bay is traditionally important shellfish-farming region in the south-eastern part of the Adriatic coast. The hydrography of the bay is influenced by the specific karstic hydrology (underwater springs "vrulje"), and the Neretva River discharge. This study is a part of complex hydrographical and biological investigation in the Mali Ston Bay during 2002 and it presents the first information on toxic dinoflagellate bloom in the bay. Phytoplankton samples were collected and hydrographic parameters were measured weekly in spring (from the March to the end of the May) at the 13 m deep Usko station. Samples were taken from the surface to the bottom at one meter intervals. Two relatively intensive phytoplankton blooms were noted in mid April and early May in Mali Ston Bay. During the spring 2002 microphytoplankton abundances varied from 2.8×10^3 to 3.2×10^5 cells L^{-1} . The maximum abundance was recorded in April 17th at the 3 m depth, caused by the development of small toxic dinoflagellate *Prorocentrum minimum*. On that day, relative contribution of *Prorocentrum minimum* to microphytoplankton abundance was 95.1%. Second *Prorocentrum minimum* bloom was recorded at the surface in May 2nd with abundance of 2.1×10^5 cells L^{-1} and relative contribution to microphytoplankton abundance 96.3%. Water temperature throughout the investigating period ranged from 12.2 to 19.8 °C, and salinity from 31.6 to 38.6. Those two blooms of *Prorocentrum minimum* occurred under conditions of increasing temperature (>16°C) and lower salinities (34-36). The abundances of *Prorocentrum minimum* in spring 2002 were the highest noted since the start of ecological research in Mali Ston Bay. Knowledge about *Prorocentrum minimum* ecology and distribution in coastal areas of the southern Adriatic is important for detection of the possible natural and anthropogenically driven ecosystem disruptions.



DIVERSITY AND GRADIENTS IN THE LEBANON CEDAR (*CEDRUS LIBANI*) FORESTS ON TAURUS MOUNTAINS IN TURKEY

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Lebanon cedar (*Cedrus libani*) forests have been under the anthropogenic pressure of humankind for thousands of years. Almost inaccessible topography of the Taurus Mountains (Southern Anatolia) has prevented cedar in this region from being extirpated differently from its other distribution in Syria and Lebanon. The study deals with a comprehensive study of Lebanon cedar forests on the Taurus Mountains. Numeric analyses of relevés confirmed the individuality of associations as well as division of Lebanon cedar forests into two ecologically and floristically different groups/alliances (*Abieti-Cedrion* and *Lonicero-Cedrion*). *Abieti-Cedrion* is distributed in the middle and eastern Taurus whereas *Lonicero-Cedrion* appears in the western Taurus. The main gradients of Lebanon cedar forest have been detected. It has been established that distribution and floristic composition of Lebanon cedar forests is strongly affected by geographical factor, as: from west to east and also from south to north. Topographical factors are also decisive on their distribution. Lebanon cedar forests are mainly part of the Mediterranean Phytogeographical region and therefore the Mediterranean floral element prevails, but with the decrease of influence of Mediterranean Climate, in more continental conditions the proportion of Iran-Turanian and Euro-Siberian floral element increases, especially in direction to the east and north, as well in higher altitudes and steeper sites.



ANTIOXIDANT CAPACITY, TOTAL PHENOL AND FLAVONOID CONTENTS OF *JOVIBARBA HEUFFELII* (SCHOTT.) A. LÖVE & D. LÖVE

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The present study examined antioxidant activity, concentration of phenols and flavonoids of *Jovibarba heuffelii* extracts from leaves and roots, using standard spectrophotometric methods. *Jovibarba heuffelii* (*Crassulaceae*) is Balkan-Carpathian endemic plant with distribution in the middle part of the Balkan peninsula and the Central and Southern parts of Karpats. It grows on rocky and karst places and spreads on silicates, carbonates and serpentinites. Plant material was collected from its natural habitats in Serbia, locality Besna Kobila Mt. (1900 m altitude, silicate) at the full flowering stage. Methanolic, ethyl acetate and acetone extracts from leaves and methanolic extracts from roots were prepared for the purpose. Antioxidant activity of plant extracts was examined *in vitro* using 2,2-Dyphenyl-1-picrylhydrazyl (DPPH) reagent and the results were expressed in terms of IC₅₀ values (µg/ml). Values obtained for the antioxidant activity ranged from 708.96 to 422.69 µg/ml while the antioxidant activity of methanolic extract from roots is 304.19 µg/ml. The concentration of phenols was determined by spectrophotometric method using the Folin-Ciocalteus reagent. The concentrations of phenols in the extracts were expressed in terms of gallic acid equivalent (mg GA/g extract). Values obtained for the concentrations of phenols in the examined extracts ranged from 35.89 to 57.12 mg/g. The concentration of flavonoids in *Jovibarba heuffelii* extracts was determined using standard spectrophotometric method and were expressed in terms of rutin equivalent (mg RU/g extract). The concentration of flavonoids in *Jovibarba heuffelii* extracts ranged from 10.48 to 30.46 mg/g. The phenol and flavonoid concentrations of methanolic extracts from root is 37.22 and 5.26 mg/g respectively. The values point to high concentration of phenols and flavonoids. Compared with the reference substances values (BHA, rutin, chlorogenic acid), the results of antioxidant activity point to high antioxidant activity of phenols in some *Jovibarba heuffelii* extracts.



AEROPALINOLOŠKA ISTRAŽIVANJA U GRADU DUBROVNIKU

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Aeropalinološka istraživanja mogu biti vrlo korisna liječnicima i njihovim pacijentima u prevenciji i liječenju alergija. Stoga je u ovom radu predstavljeno aerobiološko istraživanje peluda u zraku grada Dubrovnika. Pelud je uzorkovana standardiziranom aerobiološkom volumetrijskom metodom, uređajem za pelud i spore Hirst-ovog tipa. Analizirane su sezonske promjene različitih tipova peluda u odnosu na meteorološke parametre, tijekom trogodišnjeg razdoblja (2005.-2007.). Za navedeno razdoblje izrađen je i peludni kalendar. Koncentracija peludi izražena je brojem peludnih zrnaca/m³ zraka. Prosječna godišnja koncentracija peludi iznosila je 17297 peludnih zrnaca/m³ zraka; najniža vrijednost zabilježena je 2005., a najviša 2007. Tijekom svih istraživanih godina, najviša koncentracija peluda zabilježena je od ožujka do lipnja (77% ukupne godišnje koncentracije peluda). U zraku je zabilježena pelud 44 biljne svojte. S obzirom na udio u ukupnoj godišnjoj koncentraciji peludi, najznačajnije svojte pripadale su porodicama/rodovima: *Cupressaceae/Taxaceae*, *Parietaria/Urtica*, *Pinus*, *Olea*, *Poaceae*, *Quercus*, *Corylus*, *Carpinus/Ostrya* i *Fraxinus*. Najveći broj različitih tipova peluda zabilježen je u zraku grada Dubrovnika tijekom proljeća, dok je zimi i ujesen raznolikost manja. Rezultati Spearman-ovog korelacijskog testa između dnevnih koncentracija peludi i glavnih meteoroloških parametara (oborine, maksimalna, srednja i minimalna temperatura) bili su značajni u velikom broju slučajeva. Dnevne koncentracije uglavnom pokazuju pozitivnu korelaciju s temperaturom i negativnu s oborinama. Rezultati ovog istraživanja, kao i peludni kalendar izrađen za peludnu sezonu 2005.-2007. za grad Dubrovnik, pružaju korisne podatke za postavljanje točnih dijagnoza, a informacije o tipovima i koncentraciji peluda alergičarima omogućuju da, usklađivanjem dnevnih aktivnosti, izbjegnu kontakt s alergenima i na taj način poboljšaju kvalitetu života.



AEROPALYNOLOGICAL STUDY IN THE CITY OF DUBROVNIK (CROATIA)

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Aeropalynological studies could be very useful for physicians and allergic patients in order to enable better management of seasonal allergic symptoms. The aim of this work is to present a study of the atmospheric pollen content using the pollen calendar and the seasonal variations of different pollen types and their relationship with meteorological parameters in the city of Dubrovnik, during the three year period (2005-2007). The standardized aerobiological volumetric method of airborne pollen sampling was done by the Hirst sampler. Pollen concentration was expressed as the number of pollen grains/m³ of air. The average annual pollen count obtained during the period studied was 17297 pollen grains, the lowest value being recorded in 2005 and the highest in 2007. During these years, the greatest concentrations were always detected from March-June, a period in which 77% of the total annual pollen was collected. Airborne pollen grains of 44 taxa were recorded. Based on the annual total pollen count, the main taxa were: *Cupressaceae/Taxaceae*, *Parietaria/Urtica*, *Pinus*, *Olea*, *Poaceae*, *Quercus*, *Corylus*, *Carpinus/Ostrya* and *Fraxinus*, in order of abundance. In Dubrovnik, the period with the greatest diversity of pollen types is spring, while winter and autumn show the lowest numbers. The results of the Spearman's correlation test between daily pollen concentrations and the main meteorological parameters (precipitation, maximum and minimum temperature) were significant in a large number of cases. Daily pollen concentrations usually present a positive correlation with temperature and negative with precipitation. The results of this study and the pollen calendar designed for the pollen season 2005-2007 for the city of Dubrovnik provide useful data for accurate diagnoses and information on airborne pollen types and concentrations to individuals with pollen hypersensitivity, thus allowing them to adjust their daily activities so that they could minimize the contact with allergens and improve their quality of life.



POVEZANOST PČELARSTVA I HORTIKULTURE KROZ ODRŽIVI RAZVOJ SRIME KOD ŠIBENIKA

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Područje Srime kod Šibenika obiluje izdašnom pašnjačko-kamenjarskom vegetacijom za proizvodnju ekološki čistog meda. Prostor obuhvaća jugozapadni dio Šibensko-kninske županije počevši od ulaza na Šibenski most pa do odvojka za Jadriju na magistrali. Osim kultiviranih vrsta i tipičnih koštuničavih voćaka koje na početku sezone služe kao poticaj za daljnji stimulans zajednice, prevladavaju i izdašnije istraživane medonosne vrste. Moderni uzgoj pčela ovisi o kvaliteti i kvantiteti cvjetne paše pa je s toga cilj i ovog rada istražiti navedenu problematiku. U radu je prikazano stanje cvjetne paše u mjesecu svibnju. Uzorci su uzorkovani 2010. iz različitih košnica u razmaku od 7-14 dana. U toj fazi peludnom analizom meda u ovlaštenom laboratoriju je ustvrđeno, uz prisustvo pucaline, kadulje, rašeljke i ostalih medonosnih biljaka i korova koji se pojavljuju na obradivim i neobradivim površinama, a koji su među ostalim medonosnim biljkama itekako dobar izvor nektara. Poznavanje biljnog medonosnog i peludnog materijala bitan je preduvjet valorizacije samog terena u suvremenom pčelarenju. Peludnim analizama se dokazuje i sortnost uzorkovanog meda. Analizirat će se vrsta, kemijski sastav cvjetnog meda i peluda te historijat uporabe fermentiranog nektara na tom području. U skladu s podacima o vrsti prikazat će se detaljni prikaz nektarne vrijednosti. Kako bismo ukazali na mogućnosti iskorištavanja meda i proizvoda od meda u kulturno turističkoj ponudi, osvrnut ćemo se i na upotrebu meda na ovim prostorima još od antičkih vremena. Predlažemo i uvrštavanje u gastro ponudu, možda čak u zasebnom pčelarskom centru.



CONNECTION BETWEEN BEEKEEPING AND HORTICULTURE THROUGHOUT SUSTAINABLE DEVELOPMENT OF SRIMA NEAR ŠIBENIK

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Srima area near Šibenik abounds with rich pasture-brown bullhead vegetation for the production of ecologic pure honey. The mentioned area is located on the south-west of Šibenik-Knin county, starts on the entrance to Šibenik Bridge and reaches the branch to Jadrija on the main road. With the exclusion of the cultivated strains and typical stone fruit-trees, which in the season serves as a further community stimulus, more examined melliferous floral strains predominate. The modern beekeeping depends on the quality of the floral pasture and the purpose of this work is exploring these issues. The situation of the floral pasture in the month of May is represented in this work. The specimens are sampled in 2010 from different beehives in the 7-14 days intervals. By pollen analysis of the honey in a certified laboratory, besides the presence of Bladder Sena, Sage, Rock Cherry and many others melliferous plants, in this phase a plentiful of weeds from cultivated and non-cultivated areas were found. Among other melliferous plants the weed is a very good source of nectar. The knowing of the melliferous and pollen stuff is a significant precondition for valorisation of the pasture in contemporary beekeeping. Through the pollen analysis, the variety of the sampled honey could also be demonstrated. The strain, chemical composition of the floral honey and pollen as well the usage history of the fermented nectar respectively honey on this area will be analyzed. According to the strain data, the comprehensive review of the nectar-value will be shown. These analyses could also be used in horticulture and especially in the landscape architecture as a taxonomic indicator for particular interesting floral strain in the examined area. This theory will be presented in the landscape decoration of rural and urban zones in Šibenik. In order to show the possibility of honey and honey products usage in the cultural and tourist offer, we will review the honey usage in this region from the antique times. We propose also the implementation to the gastronomical offer, maybe in a distinct beekeeping centre.



FLORISTIČKI SASTAV LIVADA NA PODRUČJU ŽUMBERKA I SAMOBORSKOG GORJA (SZ HRVATSKA)

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Livade na području Žumberka i Samoborskog gorja (SZ Hrvatska) floristički su istraživane tijekom dvije vegetacijske sezone (2008. i 2009.). Primijenjene su uobičajene metode bilježenja biljaka, prikupljanja i identifikacije. Nomenklatura svojti usklađena je prema Tutinu (1964-1980, 1993). Istraživane livade su i nalazišta lokalnih populacija crvene djeteline (*Trifolium pratense* L.). Na istraživanim livadama Žumberka i Samoborskog gorja zabilježene su ukupno 94 biljne svojte iz 30 porodica. Analiza trajanja života pokazuje prevlast zeljastih trajnica, a u spektru životnih oblika dominiraju hemikriptofiti. Najviše biljnih vrsta je euroazijskog porijekla te vrsta široke rasprostranjenosti. Brojnost vrsta ukazuje na veliku bioraznolikost, ali je i pokazatelj sve slabijeg održavanja livadnih staništa. Uslijed toga dolazi do prirodne sukcesije, a time i do genetske erozije i izumiranja prirodnih populacija crvene djeteline.



FLORISTIC COMPOSITION OF MEADOWS IN THE AREA OF ŽUMBERAK-SAMOBORSKO GORJE (NW CROATIA)

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The meadow flora was investigated in the area of Žumberak-Samoborsko gorje (NW Croatia) during two vegetational seasons (2008, 2009). Usual methods, such as collecting and identification were applied in research. The nomenclature of plants was carried out according to Tutin *et al.* (1964-1980, 1993). Investigated meadows are in the same time habitats of the local populations of red clover (*Trifolium pratense* L.). In total, 94 plant taxa from 30 families were recorded at investigated meadows on Žumberak and Samoborsko gorje. Duration of life cycle analysis showed predominance of perennial herbaceous plants, and hemicryptophytes dominated in life form spectrum. Most of the species were of the Euroasian origin and also widespread cosmopolites. The number of species point out at huge biodiversity, but in the same time it is the indicator of even badly maintained meadow habitats. This leads to the natural succession, and thus to genetic erosion and extinction of natural populations of the red clover.



MORFOLOŠKA RAZNOLIKOST KOMPLEKSA *ANTHYLLIS VULNERARIA* (FABACEAE) NA ŠIREM PODRUČJU BALKANA

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Rod *Anthyllis* jedan je od 22 roda unutar tribusa *Loteae* DC. (por. *Fabaceae*). Najrasprostranjenija vrsta roda je *Anthyllis vulneraria* L. s.l., koja se rasprostire duž cijele Europe, od Skandinavije do Sredozemlja, te dijelom u sjevernoj Africi i jugozapadnoj Aziji. Na području rasprostiranja vrsta pokazuje veliku varijabilnost, s mnogim prijelaznim oblicima koji čine stabilne i više-manje homogene populacije. Premda su oblici ove vrste do sada taksonomski različito kategorizirani, najprimjerenije ih je smatrati podvrstama, te je do sada na području Europe opisano 30 i više različitih podvrsta. Prema literaturnim i herbarnim podacima u Hrvatskoj raste šest podvrsta vrste *A. vulneraria*: *A. vulneraria* L. subsp. *alpestris* (Kit. ex Schult) Asch. et Graebn., *A. v.* subsp. *carpatica* (Pant.) Nyman, *A. v.* subsp. *polyphylla* (DC.) Nyman, *A. v.* subsp. *pulchella* (Vis.) Bornm., *A. v.* subsp. *praepropera* (A.Kern.) Bornm. i *A. v.* subsp. *weldeniana* (Rchb.) Cullen. Razgraničenje ovih svojta, kao i pripadajuća taksonomija, vrlo su upitni. Cilj istraživanja bio je preliminarno proučiti morfološku raznolikost kompleksa *A. vulneraria* na dijelu Balkanskog poluotoka te razriješiti zbunjujuće kriterije u razgraničenju dvojbениh svojta. Analiza je uključila 493 primjerka uzorkovana na 64 lokaliteta u Hrvatskoj, Italiji, Bosni i Hercegovini, Bugarskoj i Srbiji. Za svaki je primjerak zabilježeno ukupno 30 vegetativnih i generativnih osobina, od kojih je 23 izraženo kvantitativno, a sedam kvalitativno. Svaka je osobina analizirana pomoću standardnih statističkih metoda, koje pokazuju cjelokupnu varijabilnost, kao i unutar- i međupopulacijsku varijabilnost te varijabilnost među svojta. Diskriminantna analiza (Wilks Lambda distribucija) upotrijebljena je kako bi se ustanovile najznačajnije dijagnostičke osobine, a one su: suha siva čaška, boja čaške, boja vjenčića, visina stabljike, pokrov čaške i boja vrha lađice. Nakon toga uslijedila je kanonička analiza koja je rezultirala formiranjem četiri jasno odvojene skupine svojta: i) *A. vulneraria* subsp. *alpestris*, ii) mediteranska crvenocvjetna skupina (*A.v. praepropera*, *A.v. weldeniana*, *A.v. maura*), iii) *A.v. pulchella*, iv) *A.v. polyphylla*, *A.v. carpatica*. Pogrešno determinirani primjerci pridodani su odgovarajućem taksonu.



MORPHOLOGICAL DIVERSITY OF *ANTHYLLIS VULNERARIA* COMPLEX (*FABACEAE*) IN WIDER BALKAN AREA

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The genus *Anthyllis* L. is one of 22 genera in the tribe *Loteae* DC. of *Fabaceae* family. The most widespread species of the genus is *Anthyllis vulneraria* L. s.l. that occurs from Scandinavia to the Mediterranean, partly in North Africa and South-west Asia. The species shows a seemingly bewildering range of variation throughout its area of distribution, with many variants of intermediate morphology that form stable and more or less homogeneous populations. Although treated at different taxonomic ranks, variants of *A. vulneraria* are most appropriately treated as subspecies, and so far 30 or more subspecies have been recognized in Europe. Based on literature and herbarium data there are six subspecies of *A. vulneraria* recorded for Croatia: *A. vulneraria* L. subsp. *alpestris* (Kit. ex Schult) Asch. et Graebn., *A. v.* subsp. *carpatica* (Pant.) Nyman, *A. v.* subsp. *polyphylla* (DC.) Nyman, *A. v.* subsp. *pulchella* (Vis.) Bornm., *A. v.* subsp. *praepropera* (A.Kern.) Bornm. and *A. v.* subsp. *weldeniana* (Rchb.) Cullen. Delimitation of these taxa, as well as related taxonomy is doubtful. The aims of the study were to preliminary explore morphological diversity of *A. vulneraria* complex in one part of the Balkan Peninsula and to resolve misleading criteria in the delimitation of some doubtful taxa. The analysis included 493 specimens in total, sampled in 64 localities in Croatia, Italy, Bosnia and Herzegovina, Bulgaria and Serbia. A total of 30 vegetative and floral characters were recorded for each specimen. Out of them, 23 were measured quantitatively and seven qualitatively. Each character was analysed by standard statistical tools showing overall variability, as well as inter- and intra-population and taxa variability. Discriminant analysis (Wilks Lambda distribution) was used to detect the most useful diagnostic characters, namely: grey dry calyx, calyx colour, corolla colour, stem height, calyx indumentum and keel top colour. Following Canonical analysis resulted in four clearly separated groups of taxa: i) *A. vulneraria* subsp. *alpestris*, ii) Mediterranean red flowered group (*A.v. praepropera*, *A.v. weldeniana*, *A.v. maura*), iii) *A.v. pulchella*, iv) *A.v. polyphylla*, *A.v. carpatica*. Misjudged specimens were placed in appropriate taxon.



TOWARDS A RESOLUTION OF THE "CAMPANULA PROBLEM"

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The genus *Campanula* comprises over 400 species but there is little agreement about generic boundaries within the subfamily Campanuloideae or the infra-generic classification of *Campanula* itself. Many mono- or oligotypic genera are recognised while other students prefer to merge these with *Campanula*. Both treatments have disadvantages and a balanced approach is required. We suggest that the merging of genera leads to a general loss of evolutionary insight and the appreciation of the evolutionary and ecological uniqueness. Conversely, the recognition of numerous small genera is disadvantageous for general use, particularly for gardeners and horticulturalists. Cladistic analyses, while useful for determining phylogenetic relationships, are detrimental to the construction of a workable classification, if not used with caution. It is recommended that traditional morphological characters, supplemented by ecological, biogeographic and other data sets, and guided by findings from molecular data, should allow a reclassification of *Campanula* to be achieved. Several shortcomings to our present knowledge are listed and possible novel approaches for future investigation are suggested.



GENETSKA RAZNOLIKOST HRVATSKIH POPULACIJA LJEKOVITE KADULJE (*SALVIA OFFICINALIS* L.)

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Ljekovita kadulja je višegodišnja grmolika biljka rasprostranjena sjevernim Sredozemljem. U Hrvatskoj se ljekovita kadulja često prikuplja u prirodi i komercijalizira kao ljekovita i aromatična biljka. Procjena genetičke raznolikosti početni je korak za uvođenje ljekovite kadulje u oplemenjivačke programe i poljoprivrednu proizvodnju, budući da komercijalno prikupljanje u prirodi ima negativan utjecaj na očuvanje bioraznolikosti. Glavni je cilj ovog istraživanja bio utvrditi razinu i strukturu genetičke raznolikosti populacija, zemljopisnu diferencijaciju, pojavu „demografskih uskih grla”, kao i ekotipsko razilaženje. U tu je svrhu razvijeno pet mikrosatelitnih biljega korištenjem obogaćenih knjižnica genomske DNA. Navedeni su mikrosatelitni biljezi uspješno upotrijebljeni za procjenu genetske raznolikosti deset populacija ljekovite kadulje prikupljenih u Hrvatskoj.



GENETIC DIVERSITY IN CROATIAN POPULATIONS OF DALMATIAN SAGE (*SALVIA OFFICINALIS* L.)

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Dalmatian sage is a perennial shrub native of the northern coastal region of the Mediterranean. In Croatia, Dalmatian sage is often gathered from the wild and commercialized as medicinal and aromatic plant. The assessment of genetic diversity is a starting point for its introduction into plant breeding programmes and agricultural production since commercial gathering could have a negative impact on biodiversity conservation. The aim of this study was to assess the amount and structure of population genetic diversity, the geographic differentiation, the occurrence of demographic bottlenecks and the ecotypic divergence. For this purpose five microsatellite markers were developed from enriched genomic DNA libraries and successfully applied for the assessment of genetic diversity in ten Dalmatian sage populations collected in Croatia.



CYANOBACTERIA OF THE KARSTIC SPRINGS IN HERZEGOVINA (BOSNIA AND HERZEGOVINA)

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Karst occupies 50% of the total surface area of Bosnia and Herzegovina and it is of a great value for the country. Algae of karstic springs were not sufficiently investigated in Bosnia and Herzegovina. Most of the microphyte populations in karstic springs belong to the periphyton (litophyton and epiphyton). The aim was to investigate the springs periphytic *Cyanobacteria* in rivers of Buna (altitude 54 m, N 43°15'25.4 / EO 17°54'15.1), Bunica (altitude 52 m, N 43°13'31.1 / EO 17°53'9.3) and Radobolja (altitude 112 m, N 43°21'16.9 / EO 17°45'34.7) – all three of them located near the city of Mostar in Herzegovina. Abiotic environmental factors were investigated at the same time. In total, 43 taxa of *Cyanobacteria* were identified in all springs investigated (in Bunica 29, Buna 24 and 17 in Radobolja). Out of 43 total taxa, eight taxa (19%) were found exclusively in Bunica spring; four (9%) were found only in Buna spring, and seven (16%) just in Radobolja spring. Only seven taxa (16%) were common at all three springs. Genera *Phormidium* (11) and *Plectonema* (4) had the highest number of taxa. This study found that oligosaprobic zone indicators were prevailed among *Cyanobacteria*.



NISKA STOPA TOČKASTIH MUTACIJA U NEKODIRAJUĆIM SLIJEDOVIMA mtDNA VRSTA RODA *HYPERICUM*

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Za razliku od široke primjene mitohondrijske DNA u proučavanju filogenetskih odnosa životinja i čovjeka, u filogenetskim istraživanjima biljaka njezina je primjena sporadična, zbog visoke stope strukturalnih preraspodjela i niske stope točkastih mutacija. Ipak, u nekih je vrsta utvrđena adekvatna varijabilnost i filogenetska primjenjivost. S ciljem testiranja varijabilnosti i primjenjivosti mtDNA za filogenetska istraživanja vrsta roda *Hypericum*, u ovom su istraživanju metodom mtDNA RFLP uspoređene tri nekodirajuće regije velikog broja vrsta roda *Hypericum*. Od ukupno 36 vrsta, koje pripadaju u 15 sekcija roda *Hypericum* i 15 restriksijskih profila, razlike u profilima uočene su samo u tri vrste. Jedna delecija desila se u mtNAD1/*Hinf*I profilu vrste *H. pseudohenryi*, dok je gubitak restriksijskog mjesta uočen u mtNAD1/*Rsa*I profilu vrste *H. olympicum*, a dobitak restriksijskog mjesta u mtNAD1/*Rsa*I profilu vrste *H. hirsutum*. Ovakav rezultat potvrđuje sporu evoluciju u slijedovima mtDNA vrsta roda *Hypericum* što je slučaj sa biljnom mitohondrijskom DNA općenito.



LOW RATE OF POINT MUTATION IN THE mtDNA NONCODING FRAGMENT OF *HYPERICUM* TAXA

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Contrary to major impact on the study of phylogeny in animals and human, application of mitochondrial DNA (mtDNA) analyses in phylogenetic researches of plants is sporadic due to their high rate of rearrangements and low rate of point mutations in plants. Nevertheless, in some taxa mtDNA analysis gave interesting results. With aim to test variability and applicability of mtDNA in genus *Hypericum*, in this investigation 4 noncoding regions of mtDNA was compared using mtDNA RFLP on large number of *Hypericum* taxa. Out of thirtysix *Hypericum* taxa, belonging to fifteen sections, and fifteen restriction profiles, difference in profiles of only three species were observed. One deletion was found in mtNAD1/*Hinf*I profile of *H. pseudohenryi*, while lose of restriction site was detected in mtNAD1/*Rsa*I profile of *H. olympicum* and gain of restriction site in mtNAD1/*Rsa*I profile of *H. hirsutum*. Such result confirms slow sequence evolution of the *Hypericum* mtDNA as is the case with the plant mtDNA in general.



ZNAČAJKE PELUDNIH SEZONA PITOMOG KESTENA (*CASTANEA SATIVA* MILL.) U ZAGREBU I SAMOBORU (SJEVEROZAPADNA HRVATSKA)

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Ciljevi istraživanja bili su analizirati značajke peludnih sezona pitomog kestena (*Castanea sativa* Mill.) i usporediti aerobiološke podatke gradova Zagreba i Samobora (sjeverozapadna Hrvatska). Istraživanje je provedeno u razdoblju od 2003. do 2006. godine, tijekom vegetacijskih sezona, a za sabiranje uzoraka peluda iz zraka korišten je volumetrijski uređaj za pelud i spore Hirst-ovog tipa. Sezona pojavljivanja peluda pitomog kestena u zraku traje od lipnja do kraja srpnja u oba ispitivana područja i usporediva je i sa sezonama polinacije u ostalim europskim gradovima. Uočena je pravilnost – što je kraća peludna sezona to je veća koncentracija peluda. Iako se zbog ljetne polinacije roda *Castanea* može produžiti i sezona pojavnosti simptoma alergijskih reakcija kod osoba osjetljivih na pelud biljaka iz reda Fagales, broj dana s koncentracijom peluda većom od 50 zrnaca u m³ zraka je relativno mali te vjerojatno ne bi značajnije utjecao na alergične osobe. Korelacija koncentracije peluda s temperaturom je pozitivna i signifikantna, a s oborinama negativna i nije signifikantna. Zbog nesignifikantnih razlika u koncentraciji peluda između dviju aerobioloških postaja, potencijalne dugoročne prognoze peludnih sezona biljaka iz reda Fagales za sjeverozapadno područje Hrvatske, dovoljni su i aerobiološki podaci dobiveni s jedne postaje.



CHARACTERISTICS OF POLLEN SEASONS OF SWEET CHESTNUT (*CASTANEA SATIVA* MILL.) IN ZAGREB AND SAMOBOR (NORTH-WEST CROATIA)

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The aims of the study were to analyse characteristics of the *Castanea* airborne pollen and to compare aeropalynological data obtained from two sampling stations in north-west Croatia. The study was conducted in Zagreb and Samobor during the 2003-2006 periods, using the seven-day volumetric samplers of the Hirst design. In both study areas, the seasons of chestnut pollination were similar and lasted from June to the end of July, which is comparable to other European cities. A general rule was noticed - the shorter the main pollen season, the higher the pollen peak concentration. Although the pollen season of Fagales pollen is prolonged to summer in the area of inland west-north Croatia due to the genus *Castanea* summer pollination, the number of days with pollen air concentration higher than 50 per m³ was low and was not likely to have any major effects in allergic individuals. Airborne pollen concentration of *Castanea* showed positive statistically significant correlation with air temperature and negative non-significant correlation with precipitation. Because of the non-significant differences between the two stations, for a possible long-term forecast model for Fagales airborne pollen for this part of north-west Croatia, aerobiological data obtained from only one station are sufficient.



THE NEW SPECIES OF THE GENUS *CROCUS* L. - *CROCUS JABLANICENSIS*

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In the spring 2007, on the mountain Jablanica, in the Republic of Macedonia, above Struga, around snow banks, at the altitude above 2000 m, at the alpine region, on the peak Čuma, we found the large populations of yellowish-white saffron. In 2008, we visited the peak Krstač, where we determined large populations of the same saffron which grew around snow banks. In the spring 2010, we visited the peaks Čuma and Krstač again, and peak Strižak, the day after. Except the yellowish-white coloured saffrons which represented dominant populations, we also found the small populations of the violet saffron at Čuma and Krstač, and we believe that they belong to species *C. veluchensis* Herb. Beneath the peak Strižak, we found the populations of orange coloured saffron, and we are sure they represent the individuals of saffron - *C. scardicus* Košanin. The populations of the yellowish-white saffron took our attention. The white coloured saffron is described by V. Pulević (1976) like *C. malyi* Vis. on Velebit and *C. albiflorus* Kit in Croatia. Our populations did not belong to these schemes. It is also known that species *C. alexandrii* Ničić and *C. pallidus* Kit. et Drenk., have white and yellowish-white flowers, but these species grow in hilly regions and they belong to the annulated saffron. In the populations of the species *C. veluchensis* Herb., all the time we were encountering the white coloured individuals belonging to f. *albiflorus* N. Ranđ. which, like the typical individuals of the species, have orange coloured styles and stigmas, but in the large populations of *C. veluchensis* there are only dozen of them on one mountain. All the analysis showed that populations of the yellowish-white saffron from Jablanica can not belong to the mentioned species - therefore we found a new species. That conclusion was made on the basis of next facts:

- a) there are large populations of yellowish-white saffron, around the peaks of Jablanica: Čuma, Krstač, Strižak,
- b) the populations are situated at alpine part of mountain, around the snow banks, in the mixed populations with the species *C. scardicus* and *C. veluchensis*,
- c) morphologically, the individuals of these populations are similar with the species *C. cvjicii* and *C. scardicus* because: they have white styles and stigmas, the tunic of bulb covers the lower parts of stem, the tubers are small and cookie-like, the plants are short with large flowers,
- d) ecologically, they are similar because they grow in subalpine and alpine zone, around snow banks in running water, and beneath the peak Strižak they are mixed with the species *C. scardicus* at bogs.



KARTIRANJE FLORE U NASTAVI BIOLOGIJE

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Sistematika bilja izučava se u drugom razredu gimnazije u okviru predmeta Biologija. Svi su učenici na redovitom satu, a u skladu s uzrastom, upoznati sa standardnim postupkom kartiranja flore (Nikolić i sur., 1998) te korištenjem *Flora Croatica Database*. Učenici koji su posebno zainteresirani za sistematsku botaniku šire su upoznati s metodom kartiranja flore, prvo na terenu, a zatim s postupkom unošenja vrsta u *Flora Croatica Database*. U tu svrhu biljne su vrste popisane u makiji oštrike (*Quercus coccifera* L.) u okolini Pendovog sela u Konavlima, koristeći florne liste. Biljke koje nismo na terenu uspjeli determinirati, odredili smo u laboratoriju, korištenjem standardnih ključeva za determinaciju. Unos podataka u *Flora Croatica Database* obavili smo uz vodstvo i nadzor osobe koja ima pristup bazi. Dodatne informacije, praktična vježba kartiranja flore i korištenje *Flora Croatica Database* i sličnih baza način su kako učenike zainteresirati za botaniku i razviti kod njih želju za istraživanjem hrvatske flore. Važno je da se učenici upoznaju s postupcima determiniranja i metodama kartiranja, kao i načinom unošenja podataka, jer tako teorija iz udžbenika postaje zanimljiva praktična nastava i njima veliki poticaj za znanstvena istraživanja.



FLORA MAPPING IN BIOLOGY CLASSES

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The systematic of plants is studied in the second grade of secondary school (gymnasium), according to the curriculum within biology classes. All students, within regular classes and according to their age, have been introduced to the standard procedure of flora mapping (Nikolić *et al.* 1998). They have also been instructed how to use Flora Croatica Database. Students particularly interested in systematic botany were first thoroughly introduced to the method of flora mapping in the field study. They were then introduced to the process of entering species into Flora Croatica Database. For this purpose, we listed plant species within the kermes oak maquis (*Quercus coccifera* L.) found in the surrounding area of Pendovo selo, a village in Konavle. A data entry sheet was used for this occasion. The origin of plants we were not able to classify in the field was later determined in the laboratory by using standard determination keys. The process of entering data into Flora Croatica Database was carried out under surveillance of an authorized person with access to the database. Additional information on flora mapping, the use of Flora Croatica Database as well as other similar data bases, provides teachers with new ways of making students interested in the subject as well as arising their eagerness to explore Croatia's flora. It is important that students be introduced to the processes of determination, methods of mapping as well as entering data in the database. In this way, sheer theory becomes appealing practical study which serves as a great incentive for further scientific research.



AKTIVNOST ALKALNE FOSFATAZE U STRATIFICIRANIM ESTUARIJIMA KRKE I ZRMANJE (ZIMSKI ASPEKT 2004.)

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Nedostatak ortofosfata u različitim organizmima (alge, bakterije, protozoa, biljke, životinje i dr.) inducira sintezu fosfataza, koje kataliziraju oslobađanje fosfata iz organskih molekula. Aktivnost fosfataze u moru regulira prije svega koncentracija ortofosfata, dostupnost otopljenog organskog fosfora, interakcija fitoplanktona i bakterija, unutarstanični omjer N/P te UV-B inhibicija. Aktivnost bakterijske alkalne fosfataze nije isključivo vezana uz nedostatak fosfora, već i uz ciklus ugljika, pa se kao pouzdaniji indikator fosfatnog statusa okoliša koristi aktivnost alkalne fosfataze fitoplanktona (AAFF). Ovo istraživanje provedeno je 4. veljače 2004. (postaje N1 i V1A u estuariju Zrmanje) i 5. veljače 2004. (postaje E4A i E5 u estuariju Krke) s ciljem utvrđivanja fosfatnog statusa fitoplanktona. AAFP je mjerena spektrofotometrijski u frakciji nanofitoplanktona i mikrofitoplanktona (1.2-53 μ m, λ =400nm, supstrat p-nitrofenil-fosfat). Na postaji E5 haloklina je izmjerena u površinskom sloju do dubine od 2 m, a u šibenskoj luci (na postaji E4A) u sloju između 2 i 6 m. Izmjerene AAFP iznad i ispod halokline u estuariju Krke ukazuju da je rast slatkovodnog i morskog fitoplanktona limitiran fosfatom. Izraziti maksimum AAFP na postaji E5 (6 m) iznosi 22,605 nM/h, dok se maksimum (22,897 nM/h) na postaji E4A (20 m) neznatno razlikuje od AAFP na 6 m (22,415 nM/h). Najveće izmjerene AAFP u estuariju Krke u veljači 2004. veće su 3-10% od najvećih izmjerenih AAFP u listopadu 2002. i ožujku 2003. Također, te iste AAFP su veće 50-100% od AAFP na usporednim postajama u Novigradskom moru (N1) i Velebitskom kanalu (V1A) u estuariju Zrmanje, 4. veljače 2004. Hidrometeorološki uvjeti nisu se znatnije mijenjali u razdoblju 4-5. veljače 2004. u navedenim estuarijima te je stoga napravljena usporedba AAFP na postajama sličnih hidrografskih osobina. Pozicije izmjerenih maksimuma AAFP na postaji E5 varirale su (20 m, 1 m i 6 m) u tri spomenuta uzorkovanja (listopad 2002; ožujak 2003; veljača 2004.), dok su na postaji E4A izmjereni maksimumi uvijek bili pozicionirani na 6 m ili dublje, što ujedno odgovara utvrđenom dnu raspona halokline iz prijašnjih istraživanja (0,2-6,3 m) u estuariju Krke, ovisno o protoku rijeke, tj. oborinama i vjetrovima, a manje o plimnoj oscilaciji morske razine i insolaciji. Hidrometeorološki uvjeti bez znatnijih oborina i vjetrova koji su prethodili uzorkovanju 5. veljače 2004., kao i stratificiranost estuarija, pogodovali su smanjenoj izmjeni nutrijenata na granici morskog i boćatog sloja te povećanoj ekspresiji AAFP u morskome oligotrofnom sloju estuarija Krke.



ALKALINE PHOSPHATASE ACTIVITY IN STRATIFIED KRKA AND ZRMANJA ESTUARIES (WINTER ASPECT 2004)

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A lack of orthophosphate in different organisms (algae, bacteria, protozoa, plants and animals etc.) induces synthesis of phosphatases which liberates phosphate from organic compounds. Activity of phosphatases in the sea is regulated by orthophosphate concentration, availability of dissolved organic phosphorus, phytoplankton-bacteria interaction, inner cell N/P ratio and UV-B inhibition. Activity of bacterial alkaline phosphatase is not directly attached to limitation by orthophosphate concentration, but carbon cycle additionally, so alkaline phosphatase activity of phytoplankton (APAP) was used as better indicator of phosphorus status of the environment. The research was carried out at February 4th, 2004 in Zrmanja estuary (stations N1 and V1A) and February 5th, 2004 in Krka estuary (both eastern Adriatic Sea) at stations E4A and E5. APAP was measured by VIS spectroscopy ($\lambda=400\text{nm}$, substrate p-nitrophenyl-phosphate) in nanophytoplankton and microphytoplankton (1.2-53 μm). Halocline at E5 was measured in surface layer (0-2m), while at inner station E4A (Port of Šibenik), halocline was found at depth (2-6m). Significant APAP were found both above and below the halocline, indicating limitation of freshwater and seawater phytoplankton growth in the Krka estuary by phosphate concentration. Sharp maximum APAP at E5 was found at 6m (22.605 nM/h), while maximum APAP at E4A at 20m (22.897 nM/h) was similar to APAP at 6m (22.415 nM/h). Concerning inability of breaking up the halocline in the Krka estuary, no matter how intense wind or fresh water inflow could take part, it is not surprising that higher APAP were found in the oligotrophic marine layer. Maximum APAP in the Krka estuary (February 5th, 2004) are 3-10% higher than those measured in October 2002 and March 2003. Also, those values are 50-100% higher than maximum APAP found in the nearby Zrmanja estuary at February 4th, 2004. There were no significant changes in hydrometeorological parameters during sampling period, thus we made relation of APAP at hydrographically similar stations in two estuaries. The highest APAP measured at E5 were found at 20m, 1m and 6m depth over three samplings (October, 2002; March 2003; February 2004), while at inner station E4A, the highest APAP were always found at 6m or deeper, what was well in concordance with previously determined range of halocline bottom (0.2-6.3m) in the Krka estuary, depending mainly on precipitation and intensity of winds, less on tide influence from open sea and insulation.



FLORA ISTOČNE MEDVEDNICE

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U razdoblju od 2007. do 2009. godine floristički je istraživano područje između naselja Čučerje, Goranec, Vugrovec i Šimunčevac, koje visinski pripada brežuljkastom pojasu istočnog dijela Medvednice. Istraživana ploha površine je 5 km² i nalazi se izvan granica Parka prirode. Ukupno je pronađeno 537 svojiti višega bilja, razvrstano u 89 porodica. Najzastupljenije su porodice *Asteraceae* s. l. (12,3%), *Poaceae* (8,9%), *Fabaceae* (7,8%), *Lamiaceae* (6,5%) i *Rosaceae* (4,6%). U spektru životnih oblika prevladavaju hemikriptofiti (49,9%), a slijede ih terofiti (21,2%) i fanerofiti (13,0%). Fitogeografska analiza ukazuje na zastupljenost euroazijskog flornog elementa sa 37,4%, dok je udio ilirsko-balkanskog flornog elementa manji od 1%. Analiza flore prema staništima ukazuje da najveći broj svojiti nastanjuje ruderalna staništa (20,9%), a potom livade (18,1%) i šumske rubove (14,9%). Prema „Crvenoj knjizi vaskularne flore Hrvatske” 28 svojiti istraživanog područja svrstano je u neku od kategorija ugroženosti. Zakonom su zaštićene 102 biljne svojite, a 14 vrsta je invazivno. Najveći broj invazivnih vrsta (50%) podrijetlom je iz Sjeverne Amerike i pripada porodici *Asteraceae*. Otkrivena je nova vrsta u flori Hrvatske iz porodice trava – prijevarena koštreva (*Echinochloa colona* (L.) Link). Značajan udio terofita na istraživanom području, kao i brojnost vrsta koje nastanjuju ruderalna staništa, ukazuju na intezivan antropogeni utjecaj. Zbog antropogenog utjecaja flora ne odražava u potpunosti fitogeografski položaj istraživanog područja, što se ogleda u slaboj zastupljenosti ilirsko-balkanskog flornog elementa i visokom udjelu euroazijskog.



THE FLORA OF EASTERN PART OF MT. MEDVEDNICA

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In floristic research carried out from 2007 to 2009 the area of 5 km² between Čučerje, Goranec, Vugrovec and Šimunčevac was included. It belongs to the colline belt of eastern part of Mt. Medvednica and it is located immediately outside the south-east border of Nature Park. In total, 537 taxa of higher plants from 89 families were found. The most abundant families are *Asteraceae* (12.3%), *Poaceae* (8.9%), *Fabaceae* (7.8%), *Lamiaceae* (6.5%) and *Rosaceae* (4.6%). In the life form spectrum hemicriptophyta are dominant (49.9%), followed by therophyta (21.2%) and phanerophyta (13.0%). Phytogeographical analysis has shown that Euroasiatic element encompasses 37.4% of taxa, while the Illyrian-Balkan element less than 1%. Floristic analysis based on the habitat type shows that the highest number of taxa populates ruderal habitats (20.9%), followed by meadows (18.1%) and forests edges (14.9%). According to the Red Book of Vascular Flora of Croatia 28 taxa from the researched area are listed and sorted in some threat category. 102 taxa are protected by law and 14 plant species are invasive. The majority of invasive species come from North America (50%) and belongs to *Asteraceae* family. Also, one new species was discovered in the flora of Croatia - *Echinochloa colona* (L.) Link (*Poaceae*). A significant proportion of therophytes in the study area, as well as the number of species inhabiting ruderal habitats, indicate the intense anthropogenic impact. Because of anthropogenic impact, flora is not fully reflected phytogeographic position of study area which is visibly in the low representation of Illyrian-Balkan floral element and high Euroasian stakes.



OČUVANJE GENOFONDA MARUNA

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Maruni su sorte pitomog kestena (*Castanea sativa* Mill.) dobivene selekcijom i oplemenjivanjem, koje se od davnina uzgajaju radi proizvodnje krupnih i kvalitetnih plodova. U Hrvatskoj su sađeni na privatnim posjedima istočnih padina Učke, u okolici Lovrana. U 20. stoljeću većina je nasada zapuštena zbog promjene načina života i pojave raka kestenove kore, bolesti koja je uzrokovala djelomično ili potpuno sušenje postojećih stabala i otežala podizanje novih nasada. Stabla se već desetljećima postupno suše te tako dolazi do gubitka njihovog genofonda. U radu su prikazane prijetnje genofondu lovranskog maruna te aktivnosti i istraživanja koja se provode s ciljem očuvanja toga genofonda. Naglasak istraživanja je na genotipizaciji biljaka iz postojećih nasada, osnivanju klonskog arhiva, u kojem će se čuvati vegetativno razmnoženi genotipovi, kao i specifikaciji plodova, koja uključuje njihova morfološka obilježja i kemijski sastav. Također su prikazani različiti pristupi obnovi postojećih nasada maruna u drugim mediteranskim zemljama, kao i podizanje novih nasada biljaka hibridnoga porijekla.



CONSERVATION OF GENETIC RESOURCES OF MAROONS

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Maroons are a sort of sweet chestnut (*Castanea sativa* Mill.) obtained through selection and genetic improvement, which have been cultivated since early times for the production of large and quality fruits. In Croatia they have been planted on private properties on the eastern slopes of the Učka Mountain, in the vicinity of Lovran. In the 20th century most of the orchards were neglected due to change in life-style, as well as the occurrence of chestnut blight, a disease which caused serious damage of existing trees and made the establishing of new orchards difficult. The trees have been gradually dying, causing a loss of genetic resources. This article presents the threats to the genetic resources of maroons of the Lovran region, as well as the activities and research carried out for the purpose of conservation of their genetic resources. The main research topic is the genotypization of the plants in the existing orchards, the establishment of a clone archive in which the vegetatively propagated genotypes would be preserved, as well as the specification of fruits, including their morphological features and chemical composition. In addition, various approaches to the renewal of existing maroon orchards in other Mediterranean countries are presented, as well as the establishing of new orchards with plants of hybrid origin.



SUSCEPTIBILITY OF SOILS AND HABITAT TYPES TO BLACK LOCUST (*ROBINIA PSEUDOACACIA*) INVASION OUTSIDE WOODLAND IN A TRADITIONAL CENTRAL-EUROPEAN AGRICULTURAL LANDSCAPE

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A black locust *Robinia pseudoacacia* is one of the most invasive alien tree species in agricultural landscape in Central Europe. Invasiveness in the wooded stands is well known and studied. However, outside closed woodland the invasiveness is considered less problematic and it is also less known. In this study we aimed to detect the invasiveness in relation to susceptibility of different soil and habitat types and in dependence of the distance from the forest. The research was performed in a model traditional agricultural landscape of Goričko Landscape Park (Slovenia). 1307 polygons belonging to 28 different habitat types (following PHYSIS typology), aggregated to 11 types, are evidently invaded by locust and cover 0.6% of the total area of the park or 0.83 % of the non-forested share of the park. 993 polygons are pure stands with black locust with an average area of almost 2000 m². Then, locust is present also in small woodlots (127 polygons) and in lowland and collinear riverine willow scrub (71 polygons). In other habitat types black locust is present in less than 30 polygons. The presence of locust in grassland and wetland habitats is negligible. The value for average perimeter is far the highest in small woodlots (472.5 m) and about three times lower in orchards (173.1 m). The pure black locust habitat has an average perimeter around 270 m. Elongation index has the highest value in lowland and collinear riverine willow scrub, followed by stream ash-alder woods and mixed stands, channelized watercourses and small woodlots. It is confirmed that most of the polygons with black locust are of linear forms, representing edges of fields, orchards and grasslands. The habitat types with black locust don't vary very much in fractal dimension. The most frequently invaded soils are pseudogley, where pure locust stands are covering more than 800.000 m². The riverbank soils are on the second place, other types of soils, invaded with the locust are also district brown, eutric brown and – surprisingly – hypogley. It could be concluded that fresh and water-retaining soils are most favorable for locust invasion. It was confirmed also that the distance of closed woodlands matters! Almost 1 million (of 2.8 millions) square meters of invaded polygons are found in a distance 1-100 meters away of the forest.



PHYTOPLANKTON AND PHYTOBENTHOS OF BLIDINJE LAKE (BOSNIA AND HERZEGOVINA)

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Blidinje Lake is an integral part of the Blidinje Nature Park founded in 1995. District Park Blidinje (364 km²) includes most of the mountain range Čvrsnica (2228 m), mountain Vran (2074 m), valley Dugo Polje and the western part of the mountain ridge Čabulja (Large hill, 1500 m). Blidinje Lake is the largest mountain lake in Bosnia and Herzegovina, and lies at 1185 m above sea level. This paper presents the qualitative composition of phytoplankton and phytobentos of Blidinje Lake and population density of phytoplankton collected at five locations in the coastal region on the surface. Collecting materials phytoplankton carried out in a period of three months during 2008 year. Phytobentos was taken once. Based on the type of indicator values was estimate saprobiological index phytoplankton and phytobentos.



FLORA I VEGETACIJA OTOČIĆA SUPETRA (CAVTAT)

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Otočić Supetar smješten je ispred Cavtata u Konavlima. Površine je 0,039 km², a najveća nadmorska visina mu je 8 m. Najveća dubina mora oko otočića je 32 m. Zajedno s Cavtatom te susjednim otocima Mrkanom i Bobarom pripada botanički važnom području Hrvatske (Alegro *et al.* 2010). Jedini je otok u cavtat-skom arhipelagu čija flora nije sustavno istražena. Otočić nije naseljen, ali je ljeti popularno turističko odredište zbog ugostiteljskih objekata izgrađenih na samoj obali. Flora otočića utvrđena je na temelju sezonskih terenskih istraživanja tijekom 2009. i 2010. godine, kad su utvrđene četiri asocijacije: *Posidonium oceanicae* (*Posidonietea*), *Limonietum anfracti* (*Crithmo-Limonietea*), *Myrto communi-Pistacietum lentisci* (*Quercetea ilicis*) i *Narcisso-Asphodeletum microcarpi* (*Festuco-Brometea*).



FLORA AND VEGETATION OF THE ISLAND OF SUPETAR (CAVTAT ARCHIPELAGO, SOUTH CROATIA)

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The small islet of Supetar is located in front of the town of Cavtat, south Croatia. Its surface area is 0.039 km² with the highest peak of 8 m, while the greatest depth of the sea around it is 32 m. The islet of Supetar is the only island in the Cavtat archipelago, whose flora has not been studied in detail. This area is included in Important Plant Areas of Croatia (Alegro *et al.* 2010). The islet is not inhabited, but it is a popular summer tourist destination because of the restaurants built on the coast. List of taxa is presented on the basis of seasonal field research carried out in 2009 and 2010. Altogether, four associations were determined: *Posidonietum oceanicae* (*Posidonietea*), *Limonietum anfracti* (*Crit-hmo-Limonietea*), *Myrto communi-Pistacietum lentisci* (*Quercetea ilicis*) and *Narcisso-Asphodeletum microcarpi* (*Festuco-Brometea*).



NEOFITI U DUBROVNIKU

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Temeljem terenskih istraživanja od 2005. do 2007. godine u gradu Dubrovniku utvrđeno je 246 biljnih vrsta i podvrsta. Najčešće svojte (utvrđene na $\geq 50\%$ lokaliteta) su *Bidens subalternans*, *Chenopodium album*, *Conyza canadensis*, *Foeniculum vulgare*, *Parietaria judaica*, *Piptatherum miliaceum* i *Setaria viridis*. Najveći broj svojti svrstan je unutar porodica *Asteraceae* i *Poaceae*. U flori je dominirao sredozemni florni element (34%), a među životnim oblicima terofiti (36%). U urbanoj flori Dubrovnika je 13% neofita, među kojima dominiraju svojte iz obiju Amerika (94%). Broj neofita je različit u pojedinim dijelovima grada, što ovisi o stupnju urbanizacije i tipovima staništa. Prema „Preliminarnom popisu invazivnih stranih biljnih vrsta” (IAS) u Hrvatskoj, u Dubrovniku je zabilježeno 20 svojti. To su *Amaranthus retroflexus*, *Ambrosia artemisiifolia*, *Aster squamatus*, *Bidens subalternans*, *Broussonetia papyrifera*, *Chenopodium ambrosioides*, *Conyza bonariensis*, *Conyza canadensis*, *Eleusine indica*, *Erigeron annuus* ssp. *septentrionalis*, *Euphorbia maculata*, *Euphorbia prostrata*, *Helianthus tuberosus*, *Nicotiana glauca*, *Paspalum dilatatum*, *Paspalum paspalodes*, *Phytolacca americana*, *Robinia pseudoacacia* i *Solidago gigantea*. Smatramo kako je Dubrovnik tipičan mediteranski grad, a njegova urbana flora je slična flori gradova u središnjoj i južnoj Italiji.



NEOPHYTES IN THE CITY OF DUBROVNIK, SOUTH CROATIA

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According to the field investigations of urban flora in Dubrovnik between 2005 and 2007, we recorded 246 plant species and subspecies. The most frequent taxa (found in the $\geq 50\%$ localities) were: *Bidens subalternans*, *Chenopodium album*, *Conyza canadensis*, *Foeniculum vulgare*, *Parietaria judaica*, *Piptatherum miliaceum* and *Setaria viridis*. *Asteraceae* and *Poaceae* were the families characterised by the highest number of taxa. Analysis of floral elements indicated that the Mediterranean floral element dominated (34%). Therophytes prevailed (36%) in the city. Most of the adventive taxa were neophytes. Dubrovnik had 13% neophytes in its urban flora. Of these neophytes, American taxa dominated (94%). In contrast, archaeophytes were much less common and were mainly of Asiatic origin. The number of neophytes varied in different parts of the cities according to the degree of urbanization and habitat types. According to the preliminary check-list of invasive alien plant species (IAS) in Croatia, Dubrovnik had 20 invasive taxa. They were *Amaranthus retroflexus*, *Ambrosia artemisiifolia*, *Aster squamatus*, *Bidens subalternans*, *Broussonetia papyrifera*, *Chenopodium ambrosioides*, *Conyza bonariensis*, *Conyza canadensis*, *Eleusine indica*, *Erigeron annuus* ssp. *septentrionalis*, *Euphorbia maculata*, *Euphorbia prostrata*, *Helianthus tuberosus*, *Nicotiana glauca*, *Paspalum dilatatum*, *Paspalum paspalodes*, *Phytolacca americana*, *Robinia pseudoacacia* i *Solidago gigantea*. We consider Dubrovnik a typical Mediterranean city and its urban flora are comparable with those of other Mediterranean cities in central and southern Italy.



RAZNOLIKOST I DINAMIKA STANIŠTA PARKA PRIRODE „VRANSKO JEZERO”

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Raznolikost staništa na širem području Parka prirode „Vransko jezero” rezultat je dugotrajnog (među) djelovanja tri glavna čimbenika: klime, vode na staništu i čovjekovog utjecaja. U ovisnosti o intenzitetu tih djelovanja, poglavito čovjekovih aktivnosti, tipovi i površine prisutnih staništa su se mijenjali, u sukcesijskim nizovima ili zamjenom tipa staništa. Oba procesa prisutna su i danas, doprinoseći stalnoj mijeni staništa. Kvantificiranje tih promjena korištenjem postojećih povijesnih i recentnih podataka (vegetacijska karta, karte staništa) nije jednostavno, uslijed neujednačenog prostornog i tematskog razlučenja tih podloga. Usprkos tome, generalno je moguće ustvrditi da je na području Parka, izvan utjecaja vode na staništu, u posljednjih nekoliko desetljeća prevladavao proces sekundarne sukcesije u smjeru razvoja klimazonalne vegetacije. Međutim, posljednjih nekoliko godina ponovno se lokalizirano pojačava čovjekov utjecaj zamjene tipa staništa, prvenstveno sadnjom (i obnovom) maslinika, koji su uz travnjačka staništa bili u najvećoj regresiji. Nažalost, većina novih i obnovljenih maslinika pripada kategoriji intenzivnih maslinika, značaj kojih je u kontekstu ukupne biološke raznolikosti bitno manji od tradicionalnih, kojima se površina kontinuirano smanjuje, kao i kamenjarskih pašnjaka. Navedeno upućuje na potrebu vraćanja tradicionalnog načina korištenja zemljišta, koje bi osiguralo očuvanje raznolikosti staništa, a time i ukupne biološke raznolikosti.



DIVERSITY AND DYNAMICS OF "VRANSKO JEZERO" NATURE PARK HABITATS

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Habitat diversity of "Vransko jezero" Nature Park is result of long-term interaction of three main factors, namely: climate; water on habitat and human activities. In the dependence of their intensity, particularly man-made impact, habitat types and their areas has been continuously changed, through successional stages and habitat replacement. Both processes continuously contribute to habitat dynamics and shifts in their diversity. Quantifying those changes, based on available historic and recent data (vegetation and habitat maps) is not straightforward because of different spatial and thematic resolution used. Despite that, it is possible to determine that, in areas that are not influenced by water, secondary succession directed to climatogenic vegetation was dominant process taking place in habitat dynamics. However, in recent years replacement of habitats has increased locally, primarily by planting (and restoration) of olive orchards, that were with grassland - habitat types with highest regression. Unfortunately, majority of newly planted and restored olive orchards is intensively managed ones whose importance for biodiversity is significantly lower than that of traditionally managed ones that continues to decrease in area, as well as rocky pastures. This suggests that traditional way of land use is necessary to conserve the habitats diversity, hence the complete biodiversity.



DJELOVANJE TROSKE NA RAST I FIZIOLOŠKE PROCESE KUKURUZA (*ZEA MAYS L.*)

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Bazična troska, koja se koristi u ovom istraživanju, nusproizvod je pri proizvodnji čelika u elektrolučnoj peći. Obzirom da je sadržaj P, Fe, Ca, Mg i Mn u tako dobivenoj troski visok, a sadržaj Cd, Pb, Hg i ostalih toksičnih teških metala vrlo nizak, usitnjena troska je potencijalni izvor mineralnih tvari za rast i razvoj biljaka, posebice na tlima siromašnim željezom. Cilj istraživanja bio je procijeniti učinkovitost troske kao izvora određenih hranjivih elemenata na rast i fiziološke procese kukuruza te utvrditi dovodi li troska u biljci do oksidacijskog stresa, kao posljedice primanja povećanih količina Fe i Cu. Kao supstrati za sadnju biljaka korištene su mješavine zemlje i pijeska u različitim omjerima. Sjemenke kukuruza zasijane su u posudice i napunjene samo supstratom (kontrola) ili supstratom uz dodatak fino mljevene troske. Nakon dva tjedna, dijelu kontrolnih biljaka, kao i onih uzgojenih uz dodatak troske, dodan je NH_4NO_3 kao izvor N. Dijelu kontrolnih biljaka, koje služe kao pozitivna kontrola, dodano je tekuće gnojivo – NPK i Fe. Osim parametara rasta, izmjerena je fluorescencija klorofila i prinos suhe tvari biljaka, sadržaj mineralnih tvari u supstratu i listovima biljaka, sadržaj klorofila i karotenoida, lipidna peroksidacija te aktivnosti antioksidacijskih enzima. Rezultati su pokazali da je troska vrlo dobar i jeftin izvor Fe, P i drugih elemenata potrebnih biljci te da se njezinom upotrebom znatno smanjuje kloroza listova u biljaka koje rastu na tlima siromašnim željezom.



THE EFFECT OF STEEL SLAG ON GROWTH AND PHYSIOLOGY OF CORN (*ZEA MAYS* L.)

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Basic slag used in this study is a byproduct in the production of steel in electric arc furnaces. Given that the content of P, Fe, Ca, Mg and Mn in the slag is high and those of Cd, Pb, Hg and some other toxic heavy metals is very small, finely ground slag is a potential source of minerals necessary for plant growth and development, especially on iron-poor soils. The aim of this study was to evaluate the effects of steel slag, as a source of specific nutrient elements, on growth and physiological processes of corn and to determine whether steel slag can induce oxidative stress in plant cells. A mixture of earth and sand in different proportions was used as a substrate for planting. Corn seeds were sown in containers and filled with either pure substrate (control) or substrate mixed with finely ground slag. After two weeks, control plants and those grown with the addition of slag were supplemented with NH_4NO_3 as a source of N. A part of control plants that served as a positive control was supplemented with liquid fertilizers - NPK and Fe. Beside growth parameters, chlorophyll fluorescence, dry matter yield of plants, mineral content in the substrate and plant leaves, chlorophylls and carotenoids content, lipid peroxidation and antioxidant enzyme activities were measured as well. The results showed that steel slag is a very good and inexpensive source of Fe, P and other elements essential to plants and that its usage significantly reduces leaf chlorosis in plants growing on iron-deficient soils.



POPULACIJSKA STRUKTURA GLJIVE MJEŠINARKE *CRYPHONECTRIA PARASITICA* (MURRILL) BARR. U HRVATSKOJ I SLOVENIJI

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Gljiva mješinaraka *Cryphonectria parasitica* (Murrill) Barr. agresivan je patogen koji parazitira na pitomom kestenu (*Castanea sativa* Mill.) i uzrokuje velike ekonomske štete. Kako bi se dobio bolji uvid u populacijsku strukturu četiri hrvatske i pet slovenskih populacija te gljive, provedena je genotipizacija 180 uzoraka analizom 11 SCAR lokusa (*sequence characterized amplified regions*). Uzvodne početnice su bile obilježene fluorescencijskim probama i umnoženi dijelovi DNA, dobiveni lančanom reakcijom polimerazom (PCR), detektirani DNA Analyzer servisom (Macrogen, Seoul, Koreja). Od 11 istraženih lokusa, pet do osam je bilo polimorfno u raznim populacijama, dok su u populaciji iz Požege pronađena dva nova alela, vjerojatno nastala spontanom mutacijom. U devet testiranih populacija pronađeno je ukupno 66 različitih SCAR haplotipova patogene gljive, što se odrazilo i na Shannonov indeks raznolikosti, koji se kretao od 1,54 u populaciji Ostrovica do 2,97 u populaciji iz Hrvatske Kostajnice. Ujednačenost (*evenness*) je također bila vrlo visoka, od 0,79 do 0,98. Dvanaest od 28 parova lokusa je nađeno u neravnoteži vezanosti gena (*linkage disequilibrium*), s time da je i indeks višelokusne neravnoteže vezanosti gena (*index of multilocus disequilibrium* = r_d) također ukazivao na uglavnom spolno razmnožavanje i mnoge rekombinacije između jedinki u istraženim populacijama; r_d procjena se kretala između 0,024 i 0,241. Nije nađena jasna korelacija između genetičke udaljenosti istraženih populacija i zemljopisne udaljenosti mjesta na kojima su sakupljene. Zbog toga smatramo da je od početnog unosa ove patogene gljive na područja Hrvatske i Slovenije došlo do mnogo miješanja među populacijama, kao i rekombinacija među jedinkama. To je posljedica spolnog razmnožavanja, što se odrazilo na uglavnom veliki broj pronađenih SCAR haplotipova, kao i na nedostatak korelacije tipova vegetativne kompatibilnosti (vc) i SCAR haplotipova. Bayezijansko grupiranje je ukazalo na postojanje triju skupina, koje su indicirale dva izvora unošenja gljive *C. parasitica* u Hrvatsku i Sloveniju. Jedna skupina je dominantna u Sloveniji, jedna u Hrvatskoj, a jedna u populacijama uz hrvatsko-slovensku granicu. Rezultati ukazuju da je početni izvor zaraze porijeklom iz zapadne Europe (Italija), dok je drugi izvor naknadno unio dodanu raznolikost u naše populacije širenjem iz jugoistočne Europe.



POPULATION STRUCTURE OF ASCOMYCETE *CRYPHONECTRIA PARASITICA* (MURRILL) BARR. IN CROATIA AND SLOVENIA

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Ascomycete *Cryphonectria parasitica* (Murrill) Barr. is an aggressive pathogen which lives as a parasite on sweet chestnut *Castanea sativa* Mill. and causes significant economic damage. In order to gain better insight in population structure of four Croatian and five Slovenian populations of this fungus, 180 samples were genotyped using 11 SCAR (sequence characterized amplified regions) loci. Forward primers were fluorescently labelled and amplicons, obtained with polymerase chain reaction (PCR), were detected with DNA Analyzer service (Macrogen, Seoul, Korea). Out of 11 loci tested, 5 to 8 were found polymorphic in different populations and in population Požega, two new alleles that probably arose through spontaneous mutations, were detected. In nine tested populations a total of 66 different SCAR haplotypes were found. That was reflected in high Shannon diversity index, raging from 1.54 in population Ostrovica to 2.97 in population Hrvatska Kostajnica. Evenness was also very high, from 0.79 to 0.98. Twelve out of 28 pairs of loci were found in linkage disequilibrium. Index of multilocus linkage disequilibrium (r_d) was also pointing to predominantly sexual reproduction and many recombinations of *C. parasitica* in tested populations; r_d estimate ranged from 0.024 to 0.241. No clear correlation between genetic distance of studied populations and geographical distance between locations where fungal isolates were collected was observed. Therefore we think that from initial introduction of this pathogenic fungus in Croatia and Slovenia, many mixing of populations as well as recombinations between individuals has occurred. This is a consequence of sexual reproduction which is responsible for large number of SCAR haplotypes observed and lack of correlation between vegetative compatibility (vc) types and SCAR haplotypes. Bayesian clustering indicated existence of three clusters which suggested two separate sources of *C. parasitica* introduction in Croatia and Slovenia. One cluster is dominant in Slovenia, one in Croatia, and yet another along Croatian-Slovenian border. Results reveal that Western Europe (Italy) is the first source of infection, while the second introduction came subsequently from south-eastern Europe and contributed to diversity of our *C. parasitica* populations.



ON THE VARIABILITY OF GLASSWORTS (*SALICORNIA* L.) FROM THE GULF OF TRIESTE (NORTHERN ADRIATIC)

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We studied the variability of morphologic and genetic traits of annual glassworts from the Northern Adriatic. Four pre-determined morphotypes of *Salicornia* (*S. patula*, *S. emerici*, *S. veneta* and the "saline type") from 10 locations from Slovenian and Italian seacoast within the Gulf of Trieste were included in the study. Genetic variability was detected by means of ploidy level estimation using flow cytometry and with molecular DNA analysis of ITS regions of nrDNA and cpDNA. Results show that among the samples, two groups emerged: diploids and tetraploids, which match with the same nrDNA sequence. However, we found two types of cpDNA among diploids, where one type of cpDNA appears also in all three tetraploid morphotypes, being an outcome of a mutation before polyploidization. In our case the hybridization indicates tetraploid maternal progenitors, providing a plastid genome. The morphometry, based on regenerative traits, separated the four morphotypes, but the three most important characters in floral region (length of the fertile segment, length of the lateral flower, width of the scarious margin of the fertile segment) match with two genetically recognized taxa: diploid *S. patula* and widely distributed tetraploid, *S. emerici*, comprising also endemic morphotype *S. veneta* and the "saline type". We designed a determination key according to morphological differences. Observations in the field showed, that the tetraploid *S. emerici* is by far the most common species of annual glassworts in the area, occupying even more extreme habitats than *S. patula*, mostly forming monodominant stands. We conclude that the habitual variability between the tetraploids are attributed to phenotypic plasticity only, driven by salinity-moisture-nutrients gradient and tidal regime.



FLORA I VEGETACIJA U PUKOTINAMA OKOMITIH VAPNENAČKIH STIJENA U SPLITU

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Obavljena je fitocenološka analiza vegetacije u pukotinama okomitih vapnenačkih stijena na tri lokaliteta u gradu Splitu, i to na stijenama sv. Jere, Katalinića brigu te Sustipanu. Veoma nepovoljni ekološki uvjeti tih staništa, jaka insolacija, minimalna količina plodnog tla i krajnje oskudna vlaga, utjecali su na razvoj specifične kserofitske vegetacije razreda *Asplenietea trichomanis* (H. Meier) Br.-Bl. 1934. Sastavljene su 33 fitocenološke snimke s ukupno 73 biljne vrste.



FLORA AND VEGETATION OF CRACKS IN STEEP LIMESTONE ROCKS IN SPLIT

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Phytocoenological analysis was performed on vegetation of cracks, steep limestone cliffs on three sites in the city of Split. The localities were st. Jere, Katalinića brig and Sustipan. Very unfavourable environmental conditions of this habitat, strong sunshine, the minimum amount of fertile soil and extremely poor moisture, influenced the development of specific xerophitic vegetation of the *Asplenietea trichomanis* (H. Meier) Br.-B1. 1934 class. In total, 33 phytocoenological relevés have been made, and 73 plant species have been recorded.



FLORISTIC SURVEY ON THE KABAL PENINSULA, THE ISLAND OF HVAR

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Island of Hvar is a part of the Central Dalmatian archipelago and is the second largest Dalmatian island. The Kabal peninsula is situated on the very North-West part of the island, embracing the large Bay of Stari Grad. The area of the peninsula is 8.7 km² and the highest peak reaches 120 meters above sea level. The brown soil developed on the limestone and dolomite is dominant. The peninsula is covered with evergreen vegetation represented by depredated Holm Oak forests (macchia, garique) and Aleppo pine forests. Due to progressive vegetation succession present on the peninsula, rocky pastures (*Brachypodio ramosae-Trifolietum stellati*) are quite rare. In the vicinity of the shoreline, rocky and gravelly halophytic vegetation is developed. A floristic survey on the peninsula Kabal was performed in order to estimate the floristic value of the area with the aim of its protection. From 2007 to 2009 in total 275 taxa, belonging to 63 families were recorded. The most abundant families are: *Fabaceae* (15.6%), *Poaceae* (9.8%), *Asteraceae* (6.2%), *Cichoriaceae* (6.2%), *Lamiaceae* (5.1%), *Brassicaceae* (4.4%) and *Liliaceae* (4.4%), which is in accordance with families ratios of flora of Central and South Dalmatian islands. The most abundant genera is *Euphorbia* with 7 taxa, *Trifolium* with 6 taxa and *Geranium* and *Medicago* with five taxa. Therophytes (38%) are the most common life form category, followed by hemichryptophytes (29%), which is a reflection of the Mediterranean climate characterized by hot and dry summer period. Chorological analysis of the vegetation showed the dominance of Mediterranean plants. Among the recorded taxa, 14 are listed in The Croatian Red Book of endangered species; one is critically endangered (CR), two are endangered (EN), six are vulnerable (VU), four are near threatened (NT) and one is data deficient species (DD). Twenty nine taxa are protected and seventeen are strictly protected by law. There are two groups of plants that are most endangered here: orchid species, suffering the loss of their natural habitat (open grasslands) by process of natural overgrowing after the abandonment of the traditional management and halophytes of sandy and gravelly sea shores, which are rare and threatened by tourism and potential building.



ISTRAŽIVANJE USVOJENOSTI NASTAVNIH SADRŽAJA BOTANIKE U OSNOVNOJ ŠKOLI

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Usvojenost nastavnih sadržaja botanike integriranih u predmete Priroda i Biologija istraživana je tijekom 2010. u Osnovnoj školi Bogumila Tonija u Samoboru na populaciji od 150 učenika. Cilj istraživanja bio je utvrditi razinu usvojenosti ključnih koncepata vezanih za nastavne sadržaje botanike u osnovnoj školi. Istraživanje je provedeno uporabom tri pisane provjere znanja iz zadatka višestrukog izbora te zadataka povezivanja i sređivanja. Testirano je šest odjeljenja učenika iste populacije. Prvo testiranje učenika sedmih razreda provedeno je u mjesecu travnju, gdje je provjerena usvojenost nastavnih sadržaja botanike koji su obrađeni u petom i šestom razredu, u sklopu predmeta Priroda. To testiranje je provedeno prije obrade nastavnih sadržaja botanike sedmog razreda, u okviru predmeta Biologija. Drugo testiranje, provedeno je u mjesecu lipnju, gdje je provjerena usvojenost znanja, nakon obrade nastavnih sadržaja botanike sedmog razreda. Trećim testiranjem u mjesecu rujnu provjerila se retencija istraživanih nastavnih sadržaja s istom populacijom učenika. Analizom usvojenosti ključnih koncepata vezanih za sadržaje botanike uočljivo je kako učenici najslabije usvajaju koncepte: cvat i stabljika. Najbolje su usvojeni koncepti: disanje, fotosinteza, oplodnja i oprašivanje. Najviše točnih odgovora učenici su postigli u pitanjima niže kognitivne razine znanja, a to je reproduktivno znanje.



RESEARCH ON ACQUIRING THE BOTANICAL TEACHING CONTENTS IN ELEMENTARY SCHOOL

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During 2010 in the Bogumil Toni Elementary school in Samobor research on 150 pupils has been conducted on acquiring the botanical teaching materials integrated into school subjects of Nature and Biology, respectively. The goal of the research was to determine the level of acquiring key concepts related to elementary school botanical teaching contents. The research was carried out by three written tests, using multiple choice assignments and connecting-and-sorting assignments. Six classes of the same population were tested. The first testing in April was done to check the level of adopting the botanical teaching contents from the 5th and 6th grade subject of Nature, i.e. before teaching the botanical contents in the 7th grade Biology. The second testing was done in June to check the level of acquiring the botanical contents from the 7th grade, and the third testing in September was done to check the retention of those teaching contents in the same population of pupils. From the analysis of acquiring the key concepts related to botanical teaching contents it can be concluded that pupils show the lowest level of acquiring the concepts of: inflorescence and stem. The best adopted concepts were respiration, photosynthesis, fertilization and pollination. Pupils achieved the majority of correct answers of a lower cognitive level, i.e. in questions of a reproductive character.



NOVI SREDOZEMNI KAMENJAR U BOTANIČKOM VRTU PMF-a (ZAGREB)

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Flora hrvatskoga dijela jadranske obale obuhvaća oko 2500 vrsta i podvrsta od ukupno oko 5600 biljnih svojti (44% hrvatske flore). Mnoge od tih vrsta rijetke su i/ili zakonom zaštićene, a 193 su endemične, posebice na pučinskim otocima te drugim geografski izoliranim područjima (Velebit, Biokovo). Barem 128 hrvatskih priobalnih vrsta u stvarnoj je opasnosti od izumiranja, a nekoliko ih je već nestalo. Stoga je u Botaničkom vrtu PMF-a osmišljen program *ex-situ* očuvanja vrsta, koji obuhvaća sakupljanje i uzgoj priobalnih biljnih svojti, koje će tijekom nekoliko godina biti posađene na novoizgrađenu Sredozemnu vegetacijsku biogeografsku skupinu, popularno zvanu Sredozemni kamenjar. Izgled kamenjara – koji slijedi obrise jadranske obale s glavnim otocima – osmišljen je na Fakultetu za hortikulturu zagrebačkog Sveučilišta, dok su znanstvene, zaštitarske, hortikulture i (osobito) edukativne vrijednosti razrađene u Botaničkom vrtu PMF-a. Projekt podupiru hrvatska ministarstva, agencije i nevladine udruge, a financira Država, županije i gradovi, te industrija i privatne donacije koje su prikupljane u Botaničkom vrtu. Projekt je započeo lani, u godini proslave 120-te obljetnice od osnutka Botaničkog vrta PMF-a, a trebao bi biti dovršen do 2012.



ADRIATIC ROCKERY IN BOTANICAL GARDEN OF THE FACULTY OF SCIENCE (ZAGREB, CROATIA)

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Flora of Croatian Adriatic coast and islands comprises approx. 2500 species and subspecies of the total 5600 plant taxa (about 44% of Croatian flora). Many of those plants are rare and/or statutory protected, and 193 are endemic. At least 128 Croatian coastal species are in real danger of extinction, and several already disappeared. For this reason Botanical Garden of the Faculty of Science conducts *ex-situ* conservation programme which includes collecting and cultivation of many coastal plant taxa that will be planted during next several years at the newly built Adriatic Rock Garden. The layout of the Rockery – following outlines of the Croatian Adriatic coast - was designed at the Faculty of Horticulture (Zagreb University), and its scientific, conservation, horticultural and especially educational values were elaborated in the Botanical Garden. The Project is supported by Croatian ministries and financed by Governmental, Industrial and Private donations raised by the Garden. This project started in 2009, when the Garden celebrates 120 years of its foundation, and should end by 2012.



VASKULARNA FLORA VRGADSKIH OTOČIĆA

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Otok Vrgada i otočići (Murvenjak, Šipnata, Oblik, Kozina, Gira, Obrovanj, Antina, V. Školjić, M. Školjić, Vrtlić i Rakita, te hridi Lončarić, Kamičić sjeverno i Kamičić južno od Vrgade) pripadaju zadarskom arhipelagu. Šumsku vegetaciju na otočićima gradi makija tršlje i somine (as. *Pistacio-Juniperetum phoeniceae* Trinajstić 1987), a na Murvenjaku i Rakiti makija crnike s mirtom (*Myrto-Quercetum ilicis* (H-ić 1963) Trinajstić 1985). Na grebenima i položenim stijenama uz more zastupljena je halofitska vegetacija trputca i mrižice (as. *Plantagini-Limonietum cancellati* H-ić (1934) 1939), a na muljevitim tlima Murvenjaka as. *Puccinellio festucaeformi-Sarcocornietum fruticosae* (Br.-Bl. 1928) Géhu 1967. Floristička istraživanja obavljena su tijekom 2009. i proljeća 2010. godine. Zabilježene su 264 svojte vaskularne flore, od čega su 263 vrste i podvrste po otocima: Gira - 126 vrsta, Veliki Školjić - 108, Kozina - 105, Šipnata - 95, Antina - 89, Obrovanj - 85, Mali Školjić - 84, Oblik - 65, Murvenjak - 59, Rakita - 56, Vrtlić - 28, te 17 vrsta za Kamičić sjeverno od Vrgade i sedam vrsta za Kamičić južno od Vrgade. Na hridi Lončarić nismo pronašli niti jednu biljnu vrstu. U moru je zabilježena vrsta *Posidonia oceanica*. Pronađeno je sedam vrsta iz „Crvene knjige vaskularne flore Hrvatske”, od kojih su dvije ugrožene (*Carex divisa* Huds. i *Glaucium flavum* Crantz) te pet osjetljivih svojti (*Desmazeria marina* (L.) Druce, *Pharapholis incurva* (L.) C. E. Hubb., *Salsola kali* L., *S. soda* L. i *Suaeda maritima* (L.) Dumort.). Svojim florističkim sastavom posebno se ističe otočić Rakita, na kojoj su zabilježene dvije vrste orhideja (*Anacamptis pyramidalis* (L.) Rich. i *Serapias parviflora* Parl.) te tri endemične vrste (*Limonium cancellatum* (Bernh.) Kuntze, *Seseli tomentosum* Vis. i *Vincetoxicum hirundinaria* Medik. ssp. *adriaticum* (Beck) Markgr.). Iako se radi o nenaseljenim otočićima, značajan je broj ruderalnih vrsta koje su na ove otoke prenesene galebovima, koji se na njima gnijezde.



VASCULAR FLORA OF THE VRGADA ISLETS

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The island Vrgada and its islets (Murvenjak, Šipnata, Oblik, Kozina, Gira, Obrovanj, Artina, V. Školjić, M. Školjić, Vrtlić and Rakita as well as the Lončarić and Kamičić reefs north and south of Vrgada) belong to the Zadar archipelago. The vegetation on the islets consists of macchia (ass. *Pistacio-Juniperetum phoeniceae* Trinajstić 1987), and on the islets Murvenjak and Rakita macchia (ass. *Myrto-Quercetum ilicis* (H-ić 1963) Trinajstić 1985). On the reefs and rocks near the sea there is a halophytic vegetation ass. *Plantagini-Limonietum cancellati* H-ić (1934) 1939 and on the muddy soils of Murvenjak ass. *Puccinellio festucaeformi-Sarcocornietum fruticosae* (Br.-Bl. 1928) Géhu 1967. Floristic researches were conducted in the period from 2009 and the spring of 2010. 264 taxa of vascular flora were recorded out of which 263 species and subspecies on the islets (Gira – 126 taxa, Veliki Školjić - 108, Kozina - 105, Šipnata – 95, Antina – 89, Obrovanj – 85, Mali Školjić - 84, Oblik – 65, Murvenjak - 59, Rakita - 56, Vrtlić - 28, 17 taxa on Kamičić north of Vrgada and seven taxa south of Vrgada). No taxa were recorded on the Lončarić reef. *Posidonia oceanica* was found in the sea. Seven taxa from The Red Book of the Vascular Flora of Croatia were recorded. Out of those seven, two are endangered taxa (*Carex divisa* Huds. and *Glaucium flavum* Crantz) and five are vulnerable taxa: *Desmazeria marina* (L.) Druce, *Pharapholis incurva* (L.) C. E. Hubb., *Salsola kali* L., *S. soda* L. and *Suaeda maritima* (L.) Dumort. The Islet of Rakita, where two taxa of orchids (*Anacamptis pyramidalis* (L.) Rich. and *Serapias parviflora* Parl.) and endemic species (*Limonium cancellatum* (Bernh.) Kuntze, *Seseli tomentosum* Vis. and *Vincetoxicum hirundinaria* Medik. ssp. *adriaticum* (Beck) Markgr.) were recorded, is distinguished for its floristic structure. Although these islets are uninhabited, a substantial number of ruderal species were transferred to these islands and islets by the seagulls which nest there.



SUHI TRAVNJACI SLAVONSKOGA GORJA

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Slavonsko gorje smješteno je u istočnome dijelu Hrvatske, na granici panonske i ilirske vegetacijske zone. Zahvaljujući različitim klimatskim utjecajima (alpskim sa zapada, dinarskim s juga te panonskim sa sjeveroistoka), prisutna je izrazito velika raznolikost flore i vegetacije na tom području. Osim površina pokrivenih bukovim i hrastovim šumama, poseban oblik staništa na Slavonskome gorju predstavljaju suhi travnjaci (razreda *Festuco-Brometea*, redova *Festucetalia valesiaca* i *Brometalia erecti*), koji se odlikuju izrazito velikim florističkim bogatstvom. Promjene u tradicionalnom načinu korištenja zemljišta (izostanak pašarenja i košnje, intenziviranje šumskih i poljoprivrednih aktivnosti) te napuštanje sela i migracija stanovništva, dovode do nestanka takvih površina. Budući su suhi travnjaci na tom području slabo istraženi, analizirali smo njihovu sintaksonomsku pripadnost, floristička, ekološka i sindinamička svojstva. Standardnom metodom po Braun-Blanquetu napravljeno je 30 vegetacijskih snimaka. Snimke su uspoređene s drugima slične vegetacije, u širem geografskom području (travnjaci razreda *Festuco-Brometea* na području Slovenije, Mađarske i Vojvodine). U analizu su uključene ekološke značajke, poput mikroklimе i geomorfologije.



DRY GRASSLANDS ON SLAVONIAN HILLS

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Slavonian hills (Slavonsko gorje) are situated in the eastern part of Croatia, on the border of the Pannonian and Illyrian floristic area. Thanks to its location on the border of different climate influences (alpine from the west, dinaric to the south, Pannonia from the east and north), great abundance and diversity of flora and vegetation is present in this area. Beside plenty of areas covered by beech and oak forests, dry grasslands (class *Festuco-Brometea*, orders *Festucetalia valesiacae* and *Brometalia erecti*) and lots of its successional stages, which are characterized by an amazing diversity of animals and plants form specific habitats of the Slavonian hills. The change in traditional land use (decreasing of grazing and mowing activities, increasing of certain agricultural and forestry activities), abandoning villages, etc. is leading to large scale losses of such habitats. Dry calcareous grasslands in this area have not yet been studied, so we have analysed their syntaxonomic status, floristic, ecological and syndynamic features. 30 vegetational relevés have been made following the standard Braun-Blanquet method. The relevés have been compared with the relevés of similar vegetation (*Festuco-Brometea*) in the wider geographical region (Slovenia, Hungary, Serbia). Ecological characteristics, such as microclimate and geomorphology were also considered.



THE IMPACT OF FITOHORMON IN GROWTH AND RHIZOGENIC CAPACITY OF SOME ROOTSTOCK OF THE GRAPEVINE

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The research of rizogenic ability of the main rootstock grapevine is of great importance from the fact that nurseries guarantee the best economic indicators compared with traditional method. For this purpose, in Tirana at the Institute of biological researches for the period 2006-2008, two rootstocks were experimented. Macroexsplants 5-6 cm, equipped with 5% of a leaves, are treated with: (i) 1000 ppm IBA (sol.hidroalcoholic), (ii) AIA 1000 ppm (sol.hidroalkol), and (iii) control (sol. hidroalk). Each treatment used makroexsplants 160 (4x4 repetitions). Stimulation is made within two seconds, planting in the substratum perlit foginess banc, with temperature 25°C in the base, environment 20 ° C (± 2 ° C), humidity 80%. Fog is constantly applied through an electronic system with 16 hours light, 3000-33500 lux, after 40 days is evaluated, percentage and quality of rootness and the obtained data are analyzed in JMP (statistic program). Conformity with obtained data, the use of two hormones AIA and AIB has improved the percentage of rootness compared with the controls it has increased the economic effectivity. The solution of 1000 ppm of AIB, and AIA has respectively affected in additional rooting 32% and 18% better than in their control in cv.1103P Kobber.cv paulsen. The material is trapjantuar, aclimatized and conserved for reproduction purposes. The use of stimulators has urged the formation of differentiation of callus and rooting meristem in more remarkable mass than this preparation lack (control). The rooting percentage has been in correlation with cultivarin and has had remarkable differences in LSD 1.71, as where it is treated with AIA and AIB. The 1103 Paulsen cultivar has higher rooting than Kobber cultivar, at the average difference of 7 %.



COENOECOLOGICAL DIFFERENTIATION OF THE POPULATION OF TAXON *SESLERIA RIGIDA* HEUFF *SENSU LATO* IN SERBIA

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The species *S. rigida* belongs to the section *Calcariae*, sub-section *Rigida*. In a wider sense, the taxon *S. rigida* is a Carpatho-Balkans floristic element distributed in Romania, Hungary, Bulgaria, Serbia, Bosnia and Croatia. The taxa *S. rigida* var. *degenii* Deyl, *S. rigida* var. *pancicii* Deyl, *S. rigida* subsp. *achtarovii* (Deyl) Deyl, *S. filifolia* Hoppe and *S. serbica* (Adam.) Ujhelyi are related to a widely considered species *S. rigida*. Their taxonomic and geographical characteristics are not clear enough, so much so that in the modern floristic literature they are neglected or almost exclusively considered as synonyms or infraspecific taxa of the species *S. rigida*. On the territory of Serbia *Sesleria rigida sensu lato* mostly inhabits the vegetation of the open Alpine and sub-Alpine high mountain pastures, hilly rocky grounds and rocky crevices, and less frequently it occurs as a significant coenobiont within the light coniferous or dark deciduous forests. Its habitats are recorded on the altitudes between 100 and 1900 m.a.s., both on the basic-carbonate and on the ultra-basic serpentine and peridotite substratums. The aim of this paper was to establish and describe ecological and geographical differentiation of the population of taxon *Sesleria rigida sensu lato* in Serbia. The geographical analysis include chorological data (latitude, longitude, altitude), while ecological analysis include vegetation (belonging to the association, alliance, order and class) and basic bioclimate parameters data. All chorological and ecological data are georeferenced, which means that besides standard cartographic, numerical and statistical analyses, we used GIS tools for spatial data analyses.



INFLUENCE OF THE ENVIRONMENTAL CONDITIONS ON CHEMICAL ESSENTIAL OIL COMPOSITION OF *SATUREJA HORVATII* ŠILIĆ (LAMIACEAE)

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This study describes chemical composition of the essential oil of *Satureja horvatii* Šilić from two natural habitats (Mt. Orjen and Mt. Lovćen in Montenegro) and from cultivated plants (Belgrade, Serbia). Plants from *locus classicus* Orjenske lokve were transferred into Belgrade and after three years of cultivation, we analysed chemical composition of essential oil in different phenological stages. The essential oil was obtained from the aerial parts of the plant by hydrodistillation and analyzed by GC and GC-MS. In the *S. horvatii* essential oil from natural habitats, thymol (63.7%, Orjen) and carvacrol (68.1%, Lovćen) were the most abundant constituents. The main constituent in oil of cultivated plants in all investigated phenological stages was linalool (37.4%-65.8%). Differences in the composition between the oils from wild-growing and cultivated plants can be explained by climatic and pedological differences of habitats.



NEOPHYTES IN THE CITY OF MOSTAR (BOSNIA AND HERZEGOVINA)

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We identified 220 species and subspecies, belonging to 162 genera and 60 families, in the city of Mostar (Bosnia and Herzegovina) in the period from 2003 to 2007. Families with the highest number of taxa were *Asteraceae* (38) followed by *Poaceae* (20) and *Lamiaceae* (15). Widespread (25%) and cultivated and adventive taxa (21%) had highest contribution in the urban flora. Hemicryptophytes (39.5%) and therophytes (35%) dominated in Raunkiaers life-form spectra. In total, 35 neophytes were identified in urban flora of Mostar. Most of them had American origin (71%). The most frequent neophyte taxa were *Amaranthus retroflexus*, *Artemisia annua*, *Bidens subalternans*, *Conyza bonariensis*, *Conyza canadensis*, *Erigeron annuus*, *Tagetes minuta*, *Tagetes patula*, *Solanum eleagnifolium*, *Xanthium spinosum*, *Ambrosia artemisiifolia*, *Chenopodium ambrosioides*, *Eleusine indica*, *Artemisia verlotiorum*, *Euphorbia maculata*, *Heilanthus tuberosus*, etc.



SUBMEDITERRANEAN RELATIONS OF SOUTH HUNGARIAN MESIC MEADOWS

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Mesophilous meadows are threatened and valuable vegetation types of Central Europe. In spite of their high conservation importance, their diversity is rather poorly understood in the Carpathian Basin. This study aims to present preliminary results of a phytosociological investigation based on vegetation plot data sampled in the southern part of Transdanubia (Hungary) and in Croatia with additional archive relevés from older publications from Croatia and Serbia. The major concern of the study is to examine how meadow types in South Transdanubia are related to types of the two southern neighbor regions, Croatia and Serbia. Vegetation data were analysed by classification and ordination methods. Arrhenatherion-like relevés from Hungary and Croatia (mostly assigned to *Pastinco-Arrhenatheretum* or dryer, uncharacterized types) were more often classified to the same cluster while plots from other types (e.g. *Bromo-Cynosu- retum*, *Festuco-Agrostetum*, *Rhinantho-Filipenduletum*, *Ononido-Alopecuretum*, *Ononido-Arrhenatheretum*) formed geographically more distinct groups. These results suggest that Arrhenatherion-like hay meadows are more uniform within the whole area than other types, mostly pastures. Floristic differences between regions and relevé clusters are discussed based on relevé data. According to our results, the South Hungarian meadows show no marked submedi- terranean influence at the community level, despite the presence or high abun- dance of some submediterranean grassland species.



ORNITOHORNE BILJNE OAZE U KANJONIMA VELIKE I MALE PAKLENICE, U NACIONALNOM PARKU PAKLENICA

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U kanjonima Velike i Male Paklenice, na stjenovitim staništima ili na liticama, postoje eumediteranske oaze hrasta crnike (*Quercus ilex*) i kontinentalne oaze tise (*Taxus baccata*) za koje smatramo da su nastale ornitohorijom. Posebno su zanimljive manje sastojine crnike iznad planinarskog doma na nadmorskoj visini od 550 m na južnoj ekspoziciji, oko 8 km zračne linije udaljene od morske obale, kao i još nekoliko oaza crnike na Jurasovoj glavici i u pojedinim dijelovima kanjona Male Paklenice. Najveća kontinentalna oaza tise smještena je na istočnom dijelu Anića kuka, na nadmorskoj visini od oko 600 m, u sjenovitom dijelu litice, koja je zaklonjena i veći dio dana je u sjeni. Radi se o 50 - 60 grmova tise. Sve spomenute oaze nastale su najvjerojatnije ornitohorijom, prenošenjem sjemenaka, odnosno plodova spomenutih biljnih vrsta. Tisa je prenijeta iz unutrašnjosti, tijekom jesenske selidbe ptica, dok je žir crnike prenesen iz mediteranskih područja u vrijeme proljetnog povratka ptica selica iz mediteranskih zimovališta. U ovom prilogu će se prikazati osnovne ekološke karakteristike ornitohornih biljnih oaza (nadmorska visina, ekspozicija), kao i potencijalne vrste ptica koje su mogle prenijeti sjemenke, odnosno plodove na proljetnoj i jesenskoj selidbi.



ORNITHOCHOSES PLANTS OASIS FROM TWO CANYONS, VELIKA AND MALA PAKLENICA IN PAKLENICA NATIONAL PARK

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In both canyons, Velika and Mala Paklenica, on cliffs and stones habitats exists eumediterranean oasis of Holm Oak (*Quercus ilex*) and continental oasis of Common Yew (*Taxus baccata*) and their origin is possible from ornithochory. Especially are interesting the stands of Holm Oak at 550 m a.s.l. on south exposition by mountaineers hut and about 8 km from the coastline deeply in the canyon of Velika Paklenica. A few oases of Holm Oak exist in some parts of Velika (Jurasova glavica) and Mala Paklenica canyons. The greatest oasis of Common Yew is on the east part of Anića kuk, about 50-60 specimens, at the 600 m a.s.l. in shadow. This ornithochores plants oasis are on migration routes of some migratory birds species, so seeds of Common Yew transported by birds from inside of country and seeds of Holm Oak from mediterranean wintering areas on spring migration. In this contribution it is discussed about ecological features of ornithochores plants oasis (altitude of stands, exposition) and potentially birds species noted on spring and autumn migration.



PRIKAZI BILJA U BAROKNOJ UMJETNOSTI PELJEŠCA

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Posebno mjesto u razmatranju florealnih prikaza baroknog stila na Pelješcu zauzima ciklus slika s pjevališta crkve Gospe od Rozarija u Tomislavovcu (nekađašnji Kozô) iznad mjesta Putnikovići. Slikar Filippo Naldi, vojni časnik u mletačkoj službi u Neretvi tijekom treće četvrtine XVIII. stoljeća naslikao je iznimno dragocjen ciklus narativnog karaktera u toj osamljenoj grobljanskoj crkvi. Posebno je zanimljiv prikaz pogreba, onodobne nošnje, ali i florealnih motiva (hortenzija) koji se pojavljuju kao dekoracija figuralnim prikazima. Sedamdesetih godina XVIII. stoljeća Filippo Naldi oslikao je predoltarnik u župnoj crkvi sv. Martina u Žuljani, gdje u bokoru girlandi razaznajemo bilje (ruže i kamelije) koje se tada uzgajalo i cijeno. U istoj crkvi se nalazi i drugi oslikani drveni predoltarnik iz XVIII. stoljeća. U bivšoj dominikanskoj crkvi Gospe od Rozarija u Vignju, koja se započela graditi 1671. godine, nalazi se jedinstveni kameni oltar u Hrvatskoj iz apulijskog grada Lecce. Na retablu oltara izrađenog od mekanog krednjaka isklesani su gusto nanizani reljefi šipaka, akantusa te cvjetova drugih biljaka. Vrijeme XVII. stoljeća je razdoblje u kojem je cvijet tulipana bio iznimno popularan, i čije su lukovice plaćane u zlatu. Na kamenom nosaču propovjedaonice u crkvi Gospe od Rozarija isklesan je reljef bokora tulipana. Motiv tulipana bio je iznimno popularan u korčulanskim kamenoklesarskim radionicama XVII. i XVIII. stoljeća. Akantusov list, obljubljen u klasičnoj umjetnosti zbog svoje dekorativnosti, bio je u širokoj primjeni i tijekom baroknog razdoblja, pa ga nalazimo i na drvenom retablu oltara sv. Križa u crkvi Gospe od Rozarija u Vignju.



PLANTS IN THE BAROQUE ART ON THE PELJEŠAC PENNINSULA

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In the analysis of the Baroque floral presentations on the Pelješac Peninsula, a special place belongs to the cycle of paintings on the choir stalls in the church of Our Lady of Rosary in Tomislavovac (ex-Kozô) above the village of Putnikovići. A Venetian painter Filippo Naldi, a military officer in Neretva during late 18th century, painted a very precious narrative set of paintings in this secluded graveyard church. The funerals, period costumes and floral motifs (hortensia) as decoration for figurative drawings – all of these are particularly interesting. Towards the end of the 18th century, Filippo Naldi painted the facade of the altar in the parish church of St. Martin in Žuljana where the plants (roses and camelias), valuable at that time, can be clearly recognized. The same church treasures another wooden altar facade from the 18th century. In the former Dominican church of Our Lady of Rosary in Viganj – whose construction started in 1671 – there is a unique stone altar in Croatia from the Apulian city of Lecce. The altars retable made of soft limestone depicts a dense row of pomegranate, acanthus and other flowers carved into relief. In the 17th century the tulip flower was very popular and its bulbs were paid for in gold. A bunch of tulips carved into a relief is shown on the pulpits stone prop in the church of Our Lady of Rosary. The tulip motif was extremely popular in the stone quarry workshops in Korčula during 17th and 18th centuries. The acanthus leaf, because of its ornamentation so popular in classic art, was also widely used during the Baroque period. Therefore, we can find it on the wooden retable of the Holly Cross altar in the church of Our Lady of Rosary in Viganj.



HETEROGENA RASPODJELA FITOPLANKTONA U SLOJU DUBOKOG MAKSIMUMA KLOROFILA U JABUČKOJ KOTLINI (SREDNJI JADRAN)

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Tijekom velikog dijela godine u srednjem se Jadranu razvija duboki klorofilni maksimum (DCM). Istražena je fina prostorna raspodjela fitoplanktona u odnosu na fizikalna, kemijska i biooptička svojstva, u sloju dubokog maksimuma klorofila (DCM) u Jabučkoj kotlini, u svibnju i lipnju 2003. DCM je bio razvijen u periodu stratifikacije, u sloju između 70 i 125 m. U DCM je zabilježen razvoj fitoplanktona uz nutriklinu, u eufotičkom sloju. Dijatomeje i kokolitoforidi su dominantne skupine fitoplanktona u sloju DCM-a; doprinose 91% (kokolitoforidi), odnosno 76% (dijatomeje) od ukupne abundancije fitoplanktona. Kokolitoforidi i dijatomeje su bili heterogeno raspoređeni u sloju DCM-a. Pronađena su tri različita tipa nakupljanja fitoplanktona i nutrijenata u DCM: 1) Maksimalna abundancija dijatomeja (*Pseudo-nitzschia* spp. i *Chaetoceros socialis*) i kokolitoforida uz najmanju koncentraciju nitrita i nitrata, te najveću koncentraciju silikata. 2) Razvoj dijatomeja (*Leptocylindrus danicus* i *Pseudo-nitzschia* spp.) i kokolitoforida (*Emiliana huxleyii*) se u istom sloju međusobno isključuju, uz nakupljanje ortofosfata. 3) Područja u kojima je utvrđen dublji maksimum dijatomeja (100-125 m) (*Cerataulina pelagica*, *Chaetoceros* spp. i *Pseudo-nitzschia* spp.) i plići maksimum kokolitoforida (75 m) (*Emiliana huxleyii*), uz obogaćivanje nitratom i nitritom. Možemo pretpostaviti da su u vrijeme istraživanja nakupine dijatomeja i kokolitoforida sastavljene od starijih populacija uz koje je započela mikrobna regeneracija anorganskih nutrijenata.



PATCHY DISTRIBUTION OF PHYTOPLANKTON WITHIN THE DEEP CHLOROPHYLL MAKSIMUM IN JABUKA PIT (MIDDLE ADRIATIC)

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A well-developed deep chlorophyll maximum is a prominent feature in Adriatic Sea during a large part of the year. Spatial distribution of phytoplankton was investigated in the DCM layer in relation to physical-chemical and biooptical characteristics in the Jabuka Pit (Middle Adriatic). DCM was found in the 70 and 125 m layer, in the stratified conditions in May-June 2003. It was composed of phytoplankton above the nutricline and in euphotic layer. Diatoms and coccolithophorids contributed in DCM with 76% and 91% of total phytoplankton abundance, respectively. Coccolithophorids and diatoms were heterogeneously distributed in the DCM. We found three types of accumulation of phytoplankton and nutrients in DCM. 1) Maximum abundance of diatoms (*Pseudo-nitzschia* spp. and *Chaetoceros socialis*) and coccolithophorids beside minimum concentration of nitrites and nitrates, and maximum concentration of silicates. 2) Development of mutually excluded diatoms (*Leptocylindrus danicus*, *Pseudo-nitzschia* spp.) and coccolithophorids (*Emiliana huxleyii*), and accumulation of orthophosphates in the same layer. 3) The DCM was divided to deeper layer where maximum of diatoms (100-125 m) (*Cerataulina pelagica*, *Chaetoceros* spp., *Pseudo-nitzschia* spp.) and the shallower layer where maximum of coccolithophorids (75 m) (*Emiliana huxleyii*) were found, accompanied with enriched nitrates and nitrites. We can suppose that beside older populations of phytoplankton accumulated along DCM, microbial regeneration of inorganic nutrients took place.



SAMONIKLA VASKULARNA FLORA KAMENJARSKIH PAŠNJAKA NA OTOKU PAGU

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Samonikla vaskularna flora kamenjarskih pašnjaka istraživana je na osam lokaliteta koji se protežu duž otoka Paga, od jugoistoka prema sjeverozapadu. Pritom je pronađena 331 biljna svojta (296 vrsta, 34 podvrste i jedan varijetet) u okviru 201 roda i 51 porodice. Od tog broja, 287 svojti prethodno je već zabilježeno, a 44 se za istraživano područje navode po prvi put. Većina biljaka pripada porodicama *Poaceae*, *Asteraceae*, *Fabaceae*, *Lamiaceae* i *Liliaceae*. Fitogeografska analiza pokazala je najveću zastupljenost mediteranskog flor-nog elementa (52,6%). Dominacija hemikriptofita (37,2%) karakteristična je za travnjačku floru, a relativno velika zastupljenost terofita (31,7%) ukazuje na veliki utjecaj eumediteranske zone. Na istraživanom području utvrđeno je 20 ugroženih i 23 endemične svojte.



NATIVE VASCULAR FLORA OF ROCKY PASTURES ON THE ISLAND OF PAG

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Native vascular flora of rocky pastures was researched on the 8 localities, located in the southeast to northwest stretch of the island of Pag. A total of 331 plant taxa (296 species, 34 subspecies and 1 variety) were found. The taxa belonged to 201 genera and 51 families. Part of them (287) has been already registered, while 44 of them have now been registered for the first time. The most dominant families are: *Poaceae*, *Asteraceae*, *Fabaceae*, *Lamiaceae* and *Liliaceae*. Phytogeographical analysis showed that the most represented species belong to the Mediterranean floral element (52.6%). The domination of Hemicryptophyta (37.2%) is typical for the grassland flora, and the high proportion of Therophyta (31.7%) shows a big influence of the Eumediterranean zone. On the researched area we determined the presence of 20 endangered and 23 endemic plants.



SAMONIKLA I URESNA FLORA OTOKA SV. KLEMENT (PAKLENI OTOCI)

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Otok Sv. Klement najveći je u srednjodalmatinskoj skupini Paklenih otoka, smještenoj ispred jugozapadne obale otoka Hvara. Građen je uglavnom od vapnenaca i dolomita kredne starosti te je za područje karakteristična krška morfologija reljefa. Klima otoka Sv. Klement klasificira se prema Köppenu kao sredozemna klima s vrućim i suhim ljetom te blagom, kišovitom zimom (Csa). Samonikla i uresna flora otoka Sv. Klement istraživana je tijekom 2007., 2008. i 2009. godine te ukupna flora danas obuhvaća 590 vrsta, podvrsta, varijeteta i kultivara iz 346 rodova i 102 porodice. Terenskim istraživanjem potvrđen je nalaz 93 svojte, dok su zabilježene 432 nove svojte, od čega 168 samoniklih i 264 uresne svojte. Najzastupljenije porodice u samonikloj flori su *Fabaceae* (11,66 %), zatim slijede *Poaceae* (10,74 %) te *Asteraceae* (5,83 %), dok su u uresnoj najzastupljenije *Arecaceae* (19,32 %), *Agavaceae* (16,67 %), *Cactaceae* (7,26 %) i *Zamiaceae* (5,30 %). Životni oblik najzastupljeniji u samonikloj flori su terofiti (42,33 %), potom hemikriptofiti (23,93 %) i geofiti (12,27 %). U ukupnoj flori prevladavaju kultivirane i adventivne biljke (45,93 %), no ukoliko u obzir uzmemo samo samonikle vrste, uočava se jasna dominacija mediteranskog flor-nog elementa (57,36 %). Od uresnih svojti u vrtovima prevladavaju svojte porijeklom iz Meksika (16,67 %), Južne Afrike (14,39 %) te Južne Amerike (8,71 %). U flori otoka zabilježeno je ukupno sedam endemičnih svojti, 29 svojti navedenih u „Crvenoj knjizi vaskularne flore Hrvatske” te 38 svojti uvrštenih na „Crveni popis” IUCN-a. „Pravilnikom o proglašenju divljih svojti zaštićenim i strogo zaštićenim” zaštićeno je 66 zavičajnih i 27 stranih divljih svojti. Za potrebe uspoređivanja bogatstva flore otoka na temelju eksponencijalnog modela (Arrheniusova jednadžba) izračunata je z-vrijednost, kao i α – indeks raznolikosti.



NATIVE AND DECORATIVE FLORA OF THE ISLAND OF ST. KLEMENT (PAKLENI ARCHIPELAGO)

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The island of St. Klement is the biggest island in the middle-dalmatian group of Pakleni archipelago, which lies southwest from the island of Hvar. It is built mostly from Cretaceous limestone and dolomite, therefore the typical morphology of terrain is karst one. According to the climate classification by Köppen the island of St. Klement belongs to the Mediterranean climate with warm to hot, dry summers and cool, wet winters (Csa). The research of the native and decorative flora of the island of St. Klement (Pakleni archipelago) was carried out during 2007, 2008 and 2009. The total flora is comprised nowadays of 590 taxa from 346 genera and 102 families. Field research confirmed finding of 93 taxa, and reported 432 new taxa, whereof 168 belonging to native and 264 to decorative flora. The most abundant families in the native flora are *Fabaceae* (11.66 %), *Poaceae* (10.74 %) and *Asteraceae* (5.83 %), while the most abundant ones in the decorative flora are *Areaceae* (19.32 %), *Agavaceae* (16.67 %), *Cactaceae* (7.26 %) and *Zamiaceae* (5.30 %). The most abundant life-forms in the native flora are therophytes (42.33 %), hemicryptophytes (23.93 %) and geophytes (12.27 %). Dominant plants in the total flora are cultivated and adventive plants (45.93 %), but if only native species are taken into account, the most dominant becomes the Mediterranean chorological element (57.36 %). The decorative flora originates mostly from Mexico (16.67 %), South Africa (14.39 %) and South America (8.71 %). The research recorded 7 endemic taxa, 29 taxa noted in the Red Book of Vascular Flora of Croatia and 38 taxa from the IUCN Red list. Moreover, 66 native and 27 foreign wild taxa are protected according to the 2005 Nature Protection Act. For the purpose of comparing the richness of species from the power function model (Arrhenius equation) z-value, as well as α - indices of diversity were calculated.



ISTRAŽIVANJE LIHENOFLORE NACIONALNOG PARKA „KORNATI”

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Istraživanje lihenoflore provedeno je na prostoru NP „Kornati” u vremenskom razdoblju od 25. rujna do 1. listopada 2009., s naglaskom na terestričku i epifitsku lihenofloru. Uzorkovano je područje pet otoka, koji su birani prema raznolikosti vegetacije (Kornat, Velika Smokvica, Lavsa, Mana i Levernaka). Pronađeno je 80 vrsta lišajeva, od kojih su dvije vrste na „Crvenom popisu lišajeva Republike Hrvatske” - *Rocella phycopsis* Ach. i *Teloschistes chrysophthalmus* (L.) Th.Fr. Do sada su u literaturi za to područje bile navedene samo četiri vrste lišaja, od kojih je jedna determinirana samo do roda, pa je ovakav doprinos poznavanju lihenoflore ovog zaštićenog područja od iznimnog značaja. Najbogatiji otok lišajevima, koji je ujedno i najveći, jest otok Kornat, sa 63 zabilježene svoje. Unatoč prividnoj krškoj „škrтости” kopnenih prostora NP „Kornati”, flora lišajeva izuzetno je bogata, pa su nužna detaljnija istraživanja, posebice svojti koje žive na kamenu. Budući da su lišajevi značajan bioindikator uvjeta u okolišu, potrebno je pridati veću važnost poznavanju lihenoflore u Hrvatskoj, posebno u njenim zaštićenim područjima.



LICHENOLOGICAL RESEARCH IN NATIONAL PARK „KORNATI”, CROATIA

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Lichen flora of „Kornati” National Park (Croatia) was researched in September 2009, with emphasis on terrestrial and epiphytic lichens. Five islands were chosen for this research, based on vegetation diversity: Kornat, Velika Smokvica, Lavsa, Mana and Levernaka. Altogether 80 taxa were recorded, two of which are red listed for Croatia - *Rocella phycopsis* Ach. and *Teloschistes chrysophthalmus* (L.) Th.Fr. Thus far, this area was never thoroughly investigated, and only four species were recorded. Therefore, this research represents a significant contribution for knowledge on lichen flora in the aforementioned protected area and Croatia in general. The island Kornat, the biggest one in archipelago, has the richest lichen flora counting 63 taxa. Our research needs to be expanded geographically (inclusion of other islands) but also saxicolous taxa needs to be explored further, as it was only partially included in this study. Lichens are important bioindicators of environmental factors and consequently their distribution should be an important part of every inventarisation project, especially in protected areas.



PRIMJENA RAČUNALNOG PROGRAMA *COMPLEAT BOTANICA* U KATALOGIZIRANJU BILJNIH VRSTA

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Tijekom rada u botaničkom vrtu ukazuje se potreba za računalnim programom koji će vrtlarskom osoblju omogućiti uvid u fotografije svojti iz vrtnih zbirki i najnužnije podatke o svakoj pojedinoj svojti (porijeklo, uzgoj, razmnožavanje i td.). Za katalogiziranje podataka biljnih svojti služimo se bazom FCD (*Flora Croatica Database*). Program *Compleat Botanica* omogućio bi vrtlarima i pomoćnom osoblju da na lakši način dođu do podataka koji su im potrebni u svakodnevnom radu s biljnim materijalom. Uz svaku svojtu navode se osnovni podaci: naziv roda, vrste, varijeteta, kultivara, hrvatski naziv, porodica, porijeklo primjerka, te podaci o izgledu i boji pojedinih dijelova biljke, o uporabi u medicini, uzgoju i td. Svi uneseni podaci mogu se sistematizirati i ispisati, kako bi stalno bili na raspolaganju vrtlarskom osoblju. Planiran je otkup još dvije licence spomenutog programa te postavljanje na računala dostupna vrtlarima.



APPLICATION OF SOFTWARE *COMPLEAT BOTANICA* IN CATALOGING PLANTS

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A need for a computer program to be used by gardeners in the Botanical garden has recently become apparent, that would provide insight into garden collection photographs, as well as essential data on each taxa (origin, cultivation, propagation etc.). So far, we have used the FCD program (Flora Croatica Database) for cataloguing plant data, but a more specialised program like *Compleat Botanica* would allow gardeners and other staff members to easily obtain data needed in their daily work with the plant material. This program lists basic information on each plant: name of the genus, species and cultivar, Croatian name, family name, the origin of the specimen, plant description, details on cultivation and propagation, medicinal uses etc. In addition to the one existing licence, we plan to obtain at least two more, to be used on computers set for the garden staff.



SEZONSKE VARIJACIJE PELUDNIH ALERGENA U GRADU SPLITU

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Tijekom polinacijskih sezona od 2005. do 2007. godine istraživane su sezonske varijacije alergene peludi i njihova ovisnost o meteorološkim parametrima. Aerobiološko istraživanje provedeno je volumetrijskom metodom po Hirstu. U zraku grada Splita zabilježena je pelud 44 biljne svojte, od kojih je 13 alergeni. Početak svih polinacijskih sezona je u prvoj polovici siječnja, a završetak u listopadu 2005. i 2007. te u prosincu 2006. U analiziranom zraku izbrojano je ukupno 45 899 peludnih zrnaca. Udio peludi drveća iznosio je 84,6%, koro-va 13,1% i trava 2,4%. Najzastupljenija je pelud svojti *Cupressaceae/Taxaceae*, *Pinus*, *Parietaria/Urtica*, *Olea*, *Quercus*, *Poaceae*, *Carpinus/Ostrya* i *Fraxinus*. Najviše koncentracije peludi zabilježene su u travnju i ožujku, a najniže u kasnojesenskim i zimskim mjesecima. Za svaku polinacijsku sezonu izrađen je peludni kalendar. Korelacije između mjesečnih koncentracija peludi i meteoroloških parametara (temperatura i oborine) statistički su značajne. Pozitivan učinak na koncentraciju peludi imaju srednja, maksimalna i minimalna temperatura, dok je utjecaj oborina većinom negativan.



SEASONAL VARIATIONS OF POLLEN AEROALLERGENS IN THE CITY OF SPLIT

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The aim of this aerobiological study was to determine the seasonal variations (2005-2007) and the effect of meteorological parameters on aeroallergenic pollen concentrations in the city of Split, by Hirst volumetric method. Among identified pollen of 44 taxa, 13 were allergenic. The onset of pollen seasons under study was in January. In 2005, and 2007, pollen seasons terminated in October and in 2006, in December. The total of 45 899 pollen grains was recorded. The percentage proportion of tree, weed and grass pollen were 84.6%, 13.1% and 2.4%, respectively. The plants with the greatest amount of pollen were: *Cupressaceae/Taxaceae*, *Pinus*, *Parietaria/Urtica*, *Olea*, *Quercus*, *Poaceae*, *Carpinus/Ostrya* and *Fraxinus*. The highest concentrations were in April and March and the lowest in late autumn and winter. For each season, pollen calendar was created. The correlations between pollen concentration and meteorological parameters (temperature and precipitation) were statistically significant. The correlations between pollen concentration and temperature were positive, whilst the precipitation mostly showed negative influence.



USPOREDBA INVAZIVNE FLORE HRVATSKE PO BIOGEOGRAFSKIM REGIJAMA

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Analizirali smo invazivnu floru Hrvatske u četiri biogeografske regije određene programom NATURA2000, a s obzirom na vrijednosti pripadajućih Ellenbergovih indikatorskih vrijednosti, spektar životnih oblika, Grimove CSR-strategije te način rasprostranjanja. Od ukupno 66 invazivnih svojti, njih 26 (39,4%) zabilježeno je u sve četiri regije. Najčešći životni oblik bili su terofiti, s najmanje 55,9%. Usporedba spektra životnih oblika pokazala je, sukladno očekivanjima, najmanji udio geofita u mediteranskoj biogeografskoj regiji te terofita u alpinskoj. Prosječne vrijednosti Ellenbergovih indikatorskih vrijednosti među regijama su bile slične, uz iznimku mediteranske, koja je, očekivano, imala najvišu vrijednost za temperaturu (7,24) te najniže za vlažnost tla (4,71) i hranjivost podloge (5,69). Zookorija i anemokorija su najčešći načini rasprostranjanja invazivne flore u svim regijama, pri čemu je najviše anemokornih biljaka u mediteranskoj regiji (32%), koja od svih ima i najmanje autokornih (14,67%) biljaka. Usporedbom Grimovih strategija istakla se alpinska regija s najviše invazivnih biljaka kompeticijske strategije (46,4%) i najmanje biljaka ruderalne strategije (7,1%), dok je u mediteranskoj, usporedbom s drugim regijama, najviše bilo biljaka ruderalne (14,3), a najmanje kompeticijske (34,3%) strategije. Dobiveni rezultati ukazuju na razlike u invazivnoj flori biogeografskih regija, koje upućuju na potrebu razdvojenog praćenja statusa i kontrole invazivnih vrsta po biogeografskim regijama



COMPARISON OF CROATIAN INVASIVE FLORA ACROSS BIOGEOGRAPHICAL REGIONS

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We have analysed Croatian invasive flora present in four biogeographical regions, as defined in frame of NATURA2000 program, with respect to their corresponding Ellenbergs indicator values, life form spectrum, Grimes CSR-strategies and seed dispersal mechanism. Out of 66 invasive taxa, 26 of them (i.e. 39.4%) have been recorded in all four biogeographical regions. Therophytes prevailed among life forms, with at least 55.9% portion in sample. As expected, portion of geophytes was lowest in Mediterranean, and therophytes in Alpine region. Means of Ellenbergs indicator values were quite similar among regions, with exception of Mediterranean region that, as expected, has highest value for temperature (7.24), while lowest for soil humidity (4.71) and soil fertility (5.69). Zoochory and anemochory were most frequent seed dispersal mechanism of invasive flora in all regions. Mediterranean region has highest share of anemochorous plants (32%) while lowest of autochorous ones (14.67%). When comparing Grimes CSR strategies, Alpine region has highest share of invasive plant species with C (competitor) strategy (46.4%) and lowest of those with R (ruderal) strategy (7.1%) which was opposite to Mediterranean region in which there was largest share of R plants among four regions (14.3%) and lowest of C plants (34.3%). Obtained results shows that there are differences in invasive flora among biogeographical regions that indicate necessity for separate monitoring and control of invasive species across biogeographical regions.



OSJETLJIVOST HRVATSKIH ENDEMIČNIH SVOJTI RODA *IRIS* NA FITOPATOGENU GLJIVU *CLADOSPORIUM IRIDIS*

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Po broju endemičnih vrsta u flori Hrvatske značajno mjesto ima rod *Iris*, unutar kojeg je zastupljeno pet endemičnih svojti (*I. adriatica*, *I. croatica*, *I. illyrica*, *I. pseudopallida* i *Iris x rotschildii*). Vrste roda *Iris* napada veliki broj fitopatogenih vrsta gljiva, od kojih se kao vrlo česta navodi vrsta *Cladosporium iridis* (Fautrey et Roum.) G.A. de Vries (teleomorf *Davidiella macrospora* (Kleb.) Crous et U. Braun). Gljiva je uzročnik bolesti pod nazivom „pjegavost lišća”. Međutim, od biljaka domaćina do sada nije utvrđena niti jedna od naših pet endemičnih vrsta perunika (*Iris*). Tijekom 2007., 2008. i 2009. godine obilaskom područja u kojima su raširene endemične svojte perunika (NP „Paklenica”, PP „Biokovo”, PP „Žumberak-Samoborsko gorje” i dr.) uočena je pojava simptoma koji upućuju na zarazu gljivom *Cladosporium iridis*. Međutim, intenzitet pojave simptoma značajno je varirao u ovisnosti o svojtima i lokalitetima roda *Iris*. Sa zaraženog biljnog materijala izolirana je i determinirana navedena vrsta gljive. Kako bismo utvrdili osjetljivost pet hrvatskih endemičnih vrsta roda *Iris* na zarazu ovom gljivom, u kontroliranim uvjetima vršene su umjetne inokulacije suspenzijom spora gljive i nakon pojave simptoma očitao je intenzitet zaraze na temelju broja pjega. Dobiveni podaci obrađeni su prikladnim statističkim metodama, kako bi se utvrdila signifikantnost razlika. Prema dobivenim rezultatima, kao izrazito osjetljive na gljivu *Cladosporium iridis* utvrđene su vrste *I. illyrica* i *I. pseudopallida*, srednje osjetljivom pokazala se *Iris x rotschildii*, dok su manje osjetljive vrste bile *I. croatica* i *I. adriatica*.



SUSCEPTIBILITY OF CROATIAN ENDEMIC *IRIS* TAXA TO PYTOPATHOGENIC FUNGUS *CLADOSPORIUM IRIDIS*

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According to the number of endemic species, the genus *Iris* has a notable placement in flora of Croatia, with five endemic taxa present (*I. adriatica*, *I. croatica*, *I. illyrica*, *I. pseudopallida* and *Iris x rotschildii*). A number of plant pathogenic fungi are causing various diseases on *Iris* species, among which *Cladosporium iridis* (Fautrey & Roum.) de Vries (telomorph *Davidiella macrospora* (Kleb.) Crous et U. Braun) is often mentioned as very common. The fungus is the causal agent of the leaf spot disease. However, neither one of five Croatian endemic *Iris* taxa has not been reported as a host plant. During 2007, 2008 and 2009, the presence of symptoms similar to those caused by *C. iridis* has been noted in locations where endemic *Iris* taxa are widespread (Paklenica, Biokovo, Žumberak-Samoborsko gorje, etc.). The intensity of symptoms varied significantly depending on taxa and location. *C. iridis* has been isolated from the diseased plant tissue and identified as a causal agent of the disease. To determine the susceptibility of five Croatian endemic *Iris* taxa to leaf spot caused by this fungus, artificial inoculations with conidial suspension were performed in greenhouse controlled conditions. When the symptoms appeared, disease severity was assessed according to the number of spots on the leaves. Data were statistically analysed to determine the eventual differences among means. The results showed that *I. illyrica* and *I. pseudopallida* can be considered as very susceptible, *Iris x rotschildii* was moderately susceptible, while *I. croatica* and *I. adriatica* showed to be less susceptible or resistant.



PRIMJENA FENOLOŠKIH MOTRENJA U NASTAVI

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Fenologija proučava pojave bioloških ciklusa i njihovu povezanost s klimom. Prikupljajući fenološke podatke za svoje područje, možemo saznati kako vegetacija odgovara na klimatske čimbenike, a istovremeno priskrbiti važne informacije koje će pridonijeti razumijevanju kako globalna klima utječe na vegetaciju i kako se mijenja. Fenološka motrenja su obavljena na smokvi (*Ficus carica* L.) u Tisnom, Jezerima, Murteru, Zadru te u Preku na otoku Ugljanu. Fenološka istraživanja temelje se na multidisciplinarnosti koja pretpostavlja povezivanje sadržaja više različitih struka i interdisciplinarnosti, odnosno povezivanju znanja, vještina i stavova kroz integraciju sadržaja same discipline. U fenološkim motrenjima su zastupljeni sadržaji meteorologije, pedologije i biologije. Sam proces istraživanja i interpretacije dobivenih rezultata obogaćuje, nadopunjuje i, općenito, razvija postojeće kompetencije učenika. Radeći na ovakvim projektima, kod učenika se razvija znanstveni pristup istraživanju, a samim boravkom u prirodi razvija se ekološka svijest. Takav oblik rada razvija različite kompetencije učenika, ponajviše socijalne (razvoj komunikacijskih vještina, poticanje i prihvaćanje načela timskog rada, odgovornost, uvažavanje različitosti).



APPLICATION OF PHENOLOGICAL OBSERVATIONS IN TEACHING

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Phenology studies biological cycles phenomena and their relations to climate. By gathering phenological data for a certain area, we can find out how vegetation responds to climate factors and collect valuable pieces of information that will help us understand global climate effects upon vegetation and the way in changes. Our phenological observations were carried out on figs (*Ficus carica* L.) in Tisno, Jezera, Murter, Zadar and Preko on the island of Ugljan. These observations were based on a multidisciplinary approach, including interconnections among several scientific branches and interdisciplinarity, namely a combination of knowledge, skills and attitudes through an integration of the contents of the discipline itself. They include meteorology, pedology and biology contents and matters. The research and interpretation of the collected results process itself improves, completes and generally develops current competences of students. Projects like this contribute to develop scientific approach to research work with students while spending time in natural environment develops students ecological awareness. This working method improves different students skills and abilities, primarily the social ones (communication skills, stimulation and adoption of team-work principles, responsibility, diversity appreciation).



MORFOLOGIJA POLENA RODA *IRIS* (*IRIDACEAE*) U HRVATSKOJ

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Morfologija polena svojti roda *Iris* u Hrvatskoj analizirana je pomoću *scanning*-elektronskog mikroskopa. Sva polenova zrnca su sulkatna, a prema skulpturiranosti eksine može se razlikovati nekoliko polenskih tipova: "*Iris germanica* polenski tip", "*I. pseudacorus* polenski tip", "*I. graminea* polenski tip" i "*I. pumila* polenski tip". Svojta *I. sibirica* subsp. *erirrhiza* (Pospichal) Wraber, s Bjelolasice, ne pripada nijednom polenskom tipu, s eksinom koja ukazuje na njeno potencijalno hibridno podrijetlo. Nadalje, morfologija polena potvrđuje hibridno podrijetlo vrste *I. x rotschildii* Degen. Za sve ostale svojte perunika morfologija polena pokazuje podudarnost s grupama dobivenim na temelju ostalih taksonomskih istraživanja.



POLLEN MORPHOLOGY OF THE GENUS *IRIS* (*IRIDACEAE*) IN CROATIA

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Pollen morphology of *Iris* taxa present in Croatia, were analysed by scanning electron microscopy. All pollen grains are sulcate and, due to their surface ornamentation, several types can be distinguished: "*Iris germanica* pollen type", "*I. pseudacorus* pollen type", "*I. graminea* pollen type" and "*I. pumila* pollen type". Taxon *I. sibirica* subsp. *erirrhiza* (Pospichal) Wraber from Mt Bjelolasica does not belong to any pollen type, with exine which implies its possible hybridogenous origin. Furthermore, evidence from pollen morphology confirms hybridogenous origin of *I. x rotschildii* Degen. For all other taxa, pollen morphology is in good accordance with groups detected on the basis of other taxonomic researches.



PORIJEKLO I EVOLUCIJA GENOMA ALOPOLIPLOIDNIH VRSTA *ANEMONE BALDENSIS* I *ANEMONE MULTIFIDA*

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Vrsta *Anemone baldensis* L. nastanjuje planinski dio Europe i jedna je od dviju prirodnih heksaploida ($2n=6x=48$) unutar roda *Anemone*, dok je vrsta *Anemone multifida* Poir., koja se rasprostire od sjeverno-istočnog dijela Sjeverne Amerike do južnog Čilea i Argentine, tetraploid ($2n=4x=32$). Kariotip obje vrste sadrži tri odnosno dva seta kromosoma koji se razlikuju u veličini što ukazuje na njihovo aloploidno porijeklo. Genomska hibridizacija *in situ* (GISH) i fluorescencijska hibridizacija *in situ* (FISH) s 5S i 35S ribosomskom DNA (rDNA) sondom upotrijebljene su za utvrđivanje roditeljskog porijekla kromosoma ovih vrsta. Kariotip vrste *Anemone baldensis* sadrži dva seta većih kromosoma porijeklom iz vrste *A. sylvestris* i/ili njoj blisko srodne vrste, dok vrsta *A. multifida* ima jedan set većih kromosoma porijeklom iz vrste *A. cylindrica* ili *A. virginiana*. Kariotip obje vrste sadrži jedan set malih kromosoma koji svojom veličinom i morfologijom sliče kromosomima karakterističnim za vrste iz srodnog roda *Pulsatilla*.



PARENTAL ORIGIN AND GENOME EVOLUTION IN THE ALLOPOLYPLOIDS *ANEMONE BALDENSIS* AND *ANEMONE MULTIFIDA*

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Anemone baldensis L., species occurring in the mountains of Europe is one of the two natural hexaploids ($2n=6x=48$) recognized within *Anemone*, while *Anemone multifida* Poir., species widely distributed from the north eastern part of North America to southern Chile and Argentina is a tetraploid ($2n=4x=32$). Their karyotypes consist of three or two chromosome sets, respectively, dissimilar in size suggesting allopolyploid origin. Genomic *in situ* hybridization (GISH) and fluorescent *in situ* hybridization (FISH) with 5S and 35S ribosomal DNA (rDNA) probes were used to identify the parental origin of chromosomes. *Anemone baldensis* has inherited two larger chromosome sets from *A. sylvestris* and/or its close relative, while *A. multifida* has inherited the larger chromosome set from *A. cylindrica* or *A. virginiana*. The smallest chromosome set of *A. baldensis* and *A. multifida* is in common to both species. On cytogenetical grounds, it is suggested that the set of smaller chromosomes resembles those of some *Pulsatilla* species.



VEGETACIJSKE, EKOLOŠKE I HIDROLOŠKE ZNAČAJKE CRETA NA TRSTENIKU (GORSKI KOTAR, HRVATSKA)

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Na području Trstenika ustanovljena su tri travnjačka i pet cretnih tipova sastojina, koje su floristički i ekološki dobro definirane. Među ekološkim gradijenti-
ma, duž kojih se događaju promjene u sastavu vegetacije, najvažniji su gradi-
jent pH, gradijent koncentracije kalcija i kalcijevog karbonata te gradijent vlaž-
nosti, koji su istraženi i izravnim mjerenjima na uzorcima tla. Rezultati analize
utjecaja posredno (pomoću Ellenbergovih koeficijenata) i neposredno dobive-
nih ekoloških varijabli na promjene u vegetaciji međusobno se podudaraju. Od
pet cretnih tipova sastojina, rubno razvijene pripadaju minerotrofnoj vegetaci-
ji, dok središnji, uzdignuti dio creta, na kojem su razvijene sastojine vrste *Mo-
linia caerulea* s pojedinačnim humcima sastojina vrste *Sphagnum capillifolium*,
ima određena floristička, ekološka i hidrološka obilježja ombrotrofne vegetaci-
je. Cret na Trsteniku floristički, vegetacijski i ekološki predstavlja za Hrvatsku
botanički vrlo vrijedan lokalitet, pa je potrebno poduzeti mjere aktivne zaštite
kako bi se zaustavilo ili usporilo njegovo propadanje.



**PHYTOSOCIOLOGY, ECOLOGY AND HIDROLOGY
OF THE TRSTENIK MIRE
(GORSKI KOTAR, CROATIA)**

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At the Trstenik doline (NW Croatia) eight floristically and ecologically well defined vegetation types were recognised, of that three belonged to grassland vegetation and five to mire vegetation. Acidity gradient, calcium and calcium carbonate concentrations gradients and peat moisture gradient were the most important ecological factors determining vegetation patterns. Results based on the direct measurements of ecological variables and those obtained indirectly using Ellenbergs indicator values were highly congruent. Among five types of mire vegetation stands, marginally located ones belonged to the minerotrophic vegetation, while the central plateau showed some floristic, ecological and hydrological evidence of ombrotrophy. Trstenik mire represents an important habitat hosting some of the rarest plant species in Croatia. Possible conservation measures were briefly discussed.



MORSKA CVJETNICA *POSIDONIA OCEANICA* KAO BIOINDIKATOR STANJA PRIOBALNIH VODA U SREDNJEM JADRANU

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Antropogeni poremećaji u okolišu odražavaju se na stanje morskih biljaka i njihovih zajednica. Od usvajanja europske „Okvirne direktive o vodama” (*Water Framework Directive*, WFD 2000/60/EC) znanstvena zajednica je radila na razvoju novih i učinkovitih metoda za procjenu ekološkog stanja morskih ekosustava uz pomoć biljaka kao bioindikatora. Morska cvjetnica *Posidonia oceanica* je široko rasprostranjena vrsta vrlo osjetljiva na poremećaje u okolišu i često se upotrebljava kao bioindikator kvalitete mora. U ovom radu korišten je multivarijantni POMI indeks (*Posidonia oceanica Multivariate Index*) koji koristi statističku analizu fizioloških, morfoloških, strukturnih i obilježja zajednice povezanih s kvalitetom morskog okoliša. Korištenje više različitih pokazatelja omogućuje učinkovit monitoring stanja okoliša jer također daje podatke o izvorima poremećaja, što uvelike pomaže doseći ciljeve koje postavljaju agencije za upravljanje vodama. Podaci o pokazateljima stanja livada vrste *Posidonia oceanica* sakupljeni su tijekom 2007. i 2008. godine na 18 postaja u srednjem Jadranu, u obalnom i otočnom području, duž pretpostavljenog gradijenta onečišćenja. Rezultati pokazuju ekološko stanje na postajama, koje je u skladu s našim stručnim mišljenjem, terenskim i objavljenim podacima. Prikazat će se prednosti i nedostaci POMI metode pred drugim sličnim indeksima i dati preporuke za budući program monitoringa u Jadranskom moru.



SEAGRASS *POSIDONIA OCEANICA* AS BIOINDICATOR OF WATER QUALITY IN THE CENTRAL ADRIATIC SEA

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A clear link exists between specific responses of marine plants and associated ecosystem and human-induced disturbances. Since the publication of the European Water Framework Directive (WFD 2000/60/EC), scientific community has developed new and improved methods to assess the ecological status of ecosystems using marine plants as bioindicators. The seagrass *Posidonia oceanica*, a widely distributed species and very sensitive to disturbance is often used as a bioindicator of water quality. For this study, we used the multivariate POMI index (*Posidonia oceanica* Multivariate Index), based on the statistical analysis of physiological, morphological, structural and community level descriptors related to the environmental quality. The combination of different metrics in one index allows an effective monitoring of environmental status because it also gives data on the sources of disturbance which greatly helps to achieve the management goals set by policy makers. Data on *Posidonia oceanica* descriptors were collected in 2007 and 2008 on 18 sites in the central Adriatic Sea, in the coastal and insular areas, along a potential gradient of pollution. The results show the classification of stations (from bad to high ecological status) which is in accordance with our expert opinion, field knowledge and existing data. Strengths and weaknesses of the POMI method in comparison to other indices based on *Posidonia oceanica* are discussed and recommendations for the future monitoring in the Adriatic Sea are proposed.



EPIFITSKI I TERIKOLNI LIŠAJEVI GORSKOGA KOTARA

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Prema podacima prikupljenim iz literaturnih izvora, herbarija u Hrvatskoj i inozemstvu, kao i terenskim istraživanjem na 30 lokaliteta u razdoblju između 2000. i 2002. godine, floru epifitskih i terikolnih lišajeva Gorskoga kotara čini 186 svojti, svrstanih u 89 rodova liheniziranih gljiva. Zabilježeno je devet novih svojti za lišajsku floru Hrvatske te 24 za Gorski kotar. Značajna floristička sličnost utvrđena je između Gorskoga kotara i dinarskog područja Slovenije. Lišajevi istraživanog područja rastu na 27 različitih organskih i anorganskih podloga. Glavni nositelji epifitskih lišajeva su gorski javor (84 svojte), obična jela (74), obična bukva (69) i gorski brijest (25). Na mahovinama rastu 33 svojte, dok ih je 27 vezano za tlo. Ekološke značajke lišajske flore utvrđene su primjenom indikatorskih vrijednosti za sljedeće faktore: reakcija podloge, svjetlost, vlažnost i eutrofikacija. Prema raspodjeli lišajeva zabilježenih po glavnim vegetacijskim zonama u Gorskom kotaru, najveća je raznolikost, 137 svojti, utvrđena u zoni bukovo-jelovih šuma, osrednja u zoni brdskih bukovih šuma (91), a najmanja u zoni pretplaninskih smrekovih i bukovih šuma te klevovine bora (75 svojti). U lišajskoj flori Gorskoga kotara 46 svojti ili 24,7% pripada oceansko/suboceanskim elementima. Tako visok udio odražava reljefne i klimatske specifičnosti istočnojadranske obale, gdje je izražena perhumidna klima s velikim količinama oborina (od 1000 do iznad 3000 mm godišnje). Epifitska lišajska sveza *Lobarion pulmonariae*, indikator starih i očuvanih šumskih ekosistema, koja je nestala ili ugrožena u većem dijelu Europe, još uvijek je prisutna u Gorskom kotaru, mjestimično u optimalnoj kondiciji.



EPIPHYTIC AND TERRICOLOUS LICHENS OF GORSKI KOTAR

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According to data from literature sources, herbaria in Croatia and abroad, and field investigation carried out at 30 localities in the period 2000-2002, the epiphytic and terricolous lichen flora of Gorski kotar consists of 186 taxa, classified into 89 genera of lichenized fungi. Nine taxa are new records for the lichen flora of Croatia, and 24 for Gorski kotar. A noticeable floristic similarity was determined between Gorski kotar and Dinaric region in Slovenia. Lichens of the study area growth were on 27 various organic and inorganic substrates. Main trees supporting epiphytic lichens are: sycamore (84 taxa), common fir (74), common beech (69), and wych elm (25). Growing on mosses were recorded 33 taxa, while 27 growths on soil. The ecological characterization of the lichen flora was determined analyzing the indicator values for the following factors: substrate reaction, light, moisture and eutrophication. Based on lichen distribution according to main vegetational zones in Gorski kotar, the highest diversity, 137 taxa, is confirmed in zone of beech and fir forests. Moderate diversity (91 taxa) is in zone of montane beech forests, while the lowest diversity (75 taxa) is in zone of subalpine spruce and beech forests and mountain pine forests. In the lichen flora of Gorski kotar, 46 taxa or 24.7% belongs to the oceanic and suboceanic elements. Such high percentage reflects relief and climate specificities of the eastern Adriatic coast, where the perhumid climate with high amount of precipitation (from 1,000 mm up to more than 3,000 mm annual) is pronounced. The epiphytic lichen alliance *Lobarion pulmonariae*, an indicator of old and conserved forest ecosystems, which is extinct or endangered across the Europe, is still present in Gorski kotar, on some places in optimal conditions.



HISTORICAL WEED ASSEMBLAGE, RECONSTRUCTED ON THE BASIS OF SEEDS, STORED IN COTTAGE BUILDING MATERIAL FROM 19TH CENTURY

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Desiccated seeds or fruits were used in order to evaluate qualitatively and quantitatively the weed vegetation present in traditional Central-European agricultural landscape of the second half of the 19th century. In this study an original source for desiccated seed and fruits was found, which could represent a paleophytocenosis of segetal and ruderal weed vegetation in the ancient agricultural landscape. We assume that due to known technique, which usually provide straw and chaff from nearby fields, and documented datation of the sampled building, we could apply the qualitative and quantitative results of excavated seeds more or less directly to a species composition of the weed vegetation at that time. 7646 seeds or fruits were excavated from 100 kg of loam, chaff and straw that had been used as building material of cob cottages in Prekmurje region (NE Slovenia). About 7100 of these were wild plants, while only 126 belonged to cultivated/escaped species (cereals excluded). The seeds or fruits belonged to 89 taxa and most of them were attributed to weeds and ruderals. A comparison with current conservation status of species found in the region showed that some of the weeds, such as *Agrostemma githago*, *Anthemis cotula*, *Centaurea cyanus*, *Kickxia elatine*, *Papaver dubium* and *Ranunculus arvensis*, are strongly declining species, nowadays rare and threatened on national and regional level. The seeds, stored in cottages offer also a quantitative perspective, not comprised in e.g. herbarium or literature sources: the highest quantity of seeds belongs to grasses (*Setaria pumila*, *Setaria viridis*, *Agrostis tenuis*), *Polygonaceae* and *Chenopodiaceae* are also strongly represented with some hundreds seeds. *Corydalis cava* with more than 500 seeds was a surprise to be found together with chaff and straw, because it is a forest species. Also *Myosotis arvensis* was present with 456 seeds; today it is not abundant weed in the region. On the contrary, some weeds or ruderals, which are very common in the present agricultural landscape (*Erigeron annuus*, *Galinsoga ciliata*, *Ambrosia artemisiifolia* etc.), were not found in the material. They are neophytes, not yet present at the time when the seeds were captured in building material. One species, *Paronychia cephalotes*, was found, which has not been recorded before on Slovenian territory. Its origin is discussed in the study. The plant material stored in the building material of the cottage, gives us insight into the vegetation assemblages of arable land before the development of more intensive tillage and cultivation in the second half of the 20th century, which dramatically changed the Central-European agricultural landscape.



ADVENTIVE WEED FLORA IN HERZEGOVINA (BOSNIA AND HERZEGOVINA)

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From total of 192 weed species found in Herzegovina (Bosnia and Herzegovina), 13 or 6.78% was from cultivated and adventitious plants: *Amaranthus retroflexus*, *Spinacia oleracea*, *Ambrosia artemisiifolia*, *Erigeron annuus*, *Erigeron canadensis*, *Helianthus annuus*, *Lactuca sativa*, *Cucumis sativus*, *Cucurbita pepo*, *Vicia faba*, *Solanum tuberosum*, *Avena sativa* subsp. *sativa* and *Hordeum distichon*. From those species, eight (61.54%) coming with cultivated plants and rarely were spread out of cultivated field, five (34.46%) are adventitious, neophytes. Those neophyte are constantly spread and become naturalised part of the nature and anthropogenic communities.



FLORISTIC AND FUNCTIONAL COMPARISON OF ILLYRIAN SUB-MEDITERRANEAN DRY GRASSLANDS OCCOURING ON TWO CONTRASTING GEOLOGICAL SUBSTRATES

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The aim of the study was to test the impact of different geological bedrock on the relative proportions of single components of the C-S-R plant strategies and on other selected functional traits in Illyrian sub-Mediterranean grasslands. Study area was Primorski kras (Littoral Karst) and Slovenian part of Istria. Floristic and functional approach was compared for the response of the two contrasting geological bedrock, one neutral or slightly acid, fresh and relatively humid (flysch) and another dry, warm and alkaline (limestone). We actually compared two different types of sub-Mediterranean Illyrian grasslands of the association *Danthonio-Scorzoneretum villose* (alliance *Scorzonerion villosae*, order *Scorzoneretalia villosae*, class *Festuco-Brometea*). We analysed matrix of 30 relevés, sampled in both geological bedrock, comprising 119 species and matrix with 18 traits determined for 119 plant species. The DCA ordination, based on species x relevés matrix, revealed that relevés from limestone and flysch are clearly divided in two groups according to the geology. First DCA axis suggested a gradient of soil humidity and pH. Ordination of 119 species, based on selected traits, showed that 5 Plant Functional Types emerged. Ordination of relevés on the basis of plant functional traits (relevés x traits matrix) revealed that samples from limestone are separated from those taken on flysch substrate also with functional approach: along the ordination axis they positively correlated with the traits - type of reproduction Rep3 (by seed and vegetatively), competitors (C), herbs (Gherb) and rhizomes (Rhiz), which means that relevés from limestone tend to have bigger shares of competitors, herbs and species which propagate by seed and vegetatively. But these differences we consider as minor. The results of C-S-R strategy are showing relative importance of C component (competition). However, the positions of all relevés in standard C-S-R ternary diagram showed that the relative proportions of C-S-R functional types are not influenced by different geological bedrock.



VERTIKALNA DISTRIBUCIJA FITOPLANKTONA VISOVAČKOG JEZERA, NP „KRKA”

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Jezero Visovac je krško, monomiktički stratificirano riječno jezero, smješteno na SZ dijelu Dinarida (Hrvatska). Vrijeme retencije tijekom zimskog razdoblja iznosi oko 14 dana, dok ljeti, pri manjem protoku vode, iznosi oko 71 dan. U sklopu ekoloških istraživanja područja Nacionalnog parka „Krka”, na vertikalnom profilu Visovačkog jezera istraživana je distribucija fitoplanktona, kao i neki fizikalno-kemijski parametri. Uzorkovanja su provedena jednom mjesečno, u razdoblju od travnja do rujna 2009. Uzorci su uzimani na dubinama od 1, 10 i 20 m. Apsolutna učestalost fitoplanktonskih vrsta (broj stanica/L) dobivena je metodom po Uthermohlu, a biomasa je za svaku vrstu izračunata koristeći standardne formule za biovolumen, te mjerenja dobivena upotrebom programa za mikroskopiranje. Maksimalna ukupna brojnost fitoplanktona tijekom istraživanja utvrđena je u površinskom sloju ($8,7 \times 10^3$ stanica/L) i linearno se smanjuje prema dubljim slojevima. Ukupna biomasa na dubinama od 1 i 10 m iznosi 4,2 mg/L, a najmanja je na dubini od 20 m (2,7 mg/L). Izrazita vršna vrijednost (broj stanica/L i biomasa mg/L) zabilježena je u srpnju. U epilimniju i metalimniju utvrđena je izrazita dominacija biomase vrste *Cyclotella trichonidea* Ec.-AM, tijekom istraživanih mjeseci (0,07 – 0,90 mg/L), izuzev u travnju, kad u epilimniju dominira vrsta *Dinobryon divergens* O. E. Imhof (0,01 mg/L), a u metalimniju *Peridiniopsis cunningtonii* (Lemmermann) Popovsky & Pfister (0,02 mg/L). U hipolimniju tijekom travnja dominira vrsta *Melosira varians* C.Agardh (0,01 mg/L), u svibnju *Gonatozygon* sp. (0,02 mg/L), u rujnu *Gomphosphaeria lacustris* Chod (0,03 mg/L), dok je u lipnju, srpnju i kolovozu utvrđena dominacija vrste *Cyclotella trichonidea* Ec.-AM (0,1-1,0 mg/L). Koristeći multimetrički sustav *PhytoSee* ver. 3, izračunati PSI indeks iznosi 0,734. Procjena ekološke kakvoće (EK) temeljena na fizikalno-kemijskim parametrima i fitoplanktonu kao BQ pokazatelju (prema ODVu) ukazuje na 5. klasu kvalitete ili vrlo dobro stanje.



VERTICAL DISTRIBUTION OF PHYTOPLANKTON IN LAKE VISOVAC, NP KRKA

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Lake Visovac is a travertine, monomictic stratified riverine lake, situated in NW Dinarid Mountains region (Croatia). Retention time during winter period is about 14 days and in summer, at a lower water flow, about 71 days. Vertical distribution of phytoplankton, together with some physical and chemical parameters of Lake Visovac was investigated during the ecological research in National Park Krka. Samples were taken once a month in a period from April to September 2009. Water samples were taken at 1, 10, and 20 meters depths. Cell counts were obtained with the OLYMPUS CKX41 inverted microscope following Uthermohls method, and biomass was calculated for each species using standard biovolume formulas and measures obtained using microscope software. Highest phytoplankton abundance (number of cells/L) was observed at 1 m depth, and it linearly decreased towards the deeper layers. Total biomass at the depths of 1 and 10 m was 4.2 mg/L, and lowest was observed at 20 m (2.7 mg/L). During the investigated period at depths of 1 and 10 m a distinct biomass dominance of species *Cyclotella trichonidea* Ec.-AM (0.07 - 0.90 mg/L) was found with exception in April when *Dinobryon divergens* Imhof OE (0.01 mg/L) dominated at 1 m depth, and *Peridiniopsis cunningtonii* (Lemmermann) Popovsky & Pfiester (0.02 mg/L) at 10 m. In a deeper part (20 m) of the lake dominance of *Melosira varians* C. Agardh (0.01 mg/L) was observed in April, in May dominance of *Gonatozygon* sp (0.02 mg/L), in September dominance of *Gomphosphaeria lacustris* Chod (0.03 mg/L) while in June, July and August, the dominance of species *Cyclotella trichonidea* Ec.-AM (0.1-1.0 mg/L) was established. PSI index was 0.734 and it was calculated using a multimetric assessment system PhytoSee ver. 3 for phytoplankton in lakes. Assessment of environmental quality (EC) based on physico-chemical parameters and phytoplankton as BQ indicator (according WFD) points on class quality 5 or very good condition.



HERBACEOUS PERIWINKLE, *VINCA HERBACEA* WALDST. ET KIT. (APOCYNACEAE), A NEW SPECIES OF THE CROATIAN FLORA

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Populations of herbaceous periwinkle, *Vinca herbacea* Waldst. et Kit., were found on Bansko Hill (Baranja, Croatia) in April 2007. This species was not included in the current Croatian flora database. It occurs on Bansko Hill on the south-western limit of its Pontic-Pannonian distribution area. There are two other native periwinkle species occurring in Croatia: *V. major* and *V. minor*, therefore a new key for determination of *Vinca* L. species was made. Morphological features were described by measurements completed on specimens from Hungary, Serbia and Croatia. The most useful differential features of periwinkles in vegetative stage are the width of leaves, the ratio of the length to the width of leaves (Lr) as well as the length of internodes. According to our results, the greatest Lr value is counted (measured) on *V. herbacea* leaves (Lr = 4-5), then on *V. minor* (Lr = 2), and lastly on leaves of *V. major* Lr = 1.5-2. The length of *V. herbacea* and *V. minor* leaves was not significantly different, but the leaves of *V. minor* were 2-3 times wider than those of *V. herbacea*. The longest internodes were at plants of *V. minor*, the shortest at *V. herbacea* specimens. Considering the low number of individuals, the small extension of its occurrence on extremely rare habitats on the margin of its distribution, the herbaceous periwinkle should be treated as a critically endangered (CR) species in Croatia.



BILJNA RAZNOLIKOST U MASLINICIMA NA PODRUČJU TRIBUNJ - VODICE

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Tijekom istraživanja raznolikosti flore maslinika na području Tribunj-Vodice zabilježeno je ukupno 269 svojti vaskularnih biljaka razvrstanih u 175 rodova i 52 porodice. S najvećim brojem svojti ističu se *Fabaceae* (36) i *Poaceae* (32), koje zajedno čine 25,28% ukupno zabilježene flore maslinika, za kojima po broju svojti slijede porodice *Cichoriaceae*, *Asteraceae*, *Caryophyllaceae*, *Lamiaceae*, *Brassicaceae* i *Liliaceae*. Istraživanjem je utvrđeno i nekoliko vrsta navedenih u „Crvenoj knjizi vaskularne flore Hrvatske”. Iz kategorije ugroženih (EN) vrsta *Delphinium peregrinum* L. te tri vrste iz kategorije osjetljivih ili ranjivih (VU): *Ophrys bertolonii* Moretti, *Ophrys sphegodes* Mill. te *Trifolium repens* L. Od endemičnih svojti zabilježene su: *Anthyllis vulneraria* L. ssp. *praepropera* (A. Kerner) Bornm., *Aurinia sinuata* (L.) Griseb., *Carduus micropterus* (Borbás) Teyber ssp. *micropterus*, *Centaurea spinosociliata* Seenus, *Chaerophyllum coloratum* L. i *Trifolium dalmaticum* Vis. Usporedbom flore maslinika održavanih različitom obradom utvrdilo se da su maslinici održavani košnjom raznolikiji florom (235 svojti), endemima i vrstama ugroženima prema „Crvenoj knjizi”. U maslinicima održavanim okopavanjem zabilježeno je 150 svojti, od čega i dvije invazivne vrste (*Amaranthus retroflexus* L. i *Bidens subalternans* DC.). Analiza životnih oblika i flornih elemenata pokazala je dominaciju terofita i biljaka mediteranskog flornog elementa, što je usporedivo s istraživanjima flore u regiji i na Sredozemlju. Provedena istraživanja pokazuju da jačanjem antropogenog utjecaja (okopavanje tla) raste zastupljenost terofita, kultiviranih i adventivnih biljaka, a opada zastupljenost autohtonih biljaka, naročito biljaka mediteranskog i južnoeuropskog flornog elementa. Flora košenih maslinika značajna je zbog održavanja autohtone flore, endema i ugroženih vrsta te je ovakav način održavanja bolji za biološku raznolikost i očuvanje pedosfere.



PLANT DIVERSITY IN THE OLIVE ORCHARDS IN TRIBUNJ – VODICE AREA

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During research of flora diversity in the olive orchards in Tribunj–Vodice area total of 269 taxa of vascular plants belonging to 175 genera and 52 families have been observed. With largest number of taxa *Fabaceae* (36) and *Poaceae* (32) families together represents 25.28% of total registered flora. *Cichoriaceae*, *Asteraceae*, *Caryophyllaceae*, *Lamiaceae*, *Brassicaceae* and *Liliaceae* succeed them with the number of registered taxa. Several taxa listed in the Red Book of Croatian flora are registered during the investigation, one endangered (EN) *Delphinium peregrinum* L. and three vulnerable (VU) species: *Ophrys bertolonii* Moretti, *Ophrys sphegodes* Mill. and *Trifolium resupinatum* L. Furthermore six endemic taxa has been recorded, namely: *Anthyllis vulneraria* L. ssp. *praepropera* (A. Kerner) Bornm., *Aurinia sinuata* (L.) Griseb., *Carduus micropterus* (Borbás) Teyber ssp. *micropterus*, *Centaurea spinosociliata* Seenus, *Chaerophyllum coloratum* L. and *Trifolium dalmaticum* Vis. Therophytes are prevailing among life forms as well as plants of the Mediterranean floral elements what is similar to results obtained during investigations of flora in the neighboring region and in Mediterranean. It was observed that olive orchards managed by mowing was richer in flora (235 species and subspecies), including higher number of endemic and endangered species in comparison to 150 species and subspecies that was recorded in tilling managed olive orchards, with two of them being invasive i. e. *Amaranthus retroflexus* L. and *Bidens subalternans* DC. Results implicate that percentage of therophytes and cultivated and adventitious plants is increasing with human impact while the percentage of the Mediterranean and South-European plants is decreasing. Hence, the flora of mowed olive orchards is crucial for the preservation of the autochthonous flora, endemic and endangered species, making this way of management much better for conservation of the biological diversity and pedosphere protection.



ANTIBACTERIAL AND ANTIOXIDANT ACTIVITY, TOTAL PHENOL AND FLAVONOID CONTENTS OF *ACINOS ALPINUS* (L.) MOENCH EXTRACTS

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Antibacterial, antioxidant activity and total phenolic and flavonoid contents were determined in acetone, ethyl acetate and ethanolic extracts from whole plant of *Acinos alpinus* using spectrophotometric methods. Rock thyme, *Acinos alpinus* L. Moench (*Lamiaceae*) is a perennial herbaceous plant with crawling branches stems, up to 50 cm high and inhabits thermophilic rocks, dry mountain meadows and sparse forests in southern Europe. Plant material was collected from the Mt. Goč in central Serbia. Antimicrobial activity of *A. alpinus* extracts was tested by microdilution method and both minimum inhibitory (MIC) and microbicidal concentration (MMC) was determined. The tested extracts demonstrated significant antibacterial activity against pathogenic bacteria *Staphylococcus aureus* ATCC (MIC = 0.625) and *Bacillus subtilis* (MIC from 0.31 to 0.625 mg/ml). On the other hand, the extracts demonstrated moderate antibacterial activity against pathogenic bacteria *Escherichia coli* ATCC 259.2, *Pseud. aeruginosa* ATCC 27853, *Enterococcus faecalis*, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Proteus mirabilis*. Antioxidant activity of extracts was determined using DPPH reagent and expressed as IC_{50} values ($\mu\text{g/ml}$). Values of activity ranged from 501.25 $\mu\text{g/ml}$ to 39.48 $\mu\text{g/ml}$. The phenolic content of the different *A. alpinus* extracts was carried out according standard colorimetric method using Folin-Ciocalteu reagent. Obtained values ranged from 30.27 mg/g to 157.81 mg/g of dry weight of extract, expressed as gallic acid equivalents. The total flavonoid content was evaluated spectrophotometrically using aluminium chloride. The values of total flavonoid content varied from 33.18 mg/g to 135.91 mg/g expressed as rutin equivalents. In comparison to IC_{50} values of chlorogenic acid as reference substance, ethanolic extract of *A. alpinus* possesses strong antioxidant activity ($IC_{50} = 39.48 \mu\text{g/ml}$) and also has highest content of phenolic compounds (157.81 mg/g) and flavonoids (135.91 mg/g). Acetone extract contains very low concentrations of phenolic compounds and flavonoids. Obtained values indicate that the ethanolic extract from *A. alpinus* could be important natural source of phenolic compounds with high antibacterial and antioxidant capacity. The presented results suggest that plant antimicrobial substances and antioxidants could be useful and merit further investigations in the treatment and prevention of inflammatory and some degenerative disease.



**RAZVOJ, KARAKTERIZACIJA I UNAKRSNO
UMNOŽAVANJE MIKROSATELITNIH BILJEGA
LJEKOVITE KADULJE (*SALVIA OFFICINALIS* L.,
LAMIACEAE)**

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Ljekovita kadulja (*Salvia officinalis* L.) prirodno je rasprostranjena na području središnje Španjolske, južne Francuske i zapadnog dijela Balkanskog poluotoka. Zbog svojih ljekovitih i aromatskih značajki često se sakuplja iz prirodnih populacija. Procjena genetske raznolikosti upotrebom molekularnih biljega je početak njezina uvođenje u program oplemenjivanja i poljoprivrednu proizvodnju. Jedanaest novih mikrosatelitnih biljega razvijeno je iz knjižnice genomske DNA obogaćene GA i GT ponavljajućim motivima. Upotrebom razvijenih mikrosatelitnih biljega istražena je genetska raznolikost 25 jedinki ljekovite kadulje iz jedne prirodne populacije s istočne obale Jadrana. Ukupno su određena 142 alela na 11 lokusa, a broj alela po lokusu se kretao od osam do 26. Uočena heterozigotnost kretala se od 0,300 do 0,833, a očekivana od 0,666 do 0,934. Od 11 mikrosatelita, njih sedam je pokazivalo informacijski sadržaj polimorfizma (PIC) viši od 0,75, što upućuje na to da su ti mikrosatelitni biljezi vrlo vrijedni za procjenu genetske raznolikosti i populacijske strukture. Svih 11 mikrosatelitnih biljega je provjereno na mogućnost unakrsnog umnožavanja kod četiri dodatne vrste kadulje, te kod vrste *Rosmarinus officinalis* L.. Najuspješnije umnožavanje bilo je kod vrste *Salvia fruticosa* Mill. (60%), dok je kod ostalih testiranih vrsta stopa umnožavanja bila: 25% kod vrste *S. pratensis* L., 20% kod vrste *S. sclarea* L., 20% kod vrste *S. verticillata* L. te 20% kod vrste *Rosmarinus officinalis* L.



DEVELOPMENT, CHARACTERIZATION AND CROSS-AMPLIFICATION OF MICROSATELLITE MARKERS FROM COMMON SAGE (*SALVIA OFFICINALIS* L., LAMIACEAE)

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The common sage (*Salvia officinalis* L.) is a native plant of northern and central Spain, southern France and western part of the Balkan Peninsula. Because of its medicinal and aromatic characteristics it is often gathered from the wild. The assessment of genetic diversity using molecular markers is a starting point for its introduction into plant breeding programs and agricultural production. Eleven new microsatellite markers were developed from genomic DNA libraries enriched for GA and GT repeats. 25 common sage plants from a natural population from the eastern Adriatic coast were examined for polymorphism using the developed microsatellites markers. A total of 142 alleles were observed across eleven loci, the number of alleles per locus ranged from eight to 26. The observed heterozygosity ranged from 0.300 to 0.833, and the expected heterozygosity from 0.666 to 0.934. Out of eleven microsatellites, seven showed high polymorphic information content (PIC) of more than 0.75 indicating that these microsatellite markers are very useful in assessing genetic diversity and population structure. All eleven microsatellite markers were tested for cross-amplification in four different *Salvia* species and *Rosmarinus officinalis* L. The species with most successful amplification was *Salvia fruticosa* Mill. (60%), while in other tested species, amplification rate was: 25 % for *S. pratensis* L., 20% for *S. sclarea* L., 20% for *S. verticillata* L. and 20% for *R. officinalis* L.



HOROLOGY, ECOLOGY AND CONSERVATION OF GREEN ALDER (*ALNUS VIRIDIS* (CHAIX) LAM. ET DC. SSP. *VIRIDIS*) IN SERBIA AND BOSNIA AND HERZEGOVINA

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Green alder (*Alnus viridis*) is holarctic species whose typical subspecies inhabits the mountain of central and southern Europe (Alps, Carpathes and Balkans mountains). In the area of the Balkan Peninsula, this species is relatively rare, and was recorded on mountains Vranica (Bosnia and Herzegovina), Šar Planina (Macedonia), Stara Planina (Serbia and Bulgaria), Vitosha, Rila, Western Rhodope Mountains and others (Bulgaria). The aim of this study was to determine the status, endangered and fitocenological affiliation of populations of green alder. On the territory of Bosnia and Herzegovina green alder is known for mountain Vranica, while in Serbia widespread in several localities in the Stara Planina (Kopren, Tri Čuke, Žarkova Čuka). This species forms vegetation that belonged to the class *Betulo-Adenostyletea*, *Adenostyletalia* order and *Adenostylian alliariae* alliance. Applying the IUCN threat category was determined that this taxon belongs to the representatives of the critically endangered flora.



MONITORING VODENIH MAKROFITA VRANSKOG JEZERA

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Detaljnija istraživanja makrofitskih vodenih biljaka na području Parka prirode „Vransko jezero” provedena su tijekom 2003., 2008. i 2009. godine u suradnji s upravom Parka prirode „Vransko jezero”. Podaci o staništu i biljkama prikupljeni su iz čamca i s kopna u vodi Vranskog jezera, ulaznim kanalima u Vransko jezero (Glavni i Lateralni), području Prosike i Jugovira, obalnom dijelu Živače, te Pećini kod Vrane. Za potrebe inventarizacije i praćenja stanja izvršeno je geokodiranje pomoću GPS uređaja, uporabom Gaus-Krügerove projekcije. Cilj rada bio je analizirati sastav i pokrovnost makrofitskih vodenih biljaka Vranskoga jezera, usporediti stanje u odnosu na 2003. te načiniti prijedlog daljnjeg monitoringa. Analiza biljaka obuhvaća, osim popisa vrsta, taksonomsku analizu, zastupljenost vrsta na pojedinim postajama, analizu životnih oblika, ekološku i fitogeografsku analizu. Ustanovljena je ukupno 61 svojta. Podjednako su zastupljene dvosupnice (49,19%) i jednosupnice (45,91%), a najmanje papratnjače (3,28%) i alge (1,62%). Na istraživanom području najviše je hemikriptofita (45,91%), zatim hidrofita (27,87%), geofita (18,03%) i fanerofita (4,91%), dok je najmanje terofita (3,28%). Zastupljeno je devet ekoloških klasa prema Hejný-ju. Prve tri skupine, tipični hidrofiti, čine 42,67%. Prevladavaju biljke široke rasprostranjenosti i kozmopoliti, dok je samo pet svojti uže rasprostranjenosti. Kritično ugrožena svojta je *Hydrocotyle vulgaris* L., ugrožena je *Hippuris vulgaris* L., dvije svojte su osjetljive (*Cyperus fuscus* L. i *Cyperus longus* L.), dok je *Scirpus holoschoenus* L. gotovo ugrožena svojta. Na većini lokaliteta se smanjio broj svojti. Najmanje promjena u broju i pokrovnosti svojti izraženo je na lokalitetima gdje prevladavaju tršćaci, koji su plavljeni za viših vodostaja. U 2008. i 2009. godini nisu zabilježene vrste *Utricularia australis* R. Br. i *Hippurus vulgaris* L., dok 2008. godine vrsta *Najas marina* L. izostaje na većini lokaliteta i pokrovnost joj je znatno manja nego 2003. Monitoring vodenih makrofita potrebno je provoditi kako bi se istražile promjene koje ukazuju na stanje vodenog ekosustava (stupanj eutrofizacije, stupanj onečišćenja i dr.).



MONITORING OF AQUATIC MACROPHYTES OF THE VRANSKO LAKE

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Detailed exploration of aquatic macrophytes in the area of Nature Park Vransko Lake has been carried during the years of 2003, 2008 and 2009, in cooperation with the administration of the Park. The data about the habitat and plants have been collected from the boat and land in the water of Vransko Lake and entrance channels into the lake (Main and Lateral), in the area of Prosika and Jugovina, in the coastal part of Živača and also in Pećina near Vrana. For the purpose of inventorying and monitoring the data were geocoded using GPS device and Gaus-Krüger projection. The aim of the work was to analyse the species composition and cover of the aquatic macrophyte plants of the Vransko Lake, compare the current status to the 2003 and prepare a proposal for further monitoring. Plant analysis included beside species list, taxonomic analysis, and representation of species on specific stations, life form analysis, ecological and phytogeographic analysis. In total, 61 species have been identified. Equally were present dicotyledons (49.19%) and monocotyledons (45.91%) and the least ferns, (3.28%) and algae (1.2%). In the explored area the most represented are hemicryptophytes (45.91%), then hydrophytes (27.87%), geophytes (18.03%), phanerophytes (4.91%) and the least therophytes (3.28%). Nine ecological classes in accordance with Hejný were present. First three groups, typical hydrophytes make 42.67%. Widely distributed plants and cosmopolites prevail, while only five taxa are of a more narrow distribution range. Critically endangered species is *Hydrocotyle vulgaris* L and endangered *Hippuris vulgaris* L., also two taxa are vulnerable *Cyperus fuscus* L. and *Cyperus longus* L., while *Scirpus holoschoenus* L. is a nearly threatened species. The number of species in comparison with the year 2003 has decreased on the most of the localities. There was least change in the number and cover of the species on the localities where reeds that are flooded during higher waters prevail. In the 2008 and 2009 *Utricularia australis* R.Br. and *Hippurus vulgaris* L. were not recorded, while *Najas marina* L. was not present on the majority of the localities and the cover is much smaller than in 2003. Monitoring of water macrophytes should be carried out to explore the changes which indicate the status of the water ecosystem (trophic level, level of contamination and other).



THE VEGETATION DIVERSITY PATTERNS OF THE WESTERN BALKANS

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Vegetation diversity (VD) is an important indicator of biodiversity on certain geographic areas. It contains both syntaxonomic and taxonomic diversity. VD means the total number of syntaxa per unit area, or syntaxa level of association in a given dimension of space and time. Each syntaxa precisely determined by floristic composition and ecological conditions of habitats in which to develop (geographic coordinates, aspect and slope, the geological substrate and soil type), and the physiognomy and vertical stratification. For this purpose, a synthetic eco-syntaxonomic approach has been applied to the implementation of necessary data for this study. The basis for this investigation was studies on the vegetation of Bosnia and Herzegovina, Croatia and Montenegro published in accordance with the Code of Phytocoenological Nomenclature. Data were compared with "The Vegetation Diversity of Europe". Based on the obtained data syntaxonomic comparative analysis of all of known types of vegetation of the Western Balkans was performed on the level of associations, alliance, orders and classes. In the interpretation of syntaxonomic diversity the appropriate mathematical and statistical packages were applied. Syntaxonomic diversity of Croatia makes 408 communities, 120 alliances, 61 orders and 42 vegetation classes. Vegetation of Montenegro registered 267 associations, 97 alliances, 53 orders and 37 classes. The vegetation of Bosnia and Herzegovina contains 314 associations, 113 alliances, 60 orders and 33 classes. Very high proportions of these communities were found in the vegetation of Europe. At the European level 928 alliances, 233 orders and 80 classes have been adopted so far. At all levels and all of the above geographical areas non-forest anthropogenic communities (60%) dominated. Special centres have been established as the floristic and vegetation diversity, such as endemic development centres on the dominant karst geological background. Some of them are: the Prenj-Čvrstica-Čabulja Mts. in Herzegovina, and silicate Vranica Mt. in central Bosnia. In the area of endemic development centre in Herzegovina more communities of alliance, order and class level are determined in relation to the whole of Bosnia and Herzegovina. This indicates a high degree of correlation between the richness of vascular plants, the degree of endemism and syntaxonomic diversity, and diversity of habitats. Syntaxonomic diversity directly depends on the diversity of habitats and ecological niches, altitude, and anthropogenic influences. Syntaxonomic diversity is a valuable indicator of biodiversity richness and the existence of biodiversity hotspots. Therefore, SD can serve as very good instrument for the sustainable management of biodiversity at all levels of its organization.



**NEW FINDINGS OF THE SPECIES *SCABIOSA
SILENIFOLIA* WALDST. ET KIT. (*DIPSACACEAE*)
AT THE BOKOVO MT IN CROATIA**

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The species of *Scabiosa silenifolia* Waldst. et Kit. (Pl. Rar. Hung. 2: 170 (1803-1804)) is endemic Balkan-Apennine species with the center of the range at the Dinarides. The northwestern border of distribution is Notranjski Snežnik in Slovenia, and southeast on Prokletije Mt in Montenegro and Albania. It is known from the mountains of central Apennines. It is most common on the mountains of Bosnia and Herzegovina where it is located and center area of mountainous northwestern Dinarides and continental part. It has never been found in the littoral Dinaric mountains. During the botanical excursion to the Biokovo mountain in the littoral Dinarides, we discovered a species of *Scabiosa silenifolia* s.lat. It was in the first half of August 1998. In later botanical excursion during 2000-2006, the findings of this species were confirmed. Newly habitat is located west of the peak of Sveti Jure (1762 m), at an altitude of about 1500m. The terrain is inaccessible and rocky. It is quite a deep valley ("vrtača"). The exposition is north, and the slope is about 40°. The soil is shallow calcomelanosol and deep regosol. The species of *Scabiosa silenifolia* is quite numerous. In an area of 50 m² cover up to 25% of analyzed surface. In terms of phytocoenology the species at this habitat is a part of xerophyllous variant of subalpine pasture of class *Elyno Seslerietea* Br.-Bl. 1948, order *Edraiantho-Seslerietalia robustae* Redžić 2003 that the colder habitats continues on the boards of order *Seslerietalia tenuifoliae* Horvat 1930. In this habitat is a part of the community of alliance *Seslerio-Edraianthion* Redžić 2003. On other Croatian mountains, species *Scabiosa silenifolia* characteristic species of alliance *Seslerio juncifoliae-Caricion firmae* Trinajstić (= *Seslerion juncifoliae* Horvat 1930 p.p.). In the mountains of BiH Dinarides this species inhabits the wind exposed habitats. At the Biokovo Mt. it is linked to habitats that are sheltered from the wind. Ecologically, they are very similar to habitats of alliance *Festucion bosniacae* Horvat 1930. A comparative morphological analysis of the habit, leaves, and generative organ with populations from other mountain ranges, it was found that the populations are considerably more xerophylleous. The leaves are much narrower and leather. At this level can talk about pronounced variability. This indicates the existence of different subspecies categories. The locality of the species *Scabiosa silenifolia* on Biokovo is extremely important to fully exploring the ecological, biogeographic and taxonomic differentiation of this endemic species.



PARK-ŠUMA "PREDOLAC – ŠIBANICA"

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Park-šuma Predolac – Šibanica istočno od grada Metkovića, proglašena 1968., predstavljala je najočuvaniji šumski kompleks na području delte Neretve. To je područje ugroženo višegodišnjim požarima i erozijom tla, koji su dobrim dijelom uništili šumsku vegetaciju alepskog bora, čempresa i česvine, uz pripadajuću sredozemnu floru. Sedlo između Predolca i Šibanice nekad je bilo značajno za prelet ptica od Hutovog Blata u Bosni i Hercegovini do močvarnih površina na jugozapadu doline Neretve. U ovome se radu analiziraju prirodne i krajobrazne vrijednosti te predlažu mjere zaštite i unaprijeđenja tog vrijednog zaštićenog objekta prirode.



FOREST IN THE PROTECTED AREA "PREDOLAC – ŠIBANICA"

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The forest in the "Predolac – Šibanica", protected area since 1968 and situated in the eastern part of the town of Metković, had previously been the most preserved forest complex in the Neretva Estuary region. However, recently this has changed, it is now endangered by successive fires and severe erosion, which has devastated forest vegetation to a large extent, including: Aleppo Pine, Cypress, Holm Oak and related Mediterranean flora. The mountain ridge between Predolac and Šibanica was once also an important flight path for birds crossing over from "Hutovo Blato" in Bosnia and Herzegovina to the wetland areas in the south west of the Neretva Valley. The article provides an analysis of the natural and landscape values, and recommends protection measures aimed at improving the use of this valuable protected area.



FLORA I VEGETACIJA PRIRODNOG REZERVATA „PANTAN”

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Na 40 ha zaštićenog područja močvare Pantan žive brojne biljne i životinjske vrste. Tijekom istraživanja flore 2006., na području Pantana pronađeno je 358 biljnih vrsta vaskularne flore. Biljne vrste raspoređene su u okviru više močvarno-halofitskih zajednica i to: zajednica jesenske mrižice i modrikastog pelina (*Limonio-Artemisietum coerulescentis* H-ić 1934), zajednica sodne solnjače (*Salsoletum sodae* Pignatti 1953) zajednica tršćaka obične trske (*Phragmitetum australis* W. Koch 1926), zajednice europsko-mediteranskih sitina visokih sitova (*Juncetum maritimo-acuti* H-ić 1934), zajednica primorskog oblića (*Scirpetum maritimi* (Br.-Bl. 1931) R.Tx 1937), dijelovi zajednica livada grmolike caklenjače i slanuške (*Puccinellio festucaeformis* - *Sarcocornietum fruticosae* Br.-Bl. 1931) te različite ruderalne zajednice, koje su nastale različitim antropogenim djelovanjima. Zajednice su mozaično raspoređene u skladu s mozaično raspoređenim ekološkim čimbenicima. Određen broj vrsta su pridošlice, invazivne vrste koje su dospjele na različite načine s drugih kontinenata. Među istraženim vrstama ima zaštićenih, ugroženih i endemičnih vrsta.



FLORA AND VEGETATION OF PANTAN PROTECTED AREA

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Pantan area is protected swamp of 40 ha, rich in plant and animal species. During 2006, in flora and vegetation research it was determined 358 plant species of vascular flora according to the standard floristic keys. The species are distributed among several salt marsh communities like *Limonio-Artemisietum coeruleuscentis* H-ić 1934, *Salsoletum sodae* Pignatti 1953, *Phragmitetum australis* W. Koch 1926, *Juncetum maritimo-acuti* H-ić 1934, *Scirpetum maritimi* (Br.-Bl. 1931) R.Tx 1937, and parts of communities of *Puccinellio festucaeformis* – *Sarcocornietum fruticosae* Br.-Bl. 1931 as well as different ruderal communities developed under anthropogenic influence. Determined plant communities were distributed in mosaic way, in correspondence with mosaic distribution of ecological factors. Certain numbers of determined species are newly introduced, invasive species brought from other continents. Some of the determined species are protected, endangered and endemic Croatian species.



ALOHTONE BILJKE U SPLITU

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Istraživanjem urbane flore Splita utvrđene su 842 vrste i podvrste vaskularnih biljaka. Najveći broj biljnih svojti pripada porodici *Asteraceae* i *Poaceae*. Analizom flornih elemenata utvrđena je najveća zastupljenost mediteranskog flornog elementa (36,2%), a od životnih oblika dominiraju terofiti (37,8%). U okviru urbane flore utvrđeno je 125 alohtonih biljaka (15%), među kojima prevladavaju neofiti s 63 biljne vrste (8%), što ujedno odgovara i udjelu neofita za druge mediteranske gradove. Najveći broj neofita, 40 vrsta, potječe iz Amerike. Najčešći neofiti u urbanoj flori Splita su: *Ailanthus altissima*, *Amaranthus retroflexus*, *A. cruentus*, *A. viridis*, *Artemisia verlotiorum*, *Aster squamatus*, *Bidens subalternans*, *Broussonetia papyrifera*, *Chenopodium ambrosioides*, *Chenopodium multifidum*, *Conyza bonariensis*, *C. canadensis*, *Datura innoxia*, *Eleusine indica*, *Erigeron annuus* ssp. *septentrionalis*, *Euphorbia maculata*, *E. prostrata*, *Galinsoga ciliata*, *Helianthus tuberosus*, *Lepidium virginicum*, *Paspalum dilatatum*, *P. paspalodes*, *Phytolacca americana*, *Robinia pseudoacacia* i *Tagetes minuta*. Najveći broj neofita pripada porodicama *Asteraceae* i *Poaceae* te životnom obliku terofita (33 svojte), što odgovara rezultatima sveukupne flore Splita.



ALLOCHTHONOUS PLANTS IN SPLIT

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During the study of the urban flora of Split, we found 842 species and subspecies of vascular plants. High number of taxa had *Asteraceae* and *Poaceae*. The analysis of floristic elements was determined by the majority affiliation Mediterranean floral elements (36.2%), and the life forms dominate therophytes (37.8%). In the urban flora found is 125 allochthonous plants (15.0%), among which neophytes with 63 species (8%), which also corresponds to the proportion of neophytes to other Mediterranean cities. The majority number of neophytes, 40 species, originates from America. The most common neophytes in the urban flora of Split are: *Ailanthus altissima*, *Amaranthus retroflexus*, *Amaranthus cruentus*, *Amaranthus viridis*, *Artemisia verlotiorum*, *Aster squamatus*, *Bidens subalternans*, *Broussonetia papyrifera*, *Chenopodium ambrosioides*, *Chenopodium multifidum*, *Conyza bonariensis*, *Conyza canadensis*, *Datura inoxia*, *Eleusine indica*, *Erigeron annuus ssp. septentrionalis*, *Euphorbia maculata*, *Euphorbia prostrata*, *Galinsoga ciliata*, *Helianthus tuberosus*, *Lepidium virginicum*, *Paspalum dilatatum*, *Paspalum paspalodes*, *Phytolacca americana*, *Robinia pseudoacacia*, *Tagetes minuta*. The majority number of neophytes is the family *Asteraceae* i *Poaceae*, and belongs to the life form therophytes (33 species), which coincides with the results of the total flora of Split.



**PHYLOGENY AND EVOLUTION OF THE NON-
PHOTOSYNTHETIC *OROBANCHE* (*OROBANCHACEAE*)
AND RELATED GENERA**

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In recent years, molecular phylogenetic studies have greatly enhanced our understanding of the phylogenetic relationships of *Orobanche* and related genera. These data suggest splitting *Orobanche* into (at least) four segregates in agreement with previous suggestions based on morphological and karyological evidence. These genera show partly different evolutionary trajectories, e.g., incidence of polyploidy or diversity and evolution of retrotransposons. Irrespective of taxonomic consequences, the phylogenetic framework allows rigorous testing of character evolution, e.g., the evolution of genome size or the correlated evolution of host range and life span. Additionally, *Orobanche* and related genera may show features of general interest, such as the occurrence of horizontal gene transfer.



SADRŽAJ KLOROFILA I SEZONSKA DINAMIKA DUŠIKA U LISTOVIMA HRASTA LUŽNJAKA (*QUERCUS ROBUR* L.)

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Istraživanje je provedeno na 50 jedinki hrasta lužnjaka starosti tri godine. Uzorke su predstavljali listovi različite starosti (od 33 do 161 dana). Listovi su sakupljeni tijekom vegetacijskoga razdoblja 2009., u svibnju, srpnju i rujnu. Sve jedinke prihranjene su gnojivom NPK 15-15-15 na dan 26. ožujka 2009., u dozi od 1500 kg/ha. Uzorkovanim listovima izmjeren je indeks relativnoga sadržaja ukupnih klorofila (CCI) pomoću klorofil-metra CCM-200 (Opti-sciences, Tyngsboro, MA). Sadržaj dušika u uzorcima sakupljenima tijekom svibnja i srpnja, koje su predstavljali listovi starosti 33, 43 i 85 dana, određen je elementarnim analizatorom Leco CNS 2000. Jednostavnom linearnom regresijom određen je odnos između CCI i koncentracije dušika u listovima. Istraživanje je provedeno s ciljem određivanja sadržaja klorofila i dinamike dušika u listovima različite starosti tijekom vegetacijskoga razdoblja, te utvrđivanja međusobnoga odnosa između CCI-a i koncentracije dušika. Rezultati su pokazali kako u svibnju CCI iznosi 19,4, a koncentracija dušika 34,4 mg/g. U srpnju i rujnu CCI raste te iznosi 24,8 (srpanj) i 23,1 mg/g (rujan), dok koncentracija dušika u srpnju lagano opada te iznosi 32,2 mg/g. Sa starošću listova CCI raste, dok koncentracija dušika opada. Odnos između CCI i koncentracije dušika u listovima je signifikantan ($P < 0,001$), kako u svibnju i srpnju, tako i između listova različite starosti. Korelacijska analiza ukazuje kako je 50% varijabilnosti sadržaja dušika moguće predvidjeti pomoću CCI-a u svibnju, te 44% u srpnju. Kod listova starih 33 dana moguće je predvidjeti 46% varijabilnosti sadržaja dušika, kod listova starih 43 dana 49% varijabilnosti, a kod listova starih 85 dana 38% varijabilnosti.



CHLOROPHYLL CONTENT AND SEASONAL DYNAMIC OF NITROGEN IN LEAVES OF PEDUNCULATE OAK (*QUERCUS ROBUR* L.)

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The research was conducted on 50 plants of a 3-year old Pedunculate Oak. The samples were represented by 33 to 161 day-old leaves. The leaves were collected during the vegetative period in May, July and September of 2009. All of the plants were fertilized with N, P, K 15-15-15 fertilizer (1500 kg ha⁻¹) on the 26th of March 2009. The measurements of the relative chlorophyll content index (CCI) in the sampled leaves were taken with the CCM-200 portable chlorophyll meter (Opti-sciences, Tyngsboro, MA). The nitrogen content in the samples collected during May and July, represented by leaves 33, 43 and 85 days old, was determined by using elemental analyzer Leco CNS 2000. Simple linear regression was used in determining the relationship between CCI and nitrogen concentration in the leaves. The research was conducted with the goal of determining chlorophyll content and nitrogen dynamic in different periods of growth during the vegetative period, and also establishing the interrelationship between CCI and nitrogen concentration. The results have shown that CCI values amounted to 19.4 mg/g in May, while nitrogen concentration was 34.4 mg/g. Throughout July and September, CCI grew and amounted to 24.8 (July) and 23.1 mg/g (September), while the nitrogen concentration suffered a slight decline in July and amounted to 32.2 mg/g. As leaves age, the CCI grows, while the nitrogen concentration declines. The relationship between CCI and nitrogen concentration in the leaves was significant ($P < 0.001$) in May and July, as it was for leaves in different periods of growth. Correlation analysis indicates that 50% of nitrogen content variability could be predicted with the help of CCI in May, and 44% in July. With leaves 33 days old, it is possible to predict 46% of nitrogen content variability, with 43 day-old leaves 49% variability, and with 85 day-old leaves 38% variability.



PROGRAM ZAŠTITE *EX SITU* HRVATSKIH ENDEMIČNIH BILJNIH SVOJTI U BOTANIČKOM VRTU BIOLOŠKOG ODSJEKA PMF-A (ZAGREB)

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Dvije najpoznatije hrvatske endemične biljne vrste izabrane su za pokusni program zaštite *ex situ* putem dozvoljenog uzgoja i prodaje u Botaničkom vrtu Biološkog odsjeka Prirodoslovno-matematičkog fakulteta Sveučilišta u Zagrebu. Velebitska degenija (*Degenia velebitica*), poznati simbol hrvatskih planina i bogate hrvatske flore, stenoendemična je vrsta koja raste na kamenjarima, točilima i u pukotinama stijena na nekoliko lokaliteta duž Velebita i Kapele. Zakonom je zaštićena od 1964., a divlje populacije izravno su zaštićene unutar granica Nacionalnog parka „Sjeverni Velebit” i Parka prirode „Velebit”. Unatoč tomu, degenija se smatra ugroženom vrstom zbog nezakonitog sakupljanja biljnih dijelova i sabiranja sjemena, ali ponajviše zbog degradacije njezinih prirodnih staništa. Dubrovačka zečina (*Centaurea ragusina*), također poznati predstavnik hrvatske stenoendemične flore, raste u južnoj Dalmaciji, s najrazvijenijim populacijama na Konavoskim stijenama u blizini Dubrovnika. Poput degenije, dubrovačka zečina je uresna trajnica često sađena na kamenjarima i u mediteranskim vrtovima diljem svijeta. Trajna populacija degenije održava se u Botaničkom vrtu Biološkog odsjeka PMF-a već pedesetak godina, a posljednjih deset godina uzgaja se u pokusnim klijalštima, koja svake godine daju iznimno velik broj vijabilnih sjemenki. Tijekom 2007. i 2008. ishođena je posebna dozvola Uprave za zaštitu prirode pri Ministarstvu kulture RH, za početak programa uzgoja i prodaje, a uzgojeno je tek 10% od dozvoljenog broja, kako bi se istražilo zanimanje javnosti. Većina uzgojenih biljaka ponuđena je na svečanom otvorenju prodajne izložbe i prodana predstavnicima stotinjak osnovnih i srednjih škola iz svih krajeva Hrvatske, a preostale biljke ponuđene su posjetiteljima Vrta. Dubrovačka zečina uzgaja se iz sjemenki sabranih na prirodnim staništima, s ciljem osnivanja trajne vrtno populacije i sjemenskog matičnjaka. Prva prodaja mladih biljaka planirana je 2010. Novčana sredstva pribavljena prodajom ulažu se u razvoj programa i uzgoj novih endemičnih svojti, poput učkarskog zvončića (*Campanula tommasiniana*) i biokovskog zvonca (*Edraianthus pumilio*).



ENDEMIC CROATIAN PLANT SPECIES *EX SITU* CONSERVATION PROGRAMME IN BOTANICAL GARDEN OF THE FACULTY OF SCIENCE IN ZAGREB (CROATIA)

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Two most famous Croatian endemic plant species were selected for the experimental *ex situ* conservation programme through licensed cultivation and sale in the Botanical Garden of the Faculty of Science. Velebit degenia (*Degenia velebica*), generally recognized as a symbol of Croatian mountains as well as rich Croatian endemic flora, is a stenoendemic plant species that grows wild in rockeries, screes and crevices in several spots along the Kapela and Velebit mountains. It enjoys statutory protection since 1964, and wild populations are directly protected within the North Velebit National Park and Velebit Nature Park. Nevertheless, degenia is an endangered plant, suffering from unlawful collecting of specimens or seeds, but mostly as a result of degradation of its natural habitat. Dubrovnik cornflower (*Centaurea ragusina*) is also well recognized member of the Croatian stenoendemic flora, which grows in southern Dalmatia (Croatian Adriatic), with most beautiful populations at the Konavle cliffs near Dubrovnik. Like degenia, it is a popular perennial suited for rockeries and Mediterranean gardens. Permanent population of degenia is being cultivated in the Botanical garden for the last half of century, and two test flower beds were arranged 10 years ago, providing with a large number of germinable seeds that was being used in further experiments and cultivation. Special Licence had to be obtained from the national Nature protection agency before the start of the cultivation programme in 2007, and only 10% of the permitted number of specimens was grown, in order to investigate the purchase interest. Most of the specimens were sold to selected Elementary schools from all Croatian provinces at the Degenia Exhibition opening ceremony, and the rest was available to the public. Dubrovnik cornflower is being cultivated from seeds obtained from natural populations, in order to create large permanent garden population as well as for experimental sale in 2009. Funds obtained from the sales will be invested in the further developing of the programme, with some other endemic plants such as *Campanula tommasiniana* and *Edraianthus pumilio*.



FREE-RADICAL SCAVENGING ACTIVITY, TOTAL PHENOLIC AND FLAVONOID CONTENTS OF DIFFERENT *TEUCRIUM ARDUINI* L. EXTRACTS

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This study determined the concentration of phenolic compounds, flavonoids and *in vitro* antioxidant activity of water, methanolic, acetone, ethyl acetate and petroleum ether extracts, from the whole herb of *Teucrium arduini* L. using standard spectrophotometric methods. Germander, *Teucrium arduini* belongs to the family *Lamiaceae*, subfamily *Ajugoideae* and section *Stachyobotrys*. It is a perennial, low branched species, with half-ligneous stem, oval leaves with softly knobbed brims and compact terminal inflorescence, up 10 to 30 cm high. *T. arduini* is Mediterranean species distributed onli along eastern Adriatic coast. This is a thermophilic species on the category of xerophytes and inhabits arid limestone rocks up to 1000 meters above sea level. Aerial flowering parts of *Teucrium arduini* L. was collected in July 2009 from natural populations in the region of Montenegro. The ability of the plant extract to scavenge 1,1-dyp-henyl-2- picrylhydrazyl (DPPH) free radicals was assessed by the standard method. Obtained values for antioxidant activity of extracts were expressed as IC_{50} values ($\mu\text{g/ml}$) and ranged from 2314.37 $\mu\text{g/mL}$ to 81.68 $\mu\text{g/mL}$. Total soluble phenolic compound in the different extracts of *T. arduini* were determined with Folin-Ciocalteu reagent. The total phenolic content of the extracts ranged from 7.54 mg/g to 90.39 mg/g of dry weight of extract, expressed as gallic acid equivalents (GAE). The total flavonoid contents were determined spectrophotometrically and obtained values of flavonoid concentrations varied from 3.90 mg/g to 110.01 mg/g, expressed as rutin equivalents (RUE). Methanolic extract possess the highest phenol concentration of 90.39 mg/g and strong antioxidant activity of 81.68 $\mu\text{g/mL}$. High dissolubility of phenolic compounds in polar solvents provides high concentration of these compounds in the extracts obtained using polar solvents for the extraction. The significant linear correlation was confirmed between the values for the concentration of phenolic compounds and antioxidant activity of plant extracts. The high contents of phenolic compounds and flavonoids indicated that these compounds contribute to the strong antioxidant activity. Based on these results, *Teucrium arduini* is a potential source of phenols as a natural antioxidant substances of high value.



ANTIMICROBIAL ACTIVITY, TOTAL PHENOL AND FLAVONOID CONTENT OF *TEUCRIUM CHAMAEDRYS* L. VAR. *GLANDULIFERUM* HAUSSK. EXTRACTS

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The antimicrobial properties, total phenol and flavonoid concentration of *Teucrium chamaedrys* methanol, ethyl acetate and acetone extracts have been examined. Wall Germander, *Teucrium chamaedrys* L. var. *glanduliferum* Haussk. belongs to the family *Lamiaceae*, subfamily *Ajugoideae* and section *Chamaedrys*. This is a perennial herbaceous plant with half-ligneous lower trunk, shrub-like, smallish, up to 30 cm high. It has little branched, rectangular trunk, oval leaves with softly knobbed brims and tiny blooms on branch-tops. Inhabit rocky limestones, dry mountain meadows and pastures, the edge of the light oak and pine forest up to 1000 meters above sea level of Central Europe, Mediterranean and Western Asia. *In vitro* antimicrobial activities of *T. chamaedrys* extracts against five species of bacteria and three species of fungi were tested by microdilution method and both minimal inhibitory (MIC) and microbicidal concentration (MMC) was determined. The activity of tested extracts varied depending on the species of microorganism and type and concentration of the extract. The comparative analyses showed that the most active was methanol extract (MIC from 0.078 mg/ml to >20 mg/ml) followed by ethyl acetate (MIC from 0.6 mg/ml to >10 mg/ml) and acetone extract (MIC from 5 mg/ml to >20 mg/ml). The most sensitive bacteria were *Staphylococcus aureus* ATCC 25923 and *Pseudomonas aeruginosa* PMFB-15. On the other hand, the best inhibitory effects on growth of tested fungi (*Candida albicans* ATCC 10231, *Candida albicans* PMFG-19, *Aspergillus niger* PMFG-23) showed ethyl acetate extract. Total phenols were determined by Folin-Ciocalteu reagent and their amounts in the range from 30.39 mg/g to 169.5 mg/g were expressed in terms of gallic acid equivalent (mg of GA/g of extract). The amount of flavonoids in plant extracts were in the range from 61.80 mg/g to 87.17 mg/g expressed in terms of rutin equivalent (mg of RU/g of extract). The highest concentration of phenols were measured in methanolic and flavonoids in ethyl acetate extract. The high phenolic content indicated that these compounds contribute to the significant antimicrobial activity. Based on these results, *T. chamaedrys* extracts could be used as potential antimicrobial agents.



MOLECULAR PHYLOGENY OF *CAMPANULA* *PYRAMIDALIS* COMPLEX (*CAMPANULACEAE*): TAXONOMIC AND BIOGEOGRAPHIC IMPLICATIONS

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Campanula pyramidalis complex (also considered as rapunculoid aggregate or subsection of the *Campanulaceae* family) is a group that includes three closely related and morphologically similar species (*C. pyramidalis* L., *C. versicolor* Sibth. et Sm., *C. secundiflora* Vis. et Pančić). The distribution of this complex is centered mostly in the Balkans, from Istria to the north, to Peloponnese Peninsula to the south, and to Mt. Konjevaska planina in Bulgaria in the east, while some small disjunct parts of the range lie in the S Apennines. To capture morphological diversity observed within this group, a number of taxa related to the broadly circumscribed *Campanula pyramidalis* complex were described over the years (e.g., *Campanula pyramidalis* var. *calycina* A. DC., *C. pyramidalis* var. *compacta* auct., *C. plasonii* Formanek, *C. tenorii* Moretti; *C. versicolor* var. *tomentella* Hal., *C. versicolor* var. *thessala* Boiss., *C. mrkvickana* Vel.; *C. secundiflora* subsp. *limensis* R. Lakušić and *C. secundiflora* subsp. *montenegrina* R. Lakušić). However, their taxonomic and geographical distinctiveness is far from clear, to the point that the modern floristic literature does not recognize these taxa, and either neglects them completely or reduces them to synonymy. The basic aim of this research was to test a series of taxonomic and biogeographic hypotheses using explicit phylogenetic approaches. To reconstruct the phylogeny, gain a better understanding of the evolutionary history, and determine species boundaries within this complex, a broad dataset was constructed containing representatives from across its entire morphologic and geographic range. We present here the results of molecular phylogenetic analyses based on sequences from three non-coding chloroplast regions (*psbA-trnH*, *trnS-trnQ*, and *trnM-psbZ*) as well as nuclear ribosomal internal transcribed spacers (ITS). Our study identified several distinct monophyletic groups, some of which correspond closely to previously established taxonomic treatments and some of which are new. Taxonomical and biogeographical implications of these relationships are also discussed.



VEGETACIJA SNJEŽNIH TOČILA I BLOKOVA U HRVATSKOJ – EKOLOGIJA I UGROŽENOST

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Istražena je vegetacija i ekologija hladnih i vlažnih točila i blokova u Hrvatskoj. Sastojine toga tipa pronađene su isključivo u ponikvama Liburnijskog krša i Velebita, a fitocenološki pripadaju zajednici *Drepanoclado-Heliospermetum* (*Salicion retusae*, *Arabidetalia caeruleae*, *Thlaspietea rotundifolii*). Ove su sastojine razvijene na umirenim točilima i kamenim blokovima u najhladnijim dijelovima ponikvi (na dnu ili u manjim žljebovima) u kojima se snijeg dugo zadržava, a koje su uglavnom izložene sjeveru i zasjenjene veći dio dana. S obzirom na relativno nisku nadmorsku visinu planina, u Hrvatskoj se vegetacija snježnih točila i blokova može pronaći azonalno, unutar altimontanskih i subalpinskih šuma bukve ili bukve i jele, gdje takve sastojine uspijevaju zahvaljujući specifičnim mikroklimatskim uvjetima. Snježna točila i blokovi u Hrvatskoj stanište su nekih rijetkih i/ili zaštićenih biljnih vrsta.



SNOWBED VEGETATION IN CROATIA: PHYTOSOCIOLOGY, ECOLOGY AND CONSERVATION STATUS

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Phytosociology, ecology and chorology of snowbed vegetation in Croatia were researched. Snowbed stands, found only in freezing ravines and dolines of the Liburnian karst and Velebit Mountains (NW Dinaric Alps, NW Croatia), were classified into the association *Drepanoclado-Heliospermetum* (*Salicion retusae*, *Arabidetalia caeruleae*, *Thlaspietea rotundifolii*). Those stands, exposed mostly to the north and shaded for the majority of the growing season, were developed on more or less settled periglacial screes and boulders in the coldest parts (bottoms, smaller ditches) of the dolines with long-lasting snow cover. Due to lower altitude of Croatian mountains, snowbed vegetation could be found only azonally, in freezing ravines surrounded by altimontane and subalpine (fir-) beech and spruce forests, where these stands manage to thrive due to specific microclimatic conditions. Snowbeds host some rare, endangered and/or protected plant species in Croatia. Vulnerability of the flora and vegetation of snowbeds in Croatia is briefly discussed.



RARITY AND PERSISTENCE OF ENDEMIC *HLADNIKIA PASTINACIFOLIA* RCHB. (APIACEAE)

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Hladnikia, a narrow endemic, has an extremely restricted distribution area in Trnovski gozd (Slovenia), despite many available habitats. We performed anatomical studies and compared morphological traits of plants from various habitats and from different populations. At the micro level we monitored the occurrence of plants belonging to different ontogenetic stages and we evaluated the distribution of specimen in relation to abiotic factors. For the germination tests of *H. pastinacifolia* seeds we conducted the seed burial and laboratory experiments. We estimated also the genetic variation among and within known populations with RAPD markers. The overall pattern showed that the most favorable habitats are screes. Many of the traits observed showed an adaptation toward drought-stress (leaf anatomy, dispersal potential) while the ecological strategy belongs to the CR type. Among populations, the population from Čaven (*locus classicus*) differed significantly in terms of the size and the reproductive effort. Genetic variability of *Hladnikia pastinacifolia* showed only a low level of RAPD variability. According to the AMOVA the majority of the genetic diversity was partitioned within the selected populations. The low genetic differentiation between populations indicates repeatedly occurring bottlenecks, when the species became restricted to the refugium, and long-term survival *in situ*. The species persistence was enabled by the ecological strategy to occupy the low-productive marginal habitats and by the ability to produce viable seeds. Plants showed a high seed production and seeds displayed two types of dormancy; however, they were not forming a persistent soil seed bank. Characteristics which enabled persistence, on the other hand, together with low genetic variability also restrict the species in its occurrence.



GERMINATION CHARACTERISTICS OF THREE *SALICORNIA* SPECIES (*CHENOPODIACEAE*) AND THEIR OCCURRENCE IN CROATIA

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According to recent publications in molecular analyses of *Salicornia*, we revised the annual glassworts from the Croatian coast, being classified until now only as *Salicornia europaea*. We recognized two species, a diploid *Salicornia patula* and a tetraploid *S. emerici*. They can be easily distinguished by floral characters and they differ also in seed morphology, while the habitus varies extremely according to environmental factors. Species specific germination patterns helped to explain the habitat preferences. Both species rarely co-occur, though. Rare *S. patula* occupies drier habitats, on coastal mudflats or sands that are irregularly inundated. It occurs within the ass. *Suaedo maritimae-Salicornietum patulae*. *Salicornia emerici* occupies the lowest coastal mudflats, regularly inundated, where nutrient-rich conditions prevail, and forms an almost monodominated ass. *Salicornietum emerici*. Due to the equivalence of *S. veneta* with *S. emerici*, we exclude the occurrence of *S. veneta* in Croatia as an independent taxon.



FENOLNI SASTAV I ANTIOKSIDACIJSKA AKTIVNOST EKSTRAKTA VRSTE *RHAMNUS* *INTERMEDIA* STEUD. ET HOCHST

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Na teritoriju Republike Hrvatske raste oko 600 medicinskih te aromatičnih biljaka, od kojih se oko 120 koristi u tradicionalnoj medicini za liječenje mnogih bolesti. Jedna od njih je i krkavina (*Rhamnus intermedia* Steud. et Hochst). Kora i plodovi biljaka iz roda *Rhamnus* već se stoljećima koriste u tradicionalnoj medicini kao i u modernoj medicini za detoksikaciju organizma te za kožna oboljenja. U našem radu odredili smo antioksidacijsku aktivnost te različite skupine fenolnih spojeva u metanolnim ekstraktima kore i lista *Rhamnus intermedia* Steud. et Hochst. Koristili smo tri spektrofotometrijske metode (Ferric Reducing/Antioxidant Power (FRAP), 2,2-diphenyl-1-picrylhydrazyl (DPPH), i 2,2'-azinobis (3-ethylbenzthiazoline-6-sulphonic acid metodom) te ORAC (oxygen radical absorbance capacity) metodu za određivanje antioksidacijske aktivnosti. Također odredili smo i različite skupine fenolnih spojeva: ukupne fenole (Folin-Ciocalteu metodom), ukupne flavonoide (kolorimetrijskom reakcijom sa AlCl₃), te slobodne fenolne kiseline (UPLC-MS/MS metodom). Listovi su pokazali viši udio ukupnih fenola (46.40±4.12 mgGAE/g) te flavodoida (8.28±0.50 mg KE/g) u usporedbi sa korom (19.31±1.60 mg GAE/g, 3.58±0.10 mg KE/g). Također ekstrakti listova pokazali su jaču antioksidacijsku aktivnost od ekstrakta kore i to 2.7x za FRAP, 3.4 x za DPPH, 2.6 x za ABTS i 6.3 x za the ORAC metodu. U ekstraktima lista odredili smo deset fenolnih kiselina (protokatehinsku, p-hidroksibenzojevu, galnu, salicilnu, klorogensku, vanilinsku, kava, siringinsku, p-kumarinsku i ferulinsku) dok je u ekstraktima kore određeno šest fenolnih kiselina (protokatehinska, p-hidroksibenzojeva, galna, salicilna, p-kumarinska i ferulinska). U listovima najzastupljenija je bila vanilinska kiselina (1647.06±79.35 μmol/g) dok je u kori najzastupljenija salicilna (111.10±14.14 μmol/g). Do sada nema objavljenih radova o antioksidacijskoj aktivnosti i fenolnom sastavu ekstrakata *R. intermedia* te ovi rezultati indiciraju da metanolni ekstrakti *R. intermedia* pokazuju značajnu antioksidacijsku aktivnost i visok udio polifenolnih komponenti.



POLYPHENOLIC CONSTITUENTS AND ANTIOXIDANT ACTIVITY OF *RHAMNUS INTERMEDIA* STEUD. ET HOCHST EXTRACTS

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One of the basic characteristics of Croatian flora is an abundance of medicinal plants. Croatia hosts more than 600 wild medicinal, aromatic and honey plant species, 120 of which are traditionally used in folk medicine. One of them is *Rhamnus intermedia* Steud. et Hochst. Barks and fruits of *Rhamnus* species have been used for centuries in folk and modern medicine as purgatives and de-toxicants, as well as in treatment of wounds various skin diseases. In our study, we determined the antioxidant capacity and quantified various classes of phenolic antioxidants in leaf and bark methanol extracts of *R. intermedia*. We used three well-established spectrophotometric methods to determine the antioxidant potency of our extracts (Ferric Reducing/Antioxidant Power assay (FRAP), 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay, and 2,2'-azinobis (3-ethylbenzthiazoline-6-sulphonic acid) (ABTS) assay), as well as oxygen radical absorbance capacity (ORAC) assay. We also quantified various classes of phenolic compounds in these preparations: total phenols (TP, Folin-Ciocalteu assay), total flavonoids (TF, colorimetric assay with AlCl₃) and free phenolic acids (UPLC-MS/MS). Leaves have shown higher TP (46.40±4.12 mgGAE/g DW) and TF contents (8.28±0.50 mgCE/gDW) in comparison to bark (TP: 19.31±1.60 mg GAE/g DW, TF: 3.58±0.10 mg CE/g DW). Also, leaf extracts have shown higher antioxidant capacity compared to bark extracts: 2.7x using FRAP 3.4 x using DPPH, 2.6 x using ABTS and 6.3 x using the ORAC method. We quantified ten phenolic acids in leaf extracts (protocatechuic, p-hydroxybenzoic, gallic, salicylic, chlorogenic, vanillic, caffeic, syringic, p-coumaric and ferulic) and six phenolic acids in bark extracts (protocatechuic, p-hydroxybenzoic, gallic, salicylic, p-coumaric and ferulic). The most abundant phenolic acid in leaves was vanillic acid (1647.06±79.35 μmol/g DW) while salicylic acid was most abundant in the bark (111.10±14.14 μmol/g DW). There are no published studies characterizing phenolic metabolites and antioxidant properties of *R. intermedia*. The results of our study indicate that the methanol extracts of *R. intermedia* exhibit high antioxidant activity and are an important source of polyphenolic compounds.



PHYSICAL MAPPING OF rDNA AND GENOME SIZE IN THREE EUROPEAN *FRAXINUS* SPECIES

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The genus *Fraxinus* L. (*Oleaceae*) comprises around 52 taxa at the specific or subspecific level (the number is quite variable following different authors). It is widely distributed in the Northern hemisphere and absent from the Southern hemisphere. In Europe the genus is represented by only three species (*Fraxinus angustifolia*, *F. excelsior*, *F. ornus*). Two species (*Fraxinus angustifolia* and *F. excelsior*) belong to the section *Fraxinus* and one (*F. ornus*) to the section *Ornus*. These two sections are clearly different in the light of molecular phylogeny. The physical mapping of two rRNA gene families 5S and 18S-5.8S-26S and the distributional pattern of GC-rich regions in the chromosomes of 3 European *Fraxinus* species have been established for the first time by means of fluorescence *in situ* hybridization (FISH) and fluorochrome banding with chromomycin A₃. Heterochromatin and rDNA organization was conserved and almost identical for two species from *Fraxinus* section (*F. angustifolia* and *F. excelsior*). The number and position of two rDNA families in *Fraxinus ornus* were almost the same, but the gene organisation was quite different. In this species the 5S and 18-26S rRNA genes were colocalized and dispersed with each other at the level of satellites and secondary constrictions. In *F. angustifolia* and *F. excelsior* only 18-26S were situated at the level of satellites and secondary constrictions, the 5S was located just below. The number and position of GC-rich DNA correspond to those of 18S-26S loci. The genome size was assessed by flow cytometry. It ranges from 1,54 to 1,68 pg for *F. angustifolia* and *F. excelsior* respectively. *Fraxinus ornus* possessed the bigger 2C DNA value (1,98 pg). In the light of these cytogenetic features the clear differentiation between two sections (*Fraxinus* and *Ornus*) was observed both at the rDNA organization and genome size level.



RELATION OF DRY GRASSLANDS CSR FUNCTIONAL SIGNATURES AND CONTRASTING GEOLOGICAL SUBSTRATES

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In this research we present floristic and functional comparison of two adjacent and structurally-similar plant communities– species-rich calcareous (*Bromion erecti*) dry grasslands and silicicolous dry grasslands (*Nardo-Agrostion tenuis*). Multivariate DCA ordination method was applied for analysis of species composition. For functional comparison Grimes CSR triangle theory of plant strategies was used. The DCA ordination showed great differences in species composition between calcareous and silicicolous dry grasslands. Ordination of species within CSR space demonstrated that CR, SC, CSR are prevalent strategies of plant species on both grassland types. The positions of calculated functional signatures for all relevés of studied grasslands in CSR space showed that stress and competition in various equilibria are the most important determinants of the studied vegetation. Our hypothesis that despite very different floristic composition there will be no significant differences in functional signatures between both grassland types could be confirmed on the basis of the part of the relevés, which showed some overlap. Differences in functional signatures within the samples of both vegetation types are due to fluctuations in abundance of dominant species which can be linked to differences in soil characteristics of microhabitat or to disturbance abundance. Higher relative proportions of S component and lower relative proportions of C components in silicicolous grasslands suggest that those habitats generally experience higher intensities of stress when compared to calcareous grasslands, probably also due to their occurrence in higher altitudes.



DOPRINOS POZNAVANJU FLORE NP „KORNATI” I IZRADA OSNOVE ZA BUDUĆE PRAĆENJE STANJA STANIŠTA

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Cilj istraživanja, provedenog u sklopu „Biološkog kampa Kornati 2009” Udruge studenata biologije „BIUS”, bio je izraditi osnovu za daljnje praćenje stanja kopnenih staništa te nadopuniti postojeći popis biljnih vrsta za NP „Kornati”. Istraživanje flore provedeno je na 24 lokaliteta i šest transekata te je izrađena 21 vegetacijska snimka. Pritom je zabilježeno 365 svojti unutar 74 porodice na sveukupno 51 lokalitetu. Od tog broja, 74 svojti prvi je put zabilježeno za područje Nacionalnog parka. Među njima treba posebno istaknuti svojtu *Allium cupanii* Rafin. agg., koja je prvi put zabilježenu za floru Hrvatske. Najzastupljenije porodice su *Fabaceae* (13,42%), *Poaceae* (10,41%), *Asteraceae* (6,30%), *Cichoriaceae* (5,48%) te *Lamiaceae* (4,93%), što odgovara mediteranskoj regiji s izraženim antropogenim utjecajem. Prilikom izrade 21 vegetacijske snimke obrađeno je devet tipova staništa i zabilježeno 208 svojti. Također, zabilježeno je 12 endemičnih svojti, 20 svojti koje su uvrštene u „Crvenu knjigu vaskularne flore Hrvatske” te 62 svojte zaštićene „Pravilnikom o proglašenju divljih svojti zaštićenim i strogo zaštićenim”.



A CONTRIBUTION TO THE FLORA OF THE NP KORNATI AND BASICS FOR FURTHER BIOMONITORING OF TERRESTRIAL HABITATS

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The main aim of this research, held as part of the biological camp „Kornati 2009” and organized by the Biology Students Association – BIUS, was to establish the basics for further biomonitoring of terrestrial habitats and to update the list of vascular plants of the National Park Kornati. Research of the flora covered altogether 51 locations - 24 inventory spots, 6 transects and 21 vegetation plot. During the research 365 different plant taxa were found belonging to 74 families, thereof 74 new taxa for the National Park. The most important finding is one concerning the new taxa reported for the Croatian flora - *Allium cupanii* Rafin. agg. The most abundant families are *Fabaceae* (13.42%), *Poaceae* (10.41%), *Asteraceae* (6.30%), *Cichoriaceae* (5.48%) and *Lamiaceae* (4.93%) what corresponds to Mediterranean region with expressed anthropogenic influences. While establishing 21 vegetation plots, 9 terrestrial habitat types were covered and 208 taxa recorded. The research reported 12 endemic taxa and 20 taxa noted in the Red Book of Vascular Flora of Croatia. Furthermore, according to the Nature Protection Act, 62 plant taxa are protected.



CRETNA VEGETACIJA I NJENA UGROŽENOST NA PODRUČJU JARKA U PARKU PRIRODE „ŽUMBERAK - SAMOBORSKO GORJE”

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Cretovi su u Hrvatskoj vrlo rijetki i predstavljaju izrazito lokalizirana staništa. Zbog svoje rijetkosti, izdvojenosti i veličine, pripadaju u kategoriju kritično ugroženih staništa Hrvatske, a ugrožen je i dobar dio njihovih karakterističnih biljnih i životinjskih vrsta. Cret na području potoka Jarak pripada skupini bazofilnih cretova i do sada nije bio sustavno istraživano. Tijekom 2007. i 2008. godine područje creta je istraživano i u tu svrhu podijeljeno u četiri podpodručja – cret u užem smislu, te tri faze sukcesije: trščak, prijelazna faza između trščaka i mlade šume i mlada šuma. Nulto stanje je istraživano 2007. godine, dok je 2008. organizirano uklanjanje drvenastih i ostalih vrsta koje su ugrožavale autohtonu cretnu vegetaciju, kako bi se omogućila (re)kolonizacija cretne vegetacije. Tijekom istraživanja 2007. godine pronađene su, za područje Hrvatske, kritično ugrožene vrste (CR) *Eriophorum angustifolium* i *Tofieldia calyculata*; ugrožene vrste (EN) *Carex hostiana* i *Eriophorum latifolium*; gotovo ugrožene vrste (NT) *Daphne mezereum* i *Gentiana asclepiadea*; osjetljiva vrsta (VU) *Glyceria plicata* subsp. *declinata*; i nedovoljno poznata vrsta (DD) *Potentilla carniolica*. Uz navedene, pronađena je i vrsta *Pinguicula alpina*, specifična za ovakav tip staništa te šest vrsta orhideja. Cretna vegetacija pripada svezi *Caricion davallianae* Br.-Bl. 1949. Godine 2008. istraživane su promjene na cretnoj vegetaciji i njezinim sukcesijskim fazama. Cretna vegetacija nije pokazala promjene, dok su na novootvorenim staništima počele dominirati vrste otvorenih i vlažnih staništa, a tipične cretne biljne vrste (*Eriophorum latifolium* i *Parnassia palustris*) pronađene su jedino na rubu sukcesijske faze definirane kao mlada šuma. Utvrđeno je da jednokratno uklanjanje vegetacijskih sukcesijskih faza nije dovoljno za (re)kolonizaciju tipičnih cretnih vrsta i obnavljanje staništa, već je potrebno uvesti dodatne mjere za očuvanje ovog ugroženog staništa.



PEAT BOG VEGETATION AND ITS ENDANGERMENT ON THE AREA OF JARAK IN NATURE PARK ŽUMBERAK-SAMOBORSKO GORJE

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Peat bogs in Croatia are very rare and extremely localized habitats. Because they are rare, separated and small in area they enter the critically endangered habitats category in Croatia, as well as a large part of their characteristic plant and animal species. The peat bog on the area of Jarak is basophilous and until now was not systematically researched. During the years of 2007 and 2008 the area of peat bog was researched and for that purpose was divided into four subareas – peat bog in the narrow sense, and three successional phases: cane area, transitional phase between cane and young forest and a young forest. Zero state was researched in 2007, while in 2008 cutting and removal of woody and other species endangering peat bog indigenous vegetation was organized to enable (re)colonization of peat bog vegetation. During the research in 2007 species of different importance for Croatia were found: critically endangered (CR), *Eriophorum angustifolium* and *Tofieldia calyculata*; endangered species (EN), *Carex hostiana* and *Eriophorum latifolium*; near threatened species (NT), *Daphne mezereum* and *Gentiana asclepiadea*; vulnerable species (VU), *Glyceria plicata* subsp. *declinata*; and data deficient species (DD), *Potentilla carniolica*. We also found *Pinguicula alpina*, a species specific for this type of habitat, and also 6 orchid species. Peat bog vegetation belongs to *Caricion davallianae* Br.-Bl. 1949 alliance. During 2008 changes of peat bog vegetation and its successional phases was researched. Peat bog vegetation did not show any changes, while on newly opened areas species from wet and open habitats begun to dominate, but typical peat bog plant species (*Eriophorum latifolium* and *Parnassia palustris*) were found only on the edge of the former successional phase defined as young forest. It is concluded that a single removal of vegetation successional phases is not enough for (re)colonization of typical peat bog plant species and habitat regeneration. It is necessary to use also other methods for regeneration and preservation of this endangered habitat.



PRELIMINARNI MODEL POVOLJNOSTI STANIŠTA VRSTE *FRAXINUS ANGUSTIFOLIA* VAHL U HRVATSKOJ METODOM MAKSIMALNE ENTROPIJE

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Glavni ciljevi ove studije su testirati korisnost, odnosno primjenu modela povoljnosti staništa u predviđanju potencijalne rasprostranjenosti vrste *Fraxinus angustifolia*, široko rasprostranjene i ekonomski važne vrste drveća u Hrvatskoj, zatim istražiti koji su ekološki čimbenici najvažniji prediktori u procjeni rasprostranjenosti te procijeniti moguću varijabilnost ekološke niše. U izradi modela koristili smo metodu maksimalne entropije, koristeći se softverom MAXENT 3.3.1. koji iziskuje samo podatke o prisutnosti vrste. Korištena su ukupno 802 nalaza o prisutnosti vrste prikupljena iz baze *Flora Croatica Database*, „Nacionalne inventure šuma” i vlastitim istraživanjima. Za izgradnju modela koristili smo kao prediktorske varijable 12 nezavisnih ekoloških tematskih slojeva: bioklimatske varijable preuzete iz *WorldClim* baze, topografske varijable (nadmorska visina, ekspozicija i nagib terena) te kartu stanišnih tipova RH. Svi slojevi korišteni su u prostornoj razlučivosti od 100 x 100 m. Koristeći standardne postavke softvera ukupno smo izradili 30 uzastopnih modela, svaki put koristeći nasumično izabrani skup podataka o nalazu vrste i to: 70% kao *training* i 30% kao *test* skup. Točnost modela procijenili smo binomnim testom „stope lažne odsutnosti vrste” (*omission rate*) i ROC analizom sa izračunom AUC vrijednosti. Zabilježena je i relativna važnost pojedinih ekoloških varijabli u izgradnji modela. Model dobiven metodom maksimalne entropije pokazao je visoke AUC vrijednosti na oba skupa podataka (prosječna AUC vrijednost: *test* skup = 0,973, *training* skup = 0,978), što ukazuje na njegovu dobru prediktivsku snagu. Binomni test pokazao je da pretpostavljena rasprostranjenost statistički značajno odstupa od nasumične, a kao najvažnije prediktorske varijable pokazale su se stanišni tip i nadmorska visina. Potencijalna rasprostranjenost bila je u skladu s postojećim poznatim podacima o raširenosti poljskoga jasena u Hrvatskoj, s najvećom vjerojatnošću pojavljivanja u nizinama kontinentalne regije. Preklapanje potencijalne rasprostranjenosti kontinentalne, odnosno mediteranske biogeografske regije je nisko, što upućuje na moguću regionalnu varijabilnost ekološke niše ove vrste. Naši rezultati ukazuju da je ovim pristupom, čak i za vrste specifičnih ekoloških potreba, moguće dobiti približnu sliku o njihovoj realnoj rasprostranjenosti, što predstavlja koristan alat prilikom planiranja učinkovitih konzervacijskih programa za vrste i staništa.



PRELIMINARY HABITAT SUITABILITY MODEL FOR *FRAXINUS ANGUSTIFOLIA* VAHL IN CROATIA USING MAXIMUM ENTROPY

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Predictive species distribution modelling is a useful tool for developing effective management and conservation programmes for species and ecosystems. The main objective of this study is to test the usefulness of habitat suitability model in predicting the potential distribution of *Fraxinus angustifolia*; a wide ranged economically important tree species in Croatia, to explore which ecological factors influence the species occurrence and to assess a possible regional niche variation. We applied a maximum entropy modelling method using software MAXENT 3.3.1 which uses species presence only data. A total set of 802 occurrence points was used, obtained from Flora Croatica Database, Forest Inventory and our own sampling. Twelve independent environmental layers were included in the model as predictor variables: WorldClim bioclimatic variables, topographic variables (elevation aspect and slope) and a habitat type variable. All the variables were resampled to 100 m x 100 m spatial resolution. We performed 30 replicate runs with default modelling parameters, each time randomly selecting 70% of the occurrence points as training and remaining 30% as test data. Model performance was evaluated using the binomial tests of omission rates and threshold-independent ROC analysis with AUC. The relative variable importance to the model was recorded. The Maxent model performed well with high average training and test AUC values across 30 runs (average test AUC = 0.973, average training AUC = 0.978). Predictions were significantly different from random for all runs at all thresholds measured by the binomial omission tests. Single most important predictor variable was habitat type followed by the elevation. The modelled distribution was well congruent with present known distribution of *Fraxinus angustifolia* in Croatia with highest probabilities of occurrence in the lowlands of Continental region. The overlap between the distribution in Continental and Mediterranean biogeographical region was low, suggesting regional niche variation. Our results indicate that close approximation to the reality distribution pattern can be obtained using this approach, even for species with specialized ecological requirements.



RASPROSTRANJENOST I EKOLOŠKE ZNAČAJKE STANIŠTA ENDEMIČNE VELEBITSKE DJETELINE (*TRIFOLIUM VELEBITICUM* DEGEN)

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Premda je endemična velebitska djetelina (*Trifolium velebiticum* Deg.) opisana prije jednoga stoljeća, u botaničkoj se literaturi ne spominje mnogo te se o njezinoj rasprostranjenosti i staništima na kojima raste još uvijek nedovoljno zna. Kako proizlazi iz nekih botaničkih radova, velebitska je djetelina na nekim lokalitetima zasigurno pobrkana sa srodnom crvenom djetelinom (*Trifolium pratense*), kojoj je na prvi pogled slična, ali „izbliza” ipak značajno različita. Osim sličnosti s crvenom djetelinom, do zamjene je možda dolazilo i zbog toga što se na staništima, kao npr. na nekim krškim poljima na površinama gdje dio godine leži voda, ne bi očekivalo biljku koja „većinom raste u kamenjarama gorskog i pretplaninskog područja” (Forenbacher 1990) ili na „planinskim kamenjarima” (Domac 1990). Ona tamo zaista raste, ali je u velikoj množini raširena, također, i u poplavnoj vegetaciji nekih krških polja kao i u „suvajama”, što govori o njezinoj širokoj ekološkoj amplitudi. Zato smo pri geobotaničkim istraživanjima posljednjih godina toj našoj endemičnoj biljci posvetili posebnu pozornost sa željom da poblize upoznamo njezinu rasprostranjenost i ekološke značajke. Mišljenja smo da su potrebna i nova istraživanja taksonomskog statusa te svojte.



DINARIC HIGH MOUNTAIN FLORA AS A SOURCE OF NEW DRUGS

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The high mountain flora is very rich, but still pharmacologically poorly or not at all investigated. This is especially true in areas rich in endemic species of plants. One of these was the Dinarides in the Western Balkans. This is an important resource in getting new drugs and medicines. The aim is to make identification of endemic species of medicinal plants and their biochemical background. In order to achieve all planned objectives, it has been applied following methodology: field research on different profiles, including ethnobotanical interviews, followed at the end by comparative taxonomic-biochemical method. In the mountainous zone of the Dinarides about 1500 species were established. Very small number used in the official pharmacy and medicine – potentially the 150 species of medicinal plants. On the basis of their taxonomic similarity, biochemical similarity is also expected and the pharmacological activity. Real or potential sources of alkaloids are the species of the genera: *Onosma*, *Moltkaea*, *Colchicum*, *Senecio*, *Cynanchum*, *Astragalus*, *Oxytropis*, *Vicia*, *Papaver*, *Euphorbia*, *Edraianthus*, *Campanula*, *Galanthus*, *Lilium* and *Aconitum*. The endemic plants as a potential source of heterosides are species of genera: *Arctous*, *Ferulago*, *Atamantha*, *Plantago*, *Pancicia*, *Bupleurum*, *Seseli*, *Genista*, *Gentianella*, *Gentiana*, *Frangula*, *Rhamnus*, *Polygonum*, *Hesperis*, etc.; saponosides are: *Verbascum*, *Scrophularia*, *Primula*, *Soldanella*, *Dianthus*, *Silene*, *Arenaria*, *Minuartia*, *Knautia*, *Scabiosa*, *Viola*, etc.; tannins are: *Geum*, *Potentilla*, *Sibirea*, *Crataegus*, *Dryas*, *Saxifraga*, *Geranium*, *Asplenium*, etc.; terpenoides are species of genera: *Centaurea*, *Hieracium*, *Hypochoeris*, *Amphoricarpos*, *Petasites*, *Homogyne*, *Stachys*, *Satureja*, *Micromeria*, *Scutellaria*, *Euphrasia*, *Pedicularis*, *Veronica*, *Iris*, *Pinus*, etc.; carbohydrates are: *Orchis*, *Gymnadenia* and *Dactylorhiza*.



LAMIALES: POLLEN CHARACTERS COMPARED WITH RECENT DNA-BASED PHYLOGENIES

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Systematic classifications should include as many characters as possible: anatomical-morphological, embryological, karyological, phytochemical, genetical, ecological and palynological characters. Pollen grains are a very good tool for systematic classifications. Especially the ornamentation of the pollen wall is an important character, because it is uniform within related taxa. In the current investigation the pollen morphology and ultrastructure of 37 species of different genera of the superorder Lamiales was investigated. The pollen data are included in the pollen database *PalDat* (<http://www.paldat.org/>) and the pollen characters are compared with the classification of the Lamiales by Fischer *et al.* (2005), based on the APG II-system. The family *Lamiaceae* is not subdivided by Adler *et al.* (1994), whereas Fischer *et al.* (2005) classifies into subfamilies and tribes. The pollen features are separating the three subfamilies Ajugoideae, Scutellarioideae und Lamioideae, with tricolpate, two-cellular pollen grains from the subfamily Nepetoideae with hexacolpate, three-cellular pollen grains. Regarding the former family of *Scrophulariaceae* the pollen characters are not always in accordance with the DNA-based phylogenies. The new molecular studies caused a lot of changes within the family. For example, the correlation of the Anthirrhineae with the new family of *Veronicaceae* according to Fischer *et al.* (2005) is not supported by the pollen characters. In contrast, the fusion of the genera *Pseudolysimachion* with the genera *Veronica* and also the separation of those genera from the other *Scrophulariaceae*, by classification into a new family, are well supported by all pollen characters. Relationships among groups in the Lamiales have proven to be difficult to resolve with morphological and molecular approaches.



THE RESURRECTION OF *APOBALLIS* (ARACEAE)

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Pollen characters (ornamentation, ultrastructure) may function as a "compass needle" in systematics. Pollen characters in *Araceae* accord well with recent DNA-based phylogenies, and we here provide a new example of "compass needle" quality in *Araceae*: Schismatoglottideae. *Schismatoglottis*, a genus of c. 160 species restricted to perhumid and everwet tropical Asia is the subject of ongoing research. One outcome (Wong and Boyce, in press) resurrects generic *Apoballis*, transferring 12 former *Schismatoglottis* species. *Schismatoglottis* pollen studied by us is smooth, in accordance with literature reports. However, pollen of *Apoballis acuminatissima* and *A. mutata* is distinctively spiny. Thanikaimoni (1969) reported 14 *Schismatoglottis* (e.g., *S. forbesii* = *Apoballis longicaulis* and *S. kurzii* = *Apoballis mutata*) with spiny pollen, although this was later suspected as misinterpretation of fungal spores. Our findings strongly suggest that "*Schismatoglottis*" species with spiny pollen fall into *Apoballis*: we have proof for *A. acuminatissima*, *A. longicaulis* and *A. mutata*, although further research is required to confirm our preliminary results. Without pollinator observations for *Apoballis* it remains unclear whether there exist correlations between pollinator type and pollen ornamentation. Interestingly, *Apoballis* investigated produce a floral odour reminiscent of benzaldehyde (almond oil), contrasting to *Schismatoglottis* (methyl esterase - model airplane glue). This, together with differences in spathe mechanics (Boyce and Wong 2007), suggests pollinator differences.



BIODIVERSITY OF VASCULAR PLANTS IN ALBANIA

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Apart from small territory, only 28.000 square kilometer, Albania represents a very rich country, biodiversity point of view. Its flora is characterized by considerable specie richness, which number 3250 vascular species (36% of Europe's flora even Albania cover c.a. 0.026% of Europe's area). Extremely rich is ecological biodiversity or variability of vegetation types, as well. This is due to particular geographical position, geological and climatic variability and long history of traditional land use. The presentation intend to identify, as much as possible, aspects of Albanian plant diversity, like species richness, family richness, variability of biological and chorological aspects, the presence of species of specific status (endemic, endangerment and vulnerable species). The study method is based on the investigation and analyze of Albanian flora data base, the review of taxonomic literature, different studies focus on red list of Albanian flora, protection of natural flora as well as strategy of the biodiversity, policy and action plans. Identification of ecological diversity (virgin forests, naturalness value, restorability, representability, rarity etc.) was result of the investigation of different plant-sociological studies, potential vegetation map, Corinne Biotope, studies in the evaluation of biodiversity, in forest and pastures inventory and management plans etc. The efforts for the mapping of biodiversity are shown in this presentation as an important base for decision making, zoning and sustainable spatial planning. There is the first so deep study in Albania, concern the overall aspect of flora and vegetation biodiversity in Albania. The results are very impressive and a good base for other studies as well as the comparative and confrontation process with other regional countries. From this analyze the important recommendation for the near future, listed from the most important are:

- a) develop gynecological analysis on the basis of available data and more active field work;
- b) complete the micro-topographical mapping project;
- c) develop a bio-monitoring system for observation and management, especially of hot spots, biodiversity point of view;
- d) establish a national informative bank for the areas with specific protected status (IUCN, Corine Biotop, Natura 2000);
- e) strengthen capacity of public, non profit organization and society in processes of natural protection and conservation.



KARAKTERISTIKE TALA CRNIKINIH ŠUMA U HRVATSKOJ

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Među mnogobrojnim tipovima tala koja se javljaju u Hrvatskoj, u ovom radu opisuju se tla pod šumom crnike. Pod prirodnom vegetacijom hrasta crnike i crnog jasena (*Fraxino ornī-Quercetum ilicis* H-ić/1956/1958) nastao je humusno akumulativni horizont prosječne debljine 2 do 5 cm sivo crne do tamno sive boje. Aoh (ohrični) horizont izmješan je često s Ofh horizontom poluraspadnutog listinca. Najčešća tla na kojima raste šuma crnike su crvenica – terra rossa, tipična, plitka i lesivirana, (feralic, folic CAMBISOL chromic, luvic) smeđe tlo na vapnecima i dolomitima, plitko i srednje duboko (folic, leptic CAMBISOL colluvic, skeletic). Na dubljim matičnim supstratima mogu se također pojaviti smeđa lesivirana i lesivirana tla (leptic, cutanic LUVISOL chromic, skeletic). Prema istraživanjima tipova tala kod crnikinih šuma najzastupljenija tla su crvenice (50%), smeđe tlo na vapnencu (40%) i lesivirana tla (10%). Na temelju analiza uzoraka tla iz pedoloških profila ustanovljeno je kako su tla po reakciji (pH u M-KCl) slabo kisela do neutralna u A horizontu (srednja vrijednost pH u M-KCl iznosi 6,45 u raspon 6,9-7,3) dok su u B horizontu tla kisela (srednja vrijednost pH 5,45 u raspon od 5,2-7,4). Po sadržaju hranjiva su slabo opskrbljena fiziološki aktivnim fosforom a dobro s kalijem. Dosta su humozna a odnos C:N je dobar. Po mehaničkome sastavu u A horizontu pripadaju u lake gline a u dubljim horizontima u glinaste ilovače i u većini slučajeva teške gline. Šuma crnike vrlo je bitna za očuvanje tala na kršu i stvaranje pravog humusnog horizonta koji u drugim uvjetima i pod drugom vegetacijom ima lošije osobine što se tiče, hranjiva, debljine i količine humusa.



CHARACTERISTICS OF HOLM OAK FOREST SOILS IN CROATIA

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Among the many types of soil in Croatia, the soils under forests of Holm Oak were the subject of this study. A humus accumulative horizon average thickness 2-5 cm, of grey-black to dark-grey, formed under the natural vegetation of Holm Oak and Flowering Ash (*Fraxino ornis-Quercetum ilicis* H-ić/1956/1958). Aoh-horizon is often mixed with Ofh horizon of semi-decayed leaf litter. The soils on which Holm Oak forests most frequently grow are: terra rossa, typical, shallow and luvic; calcicambisol, shallow and medium deep. On the deeper parental materials, cambic-luvic and luvic soils may also occur. According to pedological investigations, the most frequently found soils in Holm Oak are: 50% terra rossa (feralic, folic CAMBISOL chromic, luvic), 40% calcicambisol (folic, leptic CAMBISOL colluvic, skeletal) and 10% luvic soils (leptic, cutanic LUVISOL chromic, skeletal). On the basis of analyses of soil samples from pedological profiles, it has been determined that according to reaction (pH in M-HCl), the soils are slightly acid to neutral in the A horizon (mean value pH in M-KCl amounted to 6.45, range 6.9-7.3), while in the B horizon soils were dystic (mean value pH 5.45 range 5.2-7.4). With regard to the content of nutrients, they are poorly supplied with physiologically active phosphorus, and well supplied with potassium. They are rather humous and the relation C:N is good. Regarding the mechanical structure A horizon contains light clays, and in deeper horizons clayey loam, and in the majority of cases heavy clays. The evergreen Holm Oak forest is essential for the preservation of soils on the Karst area of the Mediterranean and formation of a true humus horizon, which in other conditions and under some other vegetation has poorer characteristics regarding nutrients, thickness and amount of humus.



MEDONOSNE BILJKE STANIŠTA S LJEKOVITOM KADULJOM (*SALVIA OFFICINALIS*) U OKOLICI SENJA

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U okviru znanstvenog projekta „Palinološke odlike nektara i meda od ljekovite kadulje (*Salvia officinalis*)” praćen je floristički sastav kamenjara i kamenjarskih travnjaka s kaduljom na dva lokaliteta u okolici Senja. U proljeće 2008. i 2010. godine popisivane su biljke i procjenjivana njihova brojnost na istraživanim staništima. Svojte koje nije bilo moguće odrediti na terenu prikupljane su radi naknadne determinacije te su pohranjene u Herbarsku zbirku Hrvatskoga prirodoslovnog muzeja (CNHM). Izdvojene su endemične, rijetke, ugrožene, zakonom zaštićene i medonosne biljke. Provedena je analiza medonosnih svojti na temelju sadržaja nektara i peluda, budući da se u medonosne biljke, osim onih s kojih pčele skupljaju nektar, ubrajaju i one s kojih pčele isključivo skupljaju pelud. U florističkom sastavu oba lokaliteta utvrđen je znatan broj medonosnih biljaka, među kojima dominiraju: *Salvia officinalis* L., *Genista sylvestris* Scop. i *Helianthemum nummularium* (L.) Mill. subsp. *grandiflorum* Scop.



HONEY PLANTS IN SAGE (*SALVIA OFFICINALIS*) HABITATS IN THE SURROUNDINGS OF SENJ (CROATIA)

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Within the scientific project "Palynological characteristics of nectar and honey of Sage (*Salvia officinalis*)", the floristic composition of the rocky ground and grasslands hosting Sage was surveyed at two sites near Senj. In the spring of 2008 and 2010, plants were registered and their abundance assessed in the researched habitats. The taxa that were impossible to identify in the field were collected for subsequent determination, and stored in the Herbarium Collection of the Croatian Natural History Museum – CNHM. Endemic, rare, endangered, legally protected plants and honey plants are singled out. An analysis of honey plant taxa was carried out on the basis of the nectar and pollen content since honey plants except those from which bees collect nectar also comprise those from which bees collect pollen exclusively. A significant number of honey plants was determined in the floristic composition at both sites. The predominant ones were as follows: *Salvia officinalis* L., *Genista sylvestris* Scop. and *Helianthemum nummularium* (L.) Mill. subsp. *grandiflorum* Scop.



**FITOCENOLOŠKE ZNAČAJKE ŠUMA BIJELE JOHE
(*ALNUS INCANA* /L./ MOENCH)
U GORSKOME KOTARU**

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Na vlažnim i povremeno poplavljenim staništima uz gornji tok rijeke Kupe i njenih pritoka u zapadnoj Hrvatskoj, razvijene su čiste i mješovite sastojine u kojima je edifikatorska vrsta bijela joha. U mješovitim sastojinama najčešće je primiješana s crnom johom, gorskim jasenom, običnim grabom, običnom bukvom te bijelom i sivkastom vrbom, dok čiste sastojine prevladavaju uz izvorišne i brže vodotokove i rubove livada. Te sastojine do sada nisu fitocenološki istraživane, pa je tijekom vegetacijskih razdoblja 2009. i 2010. godine klasičnom srednjoeuropskom fitocenološkom metodom snimljeno deset ploha. Floristički sastav pokazao se vrlo bogatim, s oko 200 zabilježenih vrsta biljaka. Snimljene plohe su fitocenološki analizirane i statistički uspoređene sa sličnim zajednicama susjednih područja. Statističke usporedbe snimaka provedene su programskim paketom Syn-Tax 2000. Uz analizu florističkog sastava uspoređene su i ekoindikatorske vrijednosti zajednica, pomoću programskih paketa Juice 6.3 i Statistica 8.0.



**PHYTOCOENOLOGICAL CHARACTERISTICS
OF FORESTS OF GREY ALDER
(*ALNUS INCANA* /L./ MOENCH) IN GORSKI KOTAR**

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Pure and mixed stands featuring grey alder as an important species are developed on moist and periodically flooded sites along the upper course of the River Kupa and its tributaries in western Croatia. In mixed stands, grey alder is usually accompanied by black alder, common ash, common hornbeam, European beech, and white and Rosemary willow, whereas pure stands prevail along water springs and faster watercourses, as well as meadow edges. So far, these stands have not been phytocoenologically investigated. Ten plots were recorded in the vegetation period of 2009 and 2010 using the classical Central European phytocoenological method. The exceptionally rich floral composition contains about 200 species of higher plants. The recorded plots were phytocoenologically analyzed and statistically compared with similar communities in adjacent areas. The relevés were statistically compared by means of Syn-Tax 2000 software. In addition to the analysis of the floral composition, the eco-indicator values of the communities were compared using Juice 6.3 and Statistica 8.0 software.



NOVI PRILOZI IZ HERBARA C. STUDNICZKE

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Iz herbara C. Studniczke analizirani su redovi: *Hippocastanēn* (četiri herbarska lista), *Balsimeinēn* (četiri herbarska lista), *Acerineen* (16 herbarskih listova), *Ampelideen* (pet herbarskih listova), *Malvaceen* (35 herbarskih listova) i *Hypericineen* (33 herbarska lista) u kojima se ukupno nalazi 97 herbarskih listova. Herbarski materijal koji se nalazi na 79 herbarskih listova, sakupljen je u Europi. Prema etiketnim podacima najviše herbarskog materijala sabrano je na području USA, Italije i Francuske, a zatim slijede Austrija, Hrvatska, Češka, Crna Gora, Poljska i ostale države. Najviše herbarskih listova pripada zbirci „Flora Dalmatiens”. U odnosu na dosada analizirani dio Studniczkinog herbara, po prvi puta spominju se zbirke: „Flora von Slavonien”, „Flora Helvetiae” i „Sevier Herbarium etruscum E Flora italica”; kao i botaničari (sakupljači) Mohr, Frank, Sevier, Kugler, Reuss, Burie i Lerch. Najviše herbarskih listova potpisuje sam Studniczka (47). Najstariji herbarski list je iz 1867., a najmlađi iz 1903. Najveći broj herbarskih listova, njih 54, sakupljeno je u razdoblju od 1871.-1880. Na devet herbarskih etiketa nije navedena godina sakupljanja. Prema Studniczki, unutar 97 herbarskih listova nalazi se 13 rodova sa 64 vrste, u okviru kojih su zabilježena četiri varijeteta. Prema djelu „Flora Europaea”, tu se nalazi 12 rodova sa 61 biljnom vrstom i podvrstom.



THE NEW FINDINGS FROM C. STUDNICZKAS HERBARIUM

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From the C. Studniczka Herbarium, we analysed orders: *Hippocastanēn* (four herbarium sheets), *Balsimeinēn* (four herbarium sheets), *Acerineen* (16 herbarium sheets), *Ampelideen* (5 herbarium sheets), *Malvaceen* (35 herbarium sheets) and *Hypericineen* (33 herbarium sheets) with total of 97 herbarium sheets. Herborized material which is placed on 79 herbarium sheets was collected in Europe. According to the labels, the majority of herborized material was collected in the area of the United States, Italy and France, followed by: Austria, Croatia, the Czech Republic, Montenegro, Poland and other countries. Most herbarium sheets belong to Flora Dalmatiens collection. In reference to the part of Studniczka herbarium which has already been analysed, there are some collections which are mentioned for the first time and these are: Flora von Slavonien, Flora Helvetiae and Sevier Herbarium etruscum E Flora italica; as well as the botanists (collectors): Mohr, Frank, Sevier, Kugler, Reuss, Burie and Lerch. Most herbarium sheets were collected by Studniczka himself (47). The oldest herbarium sheet dates from 1867 and the newest one is from 1903. Most herbarium sheets, 54 to be precise, were collected in the period from 1871 till 1880. The year of collection is missing from nine herbarium labels. According to Studniczka, within 97 herbarium sheets there are 13 genera with 64 species, in terms of which 4 varieties were recorded. According to Flora Europaea, there are 12 genera with 61 species and subspecies of plants.



POPULATION STRUCTURE OF RARE MOSS SPECIES *RHODOBRYUM ONTARIENSE* AS INFERRED BY THE ISOZYMES

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Rhodobryum ontariense (Kindb.) Kindb. (*Bryaceae*, *Bryophyta*) is a rare moss, recently discovered in Serbia (Deliblatska sands). After revision of the genus *Rhodobryum* in Serbia, it was concluded that all high-mountain records belong to *R. roseum*, while Deliblatska sands is unique certain locality of *R. ontariense* in Serbia. It is listed in bryophyte red-list of Serbia and Montenegro. Within the actual locality we counted 16 small sub-populations in the total surface of 6 hectares. The species is always in sterile conditions and always recorded on the dunes exposed to the north, in the edge of shrub-grassland transition with the gap from the steppic fragments in between. No propagules are known. The question was if the populations were once continuous or it has some vectors spreading detached plants which are able to establish new subpopulations. For this purpose the isozyme analysis were performed to estimate genetic structure of this isolated population. Based on isozyme forms of super oxide dismutase and peroxydase at least six haplotypes were determined within. It can be concluded that present moss patches did not derive from one subpopulation. Some kind of short-distance spreading exists, however it remains unclear what structures act as propagules and what is the vector for it.



KOLONIZACIJA PERIFITONSKIH ALGA U POPLAVNOM PODRUČJU DUNAVA

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Proces naseljavanja perifitonskih alga u vrlo složenim i istodobno vrlo ugroženim ekosustavima poplavnih područja velikih europskih rijeka još uvijek nije dovoljno istražen. Zbog toga je u razdoblju od travnja do kolovoza 2008. provedeno istraživanje naseljavanja alga na staklene podloge (vertikalno orijentirane na dubini od oko 25 cm ispod površine vode) u Sakadaškom jezeru, trajnom vodenom lokalitetu unutar poplavnog područja Dunava, na prostoru Kopačkog rita. Tijekom istraživanog razdoblja često su se izmjenjivala poplavna i sušna razdoblja, ovisno o visini vodostaja Dunava, što je uzrokovalo i značajne oscilacije u vrijednostima fizikalno-kemijskih čimbenika vode: dubine (6,50 - 8,30 m), prozirnosti (0,72 - 3,20 m), ukupnog dušika (0,10 - 3,70 mg/L) i ukupnog fosfora (0,04 - 0,33 mg/L). Ukupna biomasa perifitona (suha tvar, sadržaj organske tvari) kontinuirano se povećavala tijekom istraživanja, posebno od srpnja, kad je većinu biomase perifitona činila invazivna vrsta *Dreissena polymorpha* (Pallas, 1771). Vrijednosti autotrofnog indeksa ukazuju da je perifitonska zajednica u početku formiranja bila autotrofna, a od srpnja do kraja istraživanja heterotrofna. U perifitonskim zajednicama ukupno je utvrđeno 199 svojti alga, a broj svojti mijenjao se od 55 u prvom tjednu do 94 svojte u trinaestom tjednu naseljavanja. Promjene vrijednosti Simpsonovog indeksa ukazuju da je početak naseljavanja bio karakteriziran većom raznolikošću, uslijed naseljavanja novih vrsta, dok od sedmog tjedna naseljavanja postupno dolazi do dominacije sve manjeg broja vrsta u perifitonskoj zajednici. Cijanobakterije su u prvom tjednu naseljavanja činile više od 90% ukupnog broja jedinki, a posebno dobro su bile razvijene vrste rodova *Phormidium*, *Aphanocapsa* i *Gloeocapsa*. Od drugog tjedna naseljavanja pa sve do kraja istraživanja dominantne su bile različite vrste dijatomeja, najprije vrste većeg biovolumena (rodovi *Fragilaria*, *Melosira*, *Gomphonema*), a u kasnijoj fazi vrste manjeg biovolumena (rodovi *Achnanthes*, *Cymbella*, *Amphora*, *Navicula*). Najveća brojnost alga (614×10^3 stanica/cm²) utvrđena je u šestom tjednu naseljavanja. Nelinearna regresijska analiza pokazala je da se perifitonska zajednica stabilizirala u sedmom tjednu naseljavanja što upućuje na sporiju kolonizaciju alga, vjerojatno zbog čestih izmjena poplavnog i sušnog razdoblja.



COLONIZATION OF PERIPHYTIC ALGAE IN THE DANUBIAN FLOODPLAIN

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Colonization processes of periphytic algae in the endangered and very complex river-floodplain systems of large European rivers have not yet been fully investigated. During the period April - August 2008, colonization of algae on glass slides (vertically oriented and placed 25 cm below the water surface) was investigated in Lake Sakadaš, a permanent water body within the Kopački Rit Nature Park, one of the biggest preserved Danubian floodplains. During the investigated period, different hydrological conditions altered the values of physical and chemical parameters of lake water: depth (6.50 – 8.30 m), transparency (0.72 – 3.20 m), total nitrogen (0.10 – 3.70 mg/L) and total phosphorus (0.04 – 0.33 mg/L). Total periphyton biomass (dry weight, organic weight) continuously increased during the investigated period, particularly from July when the invasive species *Dreissena polymorpha* (Pallas, 1771) comprised the largest portion of total periphyton biomass. Based on autotrophic index, periphyton communities were characterized as autotrophic at the beginning of the colonization, while heterotrophic communities prevailed from July till the end of the experiment. A total of 199 algal taxa were detected in periphytic communities, varied from 55 taxa during the first week to 94 taxa in the thirteenth week of colonization. The Simpsons diversity index values show that the beginning of colonization was characterized by higher diversity due to the colonization of new species, while from the seventh week, gradual domination of several algal species within the periphytic community has been detected. Cyanobacteria comprised the 90% of the total abundance during the first week with well developed species belonging to the genera *Phormidium*, *Aphanocapsa* and *Gloeo-capsa*. From the second week till the end of the investigated period various diatom species prevailed. Firstly, the periphyton was dominated by the species of higher biovolume (genera *Fragilaria*, *Melosira*, *Gomphonema*) while in the later phase the species of smaller biovolume (genera *Achnanthes*, *Cymbella*, *Amphora*, *Navicula*) dominated. Algal abundance reached maximum value (614×10^3 cells/cm²) during the sixth week of exposition. Stabilization of the periphytic community in the seventh week of colonization, indicate the possible influence of the flood dynamics on the colonization processes.



UNUSUAL POLLEN FEATURES

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Pollen is ubiquitous. Pollen is microscopically small. Pollen is highly diverse in structure and sculpture. Pollen is resistant to decay. Pollen is species-specific. Therefore, pollen is an excellent tool for many scientific fields, including plant systematics, geological and forensic sciences. *PalDat* (www.palдат.org), the worldwide largest palynological database, shows the enormous diversity and the extraordinary beauty of pollen. Some examples will deliver an insight into unique pollen features, from highly modified pollen walls and their consequences up to exploding pollen.

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