NACIONALNI INŠTITUT ZA BIOLOGIJO
MORSKA BIOLOŠKA POSTAJA

Krajinski park Sečoveljske soline
Parco Naturale delle Saline di Sicciole

PIRANSKE SOLINE

United Nations Educational, Scientific and Cultural Organization

Organizacija Združenih narodov za izobraževanje, znanost in kulturo

Slovenian National Committee of the Intergovernmental Oceanographic Commission

Slovenski nacionalni odbor Medvladne oceanografske komisije

SEČOVELJSKE SOLINE KOT ZNANSTVENORAZISKOVALNI IN IZOBRAŽEVALNI BAZEN

SEČOVLJE SALINA AS A SCIENTIFIC AND EDUCATIONAL BASIN

Sečoveljske soline, 5. Oktober 2012
Sečovlje Salina, October 5th 2012

Zbornik povzetkov

Book of abstracts

1. Mednarodni znanstveni sestanek

1st International scientific meeting

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Mednarodni znanstveni sestanek je organizirala Morska biološka postaja Piran (Nacionalni inštitut za biologijo) v sodelovanju s podjetjem SOLINE Pridelava soli d.o.o. in Krajinskim parkom Sečoveljske soline, s finančno podporo Javne agencije za raziskovalno dejavnost RS ter Slovenske nacionalne komisije za UNESCO. Srečanje je potekalo v multimedijski dvorani Krajinskega parka Sečoveljske soline.

The international scientific meeting was organized by the Marine biology station Piran in collaboration with the company SOLINE Pridelava soli d.o.o. and Sečovlje Salina Nature Park, with the financial support by Slovenian Research Agency and Slovenian National Commission for UNESCO. The meeting was held in the multimedia hall in the Sečovlje Salina Nature Park.

Znanstveni odbor / Scientific committee:	prof. dr. Lovrenc Lipej, doc. dr. Nives Kovač, Neli Glavaš, dott. Roberto Odorico
Organizacijski odbor / Organizing committee:	prof. dr. Lovrenc Lipej, doc. dr. Nives Kovač, Neli Glavaš, Jana Jurjec, dr. Andrej Sovinc
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Izhodišča

Sečoveljske soline so v slovenskem in širšem sredozemskem prostoru priznane kot izjemna lokaliteta, znana tako po svoji izjemni biotski raznovrstnosti (ornitofavna, halofitna vegetacija, redke in ogrožene vrste, izjemna pestrost habitatnih tipov) kot tudi po raznih posebnostih, ki so že od nekdaj pritegnile pozornost širše znanstvene srenje, od kemikov, biokemikov, mikrobiologov, geologov, farmacevtov in pestre množice drugih raziskovalcev. Sečoveljske soline predstavljajo danes, v času globalnega in hitrega izginjanja mokrišč v Sredozemlju in tudi drugod, uspešen model sobivanja trajnostne gospodarske panoge in varovanje izjemne naravne in kulturne dediščine.

Nameni organizacije mednarodnega srečanja so:

- seznanjanje udeležencev z dejavnostmi stroke na področju varovanja in raziskav mokrišč in solinskih območij v obliki uvodnih in plenarnih predavanj ter posterjev,
- raziskovanje in monitoring obrežnih mokrišč,
- predstavitev drugih najnovejših rezultatov raziskovalnega, strokovnega in razvojnega dela vezanega na obravnavano območje (od molekularnega in celičnega nivoja oziroma kemičnih in mikrobioloških vidikov do biotskega nivoja populacij, vrst in združb),
- pomen biodiverzitete solin in drugih obrežnih mokrišč s posebnim poudarkom na izkušnjah upravljanja z zavarovanimi območji,
- posebna pozornost bo namenjena vsebinam povezanimi s tradicionalno pridelavo soli v Sečoveljskih solinah (na mikrobni plasti imenovani petola) ter uporabo drugih produktov solin (slanica, solinsko blato-termalni in wellness turizem),
- izmenjava izkušenj raziskovalnega in strokovnega dela ter vzpostavitev novih in multidisciplinarnih pristopov za raziskovanje tega posebnega okolja.

Organizacijski odbor

The background

Sečovlje Salina represent an exceptional locality in the Slovenian and Mediterranean area known for immense biodiversity (ornitofauna, halophytes, rare & endangered species, outstanding diversity of habitat types) and important natural and cultural heritage including the natural salt production in the traditional manner. For decades Sečovlje Salina attract attention of scientists from different research topics such as chemists, biochemists, microbiologists, geologists, pharmacists and other scientists. Today, in the time of global and rapid devastation and even loss of Mediterranean Salinas and coastal wetlands as well, Sečovlje Salina represents a successful model of symbiosis between the conservation of outstanding biodiversity and cultural heritage and traditional use of Salina's natural resources within Sečovlje Salina Nature Park.

The **aims** of the scientific meeting are:

- the main scientific research activities and conservation efforts of Salinas and other Adriatic coastal wetlands presented in plenary lectures and posters,
- research and monitoring coastal wetlands,
- presentation of the new results and achievements in research, technical development and innovations from the area (from molecular to cellular level; from chemical, geochemical and biological aspect to biotic level),
- importance of the Salina's and coastal wetlands with particular interest of managing protected areas,
- special attention will be dedicated to traditional salt production in Sečovlje Salina (on microbial mat named petola) and other products from saltpans (brine, saline mud - thermal and wellness tourism),
- exchange of experiences from research and experts work and formation of a new and multidisciplinary research approaches in discussed area.

Organizing committee

Soline- ne samo mokrišče

Soline so veliko več kot samo mokrišče. So harmonija človeškega dela in naravnih procesov ter edinstveno, a hkrati nenavadno in skrajnostno življenjsko okolje. Le redke živalske in rastlinske vrste ter nekateri drugi organizmi so sposobni kljubovati ostrim in skrajnim razmeram, ki vladajo temu hipersalinemu okolju. Kakorkoli že, nekatere vrste, ki niso nujno prave solinske živali, redno iščejo hrano ali vsaj počivališče v času gnezditve.

Biologi in geologi so bili med prvimi, ki so doumeli izjemen pomen solin in solnih polj za raziskovanje naravnih procesov in biotske raznovrstnosti. Sledili so jim raziskovalci drugih naravoslovnih znanstvenih disciplin, sočasno pa so odkritja o izjemni naravni dediščini dopolnjevala spoznanja o posebni in bogati kulturni dediščini. Danes hipersalino okolje privablja veliko število raziskovalcev iz različnih znanstvenih področij, ki so spoznali posebne značilnosti v solinah. In ravno zaradi tega se je porodila zamisel o multidisciplinarnem znanstvenem srečanju, na katerem bi se lahko raziskovalci seznanili z vsemi aspekti raziskav, ki potekajo v solinah in podobnih življenjskih okoljih.

Zakaj smo za srečanje izbrali Sečoveljske soline? Ne zato, ker so ravno v Sečoveljskih solinah zabeležili zapis o velikem kitu glavaču, ki je leta 1555 nasedel v solinah in gre za enega najstarejših tovrstnih zapisov o kitih nasploh, prav tako nismo imeli v mislih skrivnostni kompleks petole ali izjemno bogato ornitofavno. Dejstvo je, da danes upravljata s solinami dva nenavadna partnerja, podjetje Soline

Salina – not only a wetland

Saltmarsh is much more than only a wetland. It is a harmony of human work and natural processes, making this unique environment such peculiar and extreme. Only few animals, plant and other species are able to withstand the harsh and extreme conditions, present in the hypersaline environment. However, many other species, not necessarily related to saltmarshes, regularly use this environment, able to finding food or at least a resting site during the period of migration.

Biologists and geologists were the first to recognize the immense importance of salinas and saltmarshes for the research of natural processes and biodiversity followed by many other scientists in the field of natural history. The outstanding natural heritage was complemented together with the peculiar and impressive cultural heritage. Nowadays, the hypersaline environments attract the attention of huge number of scientists of different scientific fields, who recognized peculiar features in salinas. And that is the main reason why the idea of the multidsciplinary meeting covering all aspects of the scientific activities involved in salinas and similar wetlands was born.

But why is this meeting held in the salina of Sečovlje? Not because this is the place where it was recorded the oldest Mediterranean case of a sperm whale stranding in 1555, neither because of the mysterious petola complex or the outstanding bird fauna. The fact is that in this salina there is an interesting couple of very committed partners, both dedicated to

Pridelava soli d.o.o. in Krajinski park Sečoveljske soline, ki se zavedata izjemne dediščine, ki jim je bila zaupana, in nanjo predano bdita. Obenem pa spodbujata raziskovanje in izobraževanje na solinah iz vseh vidikov.

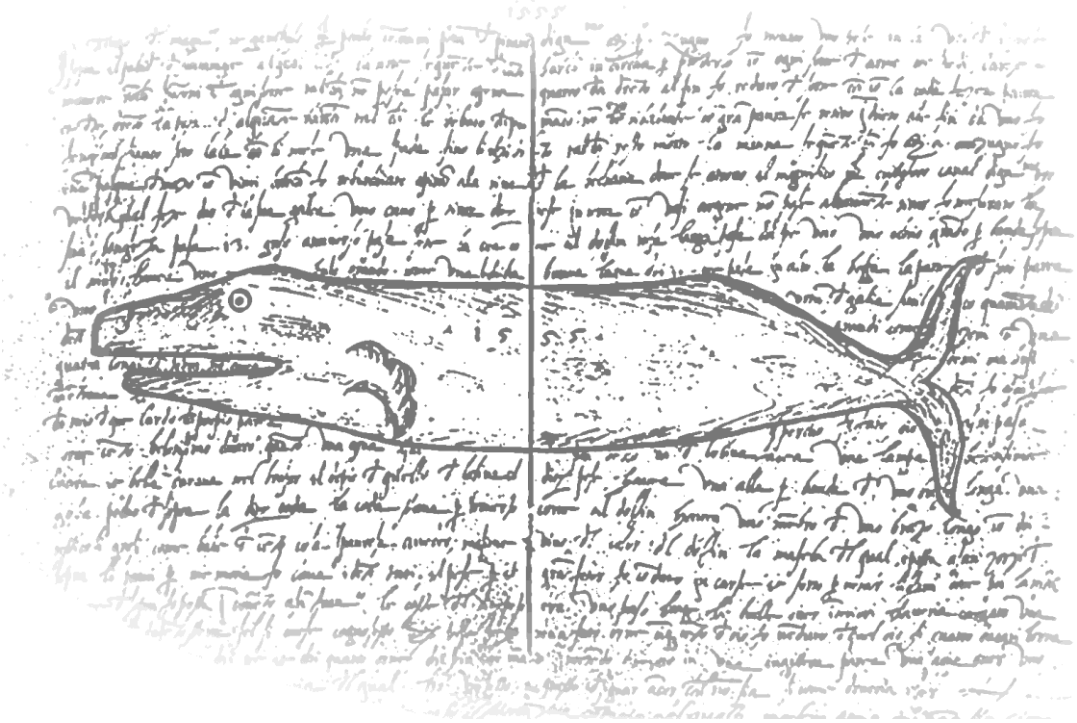
the management and protection of the salina, the enterprise SOLINE Pridelava soli d.o.o. and the Natural park KPSS. Both of them are aware of the importance of the salina and its heritage, but also support all kinds of research and education.

Zaključujem z upanjem, da bo srečanje izpolnilo pričakovanja udeležencev iz vseh inštitutov in organizacij iz treh sodelujočih držav. Zamisel o izmenjavi znanja, kresanju mnenj in po možnosti navezavi sodelovanja med raziskovalci bo gotovo ponudila nove možnosti za vse tiste, ki menijo, da si čudovito solinsko okolje zasluži vso raziskovalno pozornost.

To this end, I hope the meeting will meet the expectations of participants from all Institutes and organisations of all three countries involved. The idea to share the knowledge, to exchange opinions and hopefully to establish cooperation among various participants would certainly bring new perspectives for all of those who find the salina, this amazing environment, worth to be properly studied.

prof. dr. Lovrenc Lipej

Predsednik organizacijskega odbora/Chairman of organizing committee



Program/Programme

8:00 **Prijava udeležencev / Participants registration**

9:00 **Pozdravni govori in predstavitev srečanja / Welcome speech and presentation of the meeting**

- Klavdij GODNIČ, direktor podjetja SOLINE Pridelava soli d.o.o. / director of company SOLINE Pridelava soli d.o.o.
- prof. dr. Tamara LAH TURNŠEK, direktorica Nacionalnega inštituta za biologijo / director of National institute of biology
- dr. Peter Bossman, župan občine Piran / major of Piran
- Marjutka Hafner, generalna sekretarka Slovenske nacionalne komisije za UNESCO / secretary general of the Slovenian National Commission for UNESCO
- prof. dr. Lovrenc LIPEJ, Nacionalni inštitut za biologijo, Morska biološka postaja Piran/ National institute of biology, Marine biology station Piran
- dr. Andrej SOVINC, vodja Krajinskega parka Sečoveljske soline / Head of Sečovlje Salina Nature Park

9:30 **Raziskave flore in vegetacije Sečoveljskih solin v zadnjih tridesetih letih: kako naprej? / Flora and vegetation research of Sečovlje Salina over past 30 years: where do we go from here?**
Mitja KALIGARIČ, University of Maribor

10:00 **Val Cavanata med varovanjem in trajnostnim turizmom / Val Cavanata between conservation and nature tourism**
Roberto ODORICO, Shoreline Soc. Coop.

10:20 **Ekološke študije v solinah Commacchio / Ecological studies in the Comacchio Saltworks**
Michele MISTRI, University of Ferrara

10:40 **Maranska in gradeška laguna: status vodne favne in njeni viri / The Marano and Grado Lagoon: status of the aquatic fauna and its resources**
Nicola BETTOSO, Osservatorio Alto Adriatico ARPA FVG

11:00 **Krajinski park Sečoveljske soline: model dobre prakse tudi za življenje zunaj zavarovanega območja / Sečovlje Salina Nature Park: model of good practice for sustainable living outside of a protected area**
Andrej SOVINC, Sečovlje Salina Nature Park, Slovenia

11:20 **Odmor za kavo / Coffee break**

11:40 **Sečoveljske soline-geološki laboratorij v naravi: sedimentologija / Sečovlje saltern – geological laboratory in nature: sedimentology**
Bojan OGORELEC, Geological Survey of Slovenia

12:00 **Sečoveljske soline-geološki laboratorij v naravi: biogeokemija / Sečovlje saltern – geological laboratory in nature: biogeochemistry**
Jadran FAGANELI, Marine biology station Piran

12:20 **Glive v solinah – lokalni ali globalni fenomen? / Fungi in salterns – a local or a global phenomenon?**
Nina GUNDE CIMERMAN, University of Ljubljana

12:40 **Algne tehnologije -pregled in ideje za revitalizacijo solin, ki bazirajo na trajnosti in obnovljivosti / Algal technology – a review and some ideas for revitalization of Salinas based on sustainability and renewability**
Miha ŽITNIK, Algen, algal technology centre

13:00 **Kosilo / Lunch**

13:40 **Balneologija na Hrvaškem: preteklost, sedanjost in prihodnost / Balneology in Croatia: past, present and future**
Jagoda DOKO JELINIĆ, University of Zagreb

14:00 **Turizem kot stranski produkt pridelave soli / Tourism, a by-product of salt production**
Tomi BREZOVEC, Faculty of Tourism Studies Portorož - Turistica

14:20 **Pridelava soli, varovanje in opredelitev Naravnega rezervata solin Trapani in Paceco / Salt production, nature conservation and evaluation of the Nature reserve of Salinas Trapani and Paceco**
Girolamo CULMONE, WWF Italia, R. N. O. Saline di Trapani e Paceco

14:40 **Naravni rezervat Škocjanski zatok: ohranjanje in izboljšanje ekosistemskih storitev kljub urbanemu pritisku / Škocjanski zatok natural reserve: maintaining, enhancing ecosystem services despite urban pressures**
Barbara VIDMAR, Institute of the RS for nature conservation

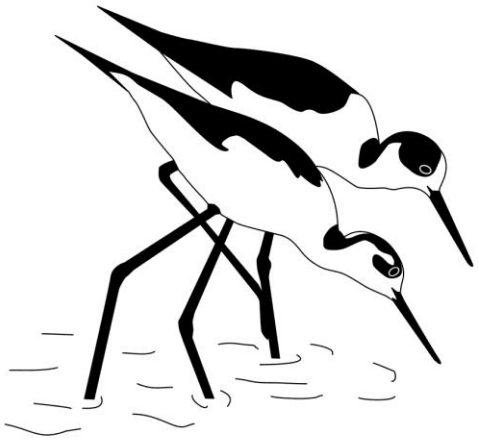
15:00 **Biogeokemijske raziskave v Sečoveljskih solin / Sečovlje Salina research on biogeochemistry: State of the art**
Neli GLAVAŠ, Nives KOVAČ, Marine biology station Piran (NIB)

15:20 **Razprava in zaključki / Discussion and conclusions**

16:00 **Ogled Krajinskega parka Sečoveljske soline / Visit to the Sečovlje Salina Nature Park**

Poster sekcija bo vseskozi odprta (9:00-16:00)

Poster session will be open throughout all the meeting (9:00-16:00).



Povzetki prispevkov /

Abstracts

RAZISKAVE FLORE IN VEGETACIJE SEČOVLEJSKIH SOLIN V ZADNJIH TRIDESETIH LETIH: KAKO NAPREJ?

FLORA AND VEGETATION RESEARCH OF SEČOVLJE SALINA OVER PAST 30 YEARS: WHERE DO WE GO FROM HERE?

Mitja KALIGARIČ, Sonja ŠKORNIK, Danijel IVAJNŠIČ and Nina ŠAJNA

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Vegetation research in Sečovlje Salina area started in 1978. First phytosociological relevees were taken in 1982 by T. Wraber. Then, in 1988 a first overview of 5 classes of halophyte vegetation had been assessed and roughly mapped. Large surfaces of *Limonium angustifolium* and *Sarcocornea fruticosa* dominated communities were present in the area of Fontanigge, however, at the end of eighties the most valuable areas was flooded and previously vegetated area substantially reduced their surfaces. In 2006 revised vegetation survey of most extreme halophyte vegetation were published. The floristically-poor association Suaedo maritimae-Salicornietum patulae tends to form monodominate stands with *Salicornia europaea* s.l. on mudflat hypersaline stands. The association Suaedo maritimae-Bassietum hirsutae occupies smaller surfaces on drier stands. Both were classified within halophile annual swards of the class Thero-Salicornietea. *Spartina maritima*-dominated perennial halophyte saltmarshes (association Limonio-Spartinetum maritimae, class Spartinetea maritimae), colonizes muddy islets, perturbed by high tide and supports brackish nutrient-rich water (on Dragonja mouth and Sv. Jernej channel) In 2007 halophyte vegetation which occur on drier stands were published The *Juncus maritimus*-dominated tall rush saltmarshes of the class *Juncetea maritimi* were classified within two association: Limonio-Puccinellietum represented hygrophilous stands, while the Juncetum maritimi-acuti is represented with more closed stands with higher species richness, thriving on rather drier sites. Tall rush saltmarshes occur in Sečovlje Salina only in fragments and are currently still declining. Within the saltmarsh scrubs of the class *Arthrocnemetea fruticosi*, 3 associations, following the declining moisture/salinity gradient were recognized: Puccinellio-Arthrocnemetum, Puccinellio-Halimionetum and Limonio-Artemisietum. Study (2008) of most prominent halophyte of the sedimentary coasts of the northern Adriatic, the glasswort (*Salicornia*), previously attributed to one species *S. herbacea* s.l., revealed that there are two different species in the Gulf of Trieste and also in Sečovlje salina. The genetic variability of four predetermined morphotypes of glassworts (*S. patula, S. emerici, S. veneta* and the ‘‘saline type’’) were studied by means of ploidy level estimation and by molecular DNA analysis of ITS regions of nrDNA and cpDNA. Along with morphometric analysis, a diploid *S. patula* and the widely distributed tetraploid *S. emerici* were confirmed. *S. emerici* is also comprising the ‘‘saline type’’ and morphotype, known as a charismatic endemic *S. veneta*, a flagship species for nature conservation in Italian coastal wetlands. However, the separate occurrence along a salinity-moisture gradient enables coexistence of these two sympatric species in all coastal wetlands, including Sečovlje Salina. A much more simple approach then vegetation mapping was applied in 2011: the detailed habitat mapping (resolution 1 meter), following the PHYSIS typology. It revealed that only 35% of the Sečovlje Salina is

still vegetated with halophyte vegetation. Taking in consideration the climate change-driven sea-level rising, modelled from data for Koper, those surfaces will be further reduced in the future, since coastal wetlands have limited buffer zones due to the usual human pressures to the coasts. In the frame of the HABIT-CHANGE project (http://www.habit-change.eu/) we built a prediction model, which demonstrated to which degree, how and where the coastal habitats will shift to each other and decrease their surfaces in total, taking into consideration scenarios for the climate change-driving sea level rise for 5, 10, 15, 20 and 30 cm. The percentage of water will increase to almost 65% in the worst case scenario. The halophyte vegetation will decrease by 2050 to 14% and till 2070 to only 12% of the total area of Sečovlje Salina. The countermeasures should go into three directions: the creation of artificial islets on desired microelevation, suited for specific habitat type; to enlarge the buffer zones and – rarely possible – artificial regulation of the sea level in a semi-closed system.

Keywords: halophyte vegetation, *Salicornia*, syntaxonomic classification, climate change, sea-level rise, mapping, predictions

VAL CAVANATA MED VAROVANJEM IN TRAJNOSTNIM TURIZMOM

VAL CAVANATA BETWEEN CONSERVATION AND NATURE TOURISM

Gianna VISINTIN[1], Milena TEMPESTA[1], Andrea ROCCO[2], Roberto ODORICO[1] and Franco ZUPPA[1]

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The Val Cavanata's district is one of the wet areas of international interest under the Ramsar Convention since 1978 and it is classified as "Oasis of protection" by the regional agriculture department in 1979. The Regional Nature Reserve "Val Cavanata" is part of the Natura 2000 network as Site of Community Importance (SCI) and Special Protected Area (SPA) respectively under the Habitats Directive 92/43 and the Birds Directive 79/409 of the European Union. The protected area is largely composed of an ex fishing hunting valley and a not very deep lagoon area with shoals and sandbanks, hydraulically contained and isolated from the surrounding waters, in addition to the northern part of the channel Averto and the band of forest that grows along its banks. The predominant landscape aspect that characterizes the area is constituted by tanks in which the fish was bred until 1995. This is an area in which the man has acted and still acts, favouring or modifying the natural tendencies in order to ensure and, if possible, to increase in a particular way the presence of the avifauna. Val Cavanata represents an extremely conspicuous part of territory once devoted in production and hunting. This usage, by now abandoned, preserves the imprint of this secular transformation, so that although there is not a general and widespread commercial component of production, these fields constitute an element of the landscape that in a perspective of the land protection represent an important alliance between man, nature and the knowledge of the natural rhythms that regulate seasonally the population of these environments. The theme of the transformation of the territory, the different modes of exploitation, often turned out to be uneconomical and the gradual renaturalization gives prominence to the appreciation of the natural cycles seen both from the point of view of a restoration of the traditional activities of the valley as an instrument of land conservation, both in terms of an alternative tourist offer. The mount of juveniles and the arrival of ichthyophagous are the phenomena more pronounced that over the years regularly characterize this area. Starting from experimental models of development aimed to pay greater attention to these natural rhythms, their spreading and sharing in larger systems including the Slovenian protected areas the project might lead to an ecological model exportable to other areas, today unproductive bringing them to make that jump of quality that now for economic reasons are not able to do.

Keywords: conservation, sustainable tourism, Val Cannavata, protected areas

EKOLOŠKE ŠTUDIJE V SOLINAH COMMACCHIO

ECOLOGICAL STUDIES IN THE COMACCHIO SALTWORKS

Cristina MUNARI and Michele MISTRI

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The Comacchio Saltworks, whose present day form is owed to the Napoleonic Government in 1808, remained productive until 1985, when the Ministry of Finance decided to cast off the Saltworks. Until the early 2000s, nothing had been done to the Saltworks, and the area appeared like a sort of completely abandoned industrial ruin. Within a LIFE Project framework, several years of ecological studies and many interventions were carried out, in order to make this site dedicated to the conservation of biodiversity and material witness of the local history and culture. Fauna and flora inventories were compiled. Then the catalogue of the different historical buildings in the Saltworks (some dating back to the Middle Age) was presented. Disused overhead electric cables and a warehouse with cement-asbestos roof were removed. Such operations greatly improved the perception of the landscape, eliminating elements which interrupted the horizontal character typical of the Saltworks. Faunal studies regarded mostly the benthic fauna of the major basins, but also birds and fish fauna were investigated. During the study period, a summer prolonged heat wave interested Western and Southern Europe, and we had the opportunity to study its effects on the benthos of the Saltworks. The summer of 2003 was the warmest summer in Europe since the 16th century. Its consequences on the fauna of the Saltworks were studied through biodiversity, functional and ecological indicators. The heat wave caused considerable changes in the benthic community structure and relative composition. Animal assemblages switched from mollusc- to annelida-dominated. The resilience of molluscs biocoenosis resulted limited with respect to other taxa, posing concerns about their conservation if, as predicted, the frequency of summers as hot as that of 2003 will progressively increase to become the norm at the end of this century.

Keywords: Comacchio Saltworks, benthic community, biodiversity, northern Adriatic

MARANSKA IN GRADEŠKA LAGUNA: STATUS VODNE FAVNE IN NJENI VIRI

THE MARANO AND GRADO LAGOON: STATUS OF THE AQUATIC FAUNA AND ITS RESOURCES

Nicola BETTOSO, Alessandro ACQUAVITA and Giorgio MATTASSI

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The Marano and Grado Lagoon is one of the best conserved wetlands in the whole Mediterranean area. It is a shallow system, extending for approximately 32 km reaching up to 5 km of width for a total area of 160 km2, located between the Tagliamento and Isonzo River deltas. The Lagoon is protected by the Ramsar Convention since 1971. Following the implementation of the Habitats Directive (92/43/EC), which concerns the protection of biodiversity, it was also identified in the state-sponsored "Natura 2000" survey as a Site of Community Importance (SCIs – IT3320037). The area hosts economic, tourism and industrial services, with fishing, clam harvesting (mainly Tapes philippinarum) and fish-farming comprising the most important resources for today's local inhabitants. On the other hand, the system experienced some remarkable environmental impacts, mainly mercury, which have affected the high-value natural ecosystem and consequently influenced relevant socio-economic aspects. In spite of the presence of this chemical pollution, taking into account the application of European environmental rules (WFD 2000/60/CE) about the aquatic fauna, no clear criticism of the ecological status for both macrozoobenthos and fish fauna was found. If the diversity and the distribution of macrozoobenthos in the Lagoon are considered, a clear relationship with the salinity gradient, due to the closeness and/or proximity of the sea, was observed. Dominant species resulted to be typical resident of lagoon environment, accompanied with opportunistic species, which are able to tolerate the wide variations of chemical and physical parameters of the system. During a three years monitoring of fish fauna, performed with the aid of local fishermen by means of fyke nets, more than 40 fish species were recorded. Most were caught in the innermost area of the Marano Lagoon, due to the concomitant presence of the typical estuarine and freshwater species, and marine migrants. Moreover, in this area were found some important protected species listed in the Habitats Directive, such as *Pomatoschistus canestrinii*, *Knipowitschia panizzae* and *Aphanius fasciatus*. Particularly, *P. canestrinii* was almost exclusive of the most confined area of Marano's basin, where salinity ranges between 5 - 20 psu. The sand smelt Atherina boyeri constitutes the target species caught by fyke nets. In terms of abundance and economic value, this species represents about 75% of the total catchments, followed by the flounder *Platichthys flesus* and the lagoon shrimps such as Palaemon adspersus and Crangon crangon. Within the Lagoon a tradition of fish farms, especially sea bream (*Sparus aurata*), sea bass (*Dicentrarchus labrax*), eel (*Anguilla anguilla*) and mullet (*Mugil* spp.) was historically developed. In addition, since 1986 Manila clam (*Tapes philippinarum*) was also introduced for aquaculture purposes. Due to the spreading, the massive abundance, the easiness of harvesting and overall the considerable market of this species, the traditional fishery was almost dismissed. Thus, an impulsive and uncontrolled exploitation of this resource occurred, followed by the remobilization of sediment with its potential contaminants. In

2010 the whole production in the Marano Lagoon amounted to 1,042 tons, of which 74% derived from aquaculture in about 130 ha. Nevertheless, after 25 years from its introduction, Manila clam has never threatened the Lagoon biodiversity, being the actual development of its sustainable culture a possible benefit for the local fisheries economy.

Keywords: Marano and Grado Lagoon, northern Adriatic Sea, fish fauna, macrozoobenthos, ecological status, fisheries resources, aquaculture, Manila clam

KRAJINSKI PARK SEČOVELJSKE SOLINE: MODEL DOBRE PRAKSE TUDI ZA ŽIVLJENJE ZUNAJ ZAVAROVANEGA OBMOČJA

SEČOVLJE SALINA NATURE PARK: MODEL OF GOOD PRACTICE FOR SUSTAINABLE LIVING OUTSIDE OF A PROTECTED AREA

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Sečovlje Salina Nature Park (Piran, SW Slovenia) was established by the Republic of Slovenia which is also the owner of almost all the land and infrastructure within the Park's borders. Management of this Protected Area was entrusted to a private company. This innovative management model is very particular and enabled reconstruction and maintenance of traditional salt-making process and related cultural landscape, development of the local community it contributes to tourism potential of the coastal region and at the same time maintains or even enhances conditions for typical, rare and endangered biodiversity in saline coastal areas. Although all the activities in this Nature Park can only be conducted if they have no adverse impacts for nature and cultural heritage of the area number of employees and visitors is still increasing. Key difference between management of the Nature park and sustainable development outside Protected Area is in understanding and implementing the fact that long-term preservation of nature on the Planet could not be achieved only by imposing »green technologies« but only when man will understand that some of the current »western culture commodity« will have to be sacrificed. Experiences gained in management of the Sečovlje Salina Nature Park – despite initial hesitations – demonstrate that such limitations expressed in the management decisions are not obstacles in further development of the Protected Area and protection of its biodiversity. Innovative ways of visitor's management will be presented together with details which draw a line between economically viable and environmentally acceptable land-uses in the Protected Area. Particular attention will be dedicated to present mitigation measures to reduce negative impacts of climate change on biodiversity of the area as result of the activities undertaken within the HABIT-CHANGE project (http://www.habit-change.eu/).

Keywords: Sečovlje Salina, sustainable development, climate change, management, protected areas, biodiversity

SEČOVELJSKE SOLINE - GEOLOŠKI LABORATORIJ V NARAVI: SEDIMENTOLOGIJA

SEČOVLJE SALTERN – GEOLOGICAL LABORATORY IN NATURE: SEDIMENTOLOGY

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The saltern of Sečovlje is located in the inner part of the Bay of Piran (Gulf of Trieste, northern Adriatic Sea) in the mouth Plain of Dragonja River. Part of the saltern complex of some 8 km^2 named Fontanigge has been abandoned some decades ago and turned into a landscape park as reservation for birds and halophilous organisms. At present, the Lera salt-pans, situated in the northern part of the river plain are still in operation. There the seawater evaporates in 16 large salt pans until crystallization of halite occurs. The Sečovlje saltern can be viewed as an artificial (human made) evaporitic environment in nature. The recent sediment of the inner part of the bay is up to 90 m deep, with rather uniform character, composed of dark gray clayey silt, rich in molluscan and foraminiferal skeletons indicating marine-brackish depositional environment. The typical fluvial deposits are scarce. Some peat horizons detected in the borehole V6 drilled in the Lera area indicate marshy phases as well. The radiometric ^{14}C dating of wood sample from the depth of 27 m revealed its age of 9160 years BP indicating a fairly fast average sedimentation of about 3 mm/y. The sediment in the salt-pans consists of fine argillaceous silt with approximately 20% of carbonate and up to of 2% $C_{org.}$ During evaporation of seawater, gypsum, Mg-calcite, halite and pyrite are formed as authigenic minerals. Special feature of the salt-pans is *petola*, up to 2 cm thick gelatinous stromatolite mostly composed of cyanobacteria and diatoms, on which salt is formed.

Keywords: hypersaline environment, sediments, sedimentation, stromatolites, northern Adriatic

SEČOVELJSKE SOLINE - GEOLOŠKI LABORATORIJ V NARAVI: BIOGEOKEMIJA

SEČOVLJE SALTERN – GEOLOGICAL LABORATORY IN NATURE: BIOGEOCHEMISTRY

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The about 90 m thick Holocene sediment of the basement of Sečovlje saltern documents, according to the composition of sedimentary organic matter in terms of Corg, Norg, Corg/Norg ratios and δ^{13}Corg values, temporal changes between riverine, brackish and marine environments. Incresed Corg contents were typical for »peat« horizonts of terrigenous origin with low δ ^{13}Corg values. The highest Corg/Norg ratios were found in horizons of reduced brackish environment where prevalently marine Norg is decomposed. The geochemical processes in the sea water evaporation and salt chrystalization leads first to calcite precipitation, due to Ca^{2+} supersaturation and lower HCO_3^- and CO_2 concentrations due to cianobacterial uptake, later (5-fold evaporation) to $CaSO_4$ precipitation and finally (10-fold evaporation) to halite precipitation. During evaporation, Mg^{2+} concentration increases. The precipitation of calcite leads to substantial pH lowering. During sea water evaporation, the temperature increases, O_2 concentration and Eh decrease leading to anoxic conditions at halite precipitation. At halite precipitation, δ^{13}C and δ^{18}O values in water increase. Evaporation processes are also reflected in ^{12}C and ^{18}O fractionation in DIC showing increasing values with salinity till calcite precipitation when ^{12}C and ^{16}O levels decrease. The pecular biogeochemical characteristics of surficial sediment in the Sečovlje salt pans is the presence of stromatolite (»petola«) composed of microbes (microalgae, bacteria) incrustated with minerals. »Petola« consists of higher carbonate and Corg contents compared to dark anoxic subsurficial sediment. The sediment surface is characterized by the formation of goethite from oxidation of Fe(II) produced in an anoxic zone. Nutrient levels in the brine are increasing with increasing salinity due to sea water evaporation and sedimentary organic matter degradation since autotrophs act as nutrient consumers and sources. The high $\sum Nin/PO_4^{3-}$ ratios, normally found at lower brine salinity suggests P as a limiting nutrient while at higher salinities the limitation turns to N and successivelly again to P. However, the important role of P is supported by low sediment δ^{15}N values indicating cyanobacterial N_2 fixation. While phosphate in the surface sediment pore waters mostly originates from Porg mineralization the authigenic formation of apatite in lower strata cannot be excluded. The increasing Si levels in brine with increasing salinity are probably the result of dissolution of diatom frustules while the pore water Si concentrations decreasing with salinity can be due to increasing benthic microbial uptake.

Keywords: hypersaline environment, organic matter, stromatolites, nutrients, northern Adriatic

GLIVE V SOLINAH – LOKALNI ALI GLOBALNI FENOMEN?

FUNGI IN SALTERNS – A LOCAL OR A GLOBAL PHENOMENON?

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Our studies initiated more than a decade ago in Sečovlje Salina and later extended to different salinas around the world, have revealed a surprising diversity of fungi that inhabit these stressful environments, hostile to most eukaryotes. They showed that not only halophilic and halotolerant Bacteria and Archaea but also selected groups of fungi can adapt to these habitats, characterized by high salt concentrations, high temperatures, neutral to basic conditions, high UV radiations, oxidative stress and low water activity. All around the globe these conditions repeatedly selected for the same groups of fungi, polyphyletic in origin, that have evolved a plethora of adaptive mechanisms to cope with these extremes. The main traits which enable successful adaptations are asexuality, synthesis of melanin-like pigments, flexible morphology and different molecular responses. These adaptations, important for understanding the adaptive evolution of extremophiles, will be exemplified by studies on three fungal model organisms: ubiquitous, halotolerant black yeast *Aureobasidum pullulans*, the extremely halotolerant black yeast *Hortaea werneckii* and the halophilic basidiomycetous fungus *Wallemia ichthyophaga*. These fungi differ considerably in their adaptations to hypersaline conditions and in their ability to grow at low aw due to high concentrations of NaCl. *A. pullulans* can grow up to 3.0 M, *H. werneckii* up to 5.0 M, *W. ichthyophaga* requires at least 1.5 M and thrives up to saturation (5.2 M) NaCl, while *Saccharomyces cerevisiae*, the usual model organism for adaptations in eukaryotes, can grow up only to 1.2 M NaCl.

Keywords: Salterns, extremophilic fungi, model organisms, black yeasts, g. *Wallemia*

ALGNE TEHNOLOGIJE – PREGLED IN IDEJE ZA REVITALIZACIJO SOLIN, KI BAZIRAJO NA TRAJNOSTI IN OBNOVLJIVOSTI

ALGAL TECHNOLOGY – A REVIEW AND SOME IDEAS FOR REVITALIZATION OF SALINES BASED ON SUSTAINABILITY AND RENEWABILITY

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Algal technology spans a set of disciplines directed into useful growth and exploitation of non-plant photosynthetic organisms. Activities in this area are not new but general interest highly correlates with oil prices thus reflecting the huge potential algae hold in producing renewable biofuels. However, biofuels are by no means the only useful product we may expect from algae. We will present an overview of the field with special emphasis on activities related to marine and saline environment. A few ideas how to integrate such activity in the salt pans environment will be given in search for coexistence of modern and traditional biotechnology and conservation integrated with sustainable development. We will propose production of high value algal products and demonstration of low value products. Production of low value products is being moved into the ocean for reasons of nutrients and land use and Salinas and adjacent aquatorium is an excellent natural laboratory for research of new marine based technologies. Extremophiles as efficient production species and as sources of new high value products may be studied. Available resources such as land space, sea space, thermal water, nutrients and CO_2, will be reviewed. Last but not least, the integration of a proposed demo and/or research center and/or science park will be considered in view of exposition to number of visitors and its touristic potential can be exploited to convey the message of sustainability and renewable to wider public with a check of potential financing options for such a project.

Keywords: algal technology, biofuels, renewable energy, high-value bioproducts, marine technology, extremophiles, science park

BALNEOLOGIJA NA HRVAŠKEM: PRETEKLOST, SEDANJOST IN PRIHODNOST

BALNEOLOGY IN CROATIA: PAST, PRESENT AND FUTURE

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Balneology and climatology are linked into unique discipline called balneoclimatology with aim to study the influence of natural remedies, especially thermomineral water, peloids and clime on human body. Recently, Croatia celebrated 300'rd anniversary of balneology service, because there is a rich tradition of using our natural remedies. Today most of research is carried out on School of Public Health "Andrija Štampar" which is the part of University of Zagreb School of Medicine. Department of Environmental and Occupational Health have a division for water and balneoclimatology. Balneological Institute was founded in 1949 and since then was made over 400 balneological analyses and around 300 opinions, also Archive was established. Croatia has over 140 sources of mineral waters and peloids but just few of them are exploited and most isn't balneologicaly analysed. There is still need for balneological analysis of natural remedies: thermomineral water, peloids, naphthalene and climate. Priority tasks would be: a) detection and registration of new locality of thermomineral waters and peloids, b) determination of indications and contraindications, c) use of thermomineral waters and peloids in health services, d) making regularly balneological analysis of mineral water and peloids, e) permanent education of people working in balneological service, f) collection and deposit of archive and other material from balneology. Division for Water and Balneoclimatology is planning: a) prepare cadastre of thermomineral waters, b) create a map of all localities of thermomineral waters and peloids, c) based on new results prepare brochure with the list of spas and springs. The use of natural remedies in Croatia has thousands of years old tradition. For three centuries last scientific-research activities, and the 63 years of organized (institutional) balneology. With all this, the use of natural remedies is far from being satisfactory, because there are yet unexplored and unused potential.

Keywords: balneology, thermomineral water, peloids, balneoclimatology, natural remedies

TURIZEM KOT STRANSKI PRODUKT PRIDELAVE SOLI

TOURISM, A BY-PRODUCT OF SALT PRODUCTION

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Tourism development in Portorož has started in late 19th century, when first tourists seeking remedy for their health problems arrived. Salt production in nearby salt pans provided mud and concentrated sea water, which were used in treatments against rheumatism, respiratory and dermatological problems. Portorož was officially proclaimed a spa in 1897 and large investments in hotels and spa facilities soon transformed an empty valley into a tourist resort. Contrary to other seaside destinations with main season from November to April when tourists came to the seaside to escape harsh continental winter, Portorož attracted tourists during summer months when mud and salt used for treatments were available. Sea bathing was also popular but spa treatments remained a primary reason for visiting Portorož until the second half of 20th century, when fun and entertainment, gambling and congress tourism prevailed. Today, in search of competitive advantage, Portorož is reconsidering its natural elements from Salinas and their use in tourism.

Keywords: tourism development, health treatments, natural elements

PRIDELAVA SOLI, VAROVANJE IN OPREDELITEV NARAVNEGA REZERVATA SOLIN TRAPANI IN PACECO

SALT PRODUCTION, NATURE CONSERVATION AND EVALUATION OF THE NATURE RESERVE OF SALINAS TRAPANI AND PACECO

PRODUZIONE DEL SALE E ATTIVITÀ DI PROTEZIONE E VALORIZZAZIONE DELLA RISERVA NATURALE ORIENTATA SALINE DI TRAPANI E PACECO

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Le saline pur essendo un ambiente costruito, modificato e controllato dall'uomo, rappresentano un'attività produttiva che non solo è compatibile con il sistema biologico ed ecologico, ma ne sono addirittura il presupposto essenziale. Come un super organismo nella successione delle vasche, trovano il loro habitat ideale specie vegetali ed animali, in una sequenza di ecosistemi, in cui il tasso di biodiversità diminuisce all'aumentare della salinità passando dal *Phoenicopterus roseus* a specie adattate ad ambienti estremi, come la *Dunaliella salina* e *l'Artemia salina*, fino ai microrganismi più resistenti in assoluto come le Halobacteriacee. Ogni differente ordine di vasche presenta una caratteristica comunità biotica, con specie strettamente legate alle diverse condizioni ecologiche e ciò spiega l'elevato numero di forme di vita in un spazio fisicamente ridotto come una salina. Ma è l'azione dell'uomo a mantenere l'equilibrio di questo ecosistema, senza la continua circolazione delle acque, le varie vasche tenderebbero a contenere acque con salinità uniforme e ciò comporterebbe la perdita di molte specie, fino ad arrivare alla totale scomparsa dell'habitat. In questo connubio tra attività produttiva e natura non va dimenticato che alcuni di questi organismi, hanno un ruolo fondamentale anche nella stessa produzione del sale. Così come, il mantenimento dell'attività produttiva tradizionale insieme agli interventi di tutela rappresentano uno strumento per la promozione del territorio e dei suoi prodotti, creando opportunità di sviluppo fondate sulla valorizzazione della biodiversità e del patrimonio culturale locale a conferma del ruolo dell'area protetta quale strumento per lo sviluppo socio-economico del territorio.

Parole chiave: saline, biodiversità, valorizzazione, uso sostenibile.

NARAVNI REZERVAT ŠKOCJANSKI ZATOK: OHRANJANJE IN IZBOLJŠANJE EKOSISTEMSKIH STORITEV KLJUB URBANEMU PRITISKU

ŠKOCJANSKI ZATOK NATURAL RESERVE: MAINTAINING, ENHANCING ECOSYSTEM SERVICES DESPITE URBAN PRESSURES

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Škocjanski zatok NR is located between the Port of Koper, the downtown, bus and train station and bounded with a motorway and regional roads. There is also a business district in construction on its east part. Due to its location, it has been and still is a subject of many urban pressures.At the moment of formation the lagoon was much lager than today (230 ha of surface) and very rich in biodiversity. At that time the historical ecosystem services (provisioning, regulating, supporting services) were fully present, especially fishing and salt production, meanwhile the cultural services, such as education and recreation were not very developed. Nowadays, after a history of degradation, official protection of the area and restoration efforts, the remaining 120 ha of protected area offer a reduced range of regulating and supporting services, but an increased amount of educational, recreational and scientific services. There is also a list of new potential provisioning services, such as use of biomass for fuel, animal products (milk, cheese and honey), use of reed and willow for handicrafts, water for irrigation and production of natural fertiliser.

Keywords: ecosystem services, Škocjanski zatok, urban pressures

BIOGEOKEMIJSKE RAZISKAVE V SEČOVELJSKIH SOLINAH

SEČOVLJE SALINA RESEARCH ON BIOGEOCHEMISTRY: STATE OF THE ART

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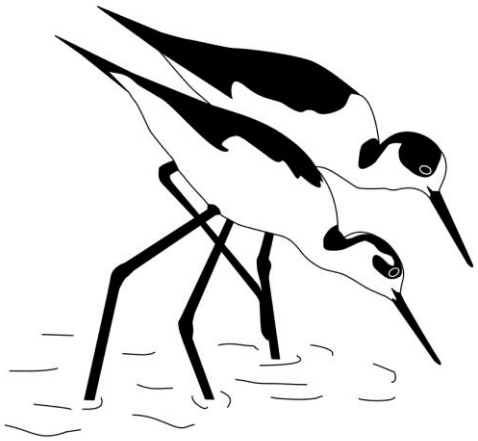
In the Sečovlje Saltpans have been performed a lot of studies of flora and fauna and numerous publications are dedicated to the cultural tradition of that area. However, there is a lack of studies of solid (sediment) and aqueous (brine) phase of saltpans. Extensive investigations of chemical processes, occurring during the salt crystallization, go back to 80ies (Golobić in Schneider, 1972; Schneider 1977; Schneider in Herrmann, 1980) and 90ies (Ogorelec et al., 1980; 1981; 1983; 1985). After 1990 more attention was devoted to mycological and microbial research (extensive work by Gunde-Cimerman et al., 1998, 1999, 2000, 2001, 2004; Tkavc et al., 2010, 2011) but the studies concerning sedimentological and biogeochemical properties of this hypersaline environment were very rare in the last 20 years (Dolenec et al., 1994; Faganeli et al., 1999; Ogorelec et al., 2000). As a result of increasing demand for various salt works products and additional data the intense research of selected substrates from Sečovlje Salina begun again in 2008 (Kovač, 2009; Glavaš et al, in preparation). The main topic is the crucial element of the traditional manner of salt-production, the microbial mat called “petola" *i.e*. a few millimeter thick surface layer covering the mud bottom of the crystallizing basins. We combined the classical analytical chemical and spectroscopic (NMR, FTIR) methods to study the petola composition and its transformations during salt season. Special attention was paid to microscopic structure using cryo-SEM technique (a scanning electron device equipped with a freeze-drying sample preparation system) that allows us to go deep into petola matrix without interfering with the fragile three-dimensional micro-organization. Besides petola research, the other currently enrolling studies are dedicated to the salt composition and preparation of peloids (from »virgin mud« to therapeutic mud *i.e*. peloid). In order to estimate the quality of various natural salts from Sečovlje Salina we determined the elemental and mineralogical composition (by XRD) and ICP-MS). Despite the centuries-old tradition of salt-making and thermal tourism, preparation of muds for pelotherapy is mostly based on practical experiences. Therefore in cooperation with the company SOLINE Pridelava soli d.o.o. in 2011 we set up the pilot study of peloid preparation (from »virgin mud« to therapeutic mud i.e. peloid). The purpose of this contribution is to present the main result of before mentioned studies in Sečovlje Salina.

Keywords: Sečovlje Salina, Sečovlje Salina Nature Park (KPSS), education



Posterji / Posters

VERTIKALNA RAZPOREDITEV IN ČASOVNO POJAVLJANJE VRSTE *Upogebia pusilla* (DECAPODA: THALASSINIDEA) V SLOVENSKEM OBALNEM PASU

VERTICAL DISTRIBUTION AND TEMPORAL OCCURRENCE OF MUD SHRIMPS, *Upogebia pusilla* (DECAPODA: THALASSINIDEA), IN THE LITTORAL ZONE OF SLOVENIAN COAST

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In the Mediterranean Sea, *Upogebia pusilla* (Petagna, 1792) is the most common member of the family Upogebiidae and as such one of the most common burrowing organisms in littoral and sublittoral sediments. This species has been used as important fishing bait for centuries. In order to explore seasonal dynamics and gather biometric features of the species from Slovenian coast, samples of mud shrimps were collected monthly (in alternation) from two localities, Lazaret at Italian border and in a lagoon in Strunjan. Samples were collected from October 2011 until June 2012, from three sampling sites of size $1m^2$ at (i.e. 0 cm), below (-50 cm) and above (+50 cm) average sea level. Biometric data showed high positive correlations between pairs of variables describing body size (carapace and total lengths, CL and TL respectively) and wet body mass (BM; Pearson correlation coefficients, $r > 0.85$). During growth of an animal, wet body mass (BM) increases more slowly than length (CL, or a shrimp becomes lighter for its length as it grows larger). In Strunjan, average CL and BM are higher in adult males and females (with no differences in juveniles), pointing at important local differences between populations. In addition, males from Strunjan are larger than females from the same locality, while there is no significant difference between the sexes from Lazaret. Also males from Strunjan are significantly larger than males from Lazaret (One way ANOVA, $p < 0.001$ for CL, TL and BM). The difference in size between the localities could partly be a consequence of frequent fishermen' collecting of shrimps from Lazaret. In Strunjan collecting is less frequent as the lagoon is a part of the protected area. Abundance of animals varies seasonally, with highest abundances in spring and beginning of summer. In April, first ovigerous females occur. There are (1.) lower abundances at higher level (+50 cm above average tidal level) and (2.) at this level, animals almost completely disappears for few months during winter (February, March). Both observations imply migration of animals in deeper waters during low temperatures in winter.

Keywords: *Upogebia pusilla*, littoral sediments, mud shrimp, lagoons, vertical distribution, temporal occurrence, Slovenia

NARAVNE SOLI IZ SEČOVELJSKIH SOLIN

NATURAL SALTS FROM SEČOVLJE SALINA

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Salt is commonly used product in food industry and is important as a daily diet requirement of humans. Recently world salt production was estimated to be about 260 million tons per year. Salt production was also one of the main commercial activities in the Gulf of Trieste and Istria and its history goes back to 9th century. The aim of the present study was determination of mineral and geochemical compositions of natural salts from Sečovlje Salina (Piran salts, Slovenia). Results indicated high quantities of halite, gypsum, bischofite, langbeinite and less dolomite, calcite, quartz and sylvine. Geochemical analyses revealed that Na, Mg, Ca, K, S, Fe together with chloride presents the majority of studied salt samples. Minor concentrations of Si, Al, P, Mn and Ti were found in all samples. Majority of trace elements were below 0.5 µg/g, meanwhile average contents of Ag, Ba, Sr, Rb and Zn were <2 µg/g, <0.5-1.7 µg/g, <28.6-134.3 µg/g, <0.1-1.9 µg/g and <0.1 – 6 µg/g. In general, serious concern about health affects is usually correlated with toxic metals like As, Cd, Cu, Pb and Hg, while they may cause different health problems. The amounts of aforementioned toxic metals found in Sečovlje salts were ranged [µg/g]: As 0.3-1.1, Cd <0.01-0.02, Cu <1-2, Hg 0.005-0.007 and Pb 0.01-0.45. Measured concentrations of all toxic metals were below the allowable levels recommended by the Codex of legalisation for the presence of toxic metals.

Keywords: Sečovlje Salina, natural salt, mineral composition, geochemical composition

KARAKTERIZACIJA POVRŠINSKIH SEDIMENTOV OPUŠČENIH SOLIN (ZALIV MAKIRINA, OSREDNJI JADRAN)

CHARACTERIZATION OF SURFICIAL SEDIMENTS FROM ABANDONED SALINA (MAKIRINA BAY, CENTRAL ADRIATIC)

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Surficial sediments also known as healing mud (peloid) from Makirina Bay (Central Adriatic) were analysed to determine their mineral and geochemical composition. According to X-ray Powder Diffraction (XRD) analysis surficial sediments from Makirina Bay contain great amounts of dolomite, and less quartz, halite, aragonite, pyrite-arsenian, calcite, ilite, chlinochlore, calcite-magnesian, gypsum and albite. Established mineral assemblage coincides with the catchment geology of the study area. Surficial sediments from Makirina bay are frequently used by tourists or locals as pomade, therefore the abundance of potentially toxic elements (PTE) in surficial sediments was studied. Geochemical analysis revealed that PTE are ranged as follows [mg/kg]: As 11.26-15.16, Cd 0.16-0.36, Cu 22.13-43.06, Mo 12.30-18.60, Ni 22.26-32.00, Pb 18.83-24.96, Sb 0.20-0.36 and Zn 38.66-48.00. Preliminary study of surficial sediments from Sečovlje Salina showed much the same mineral composition as was detected in Makirina Bay surficial sediments. In addition, the measured concentrations of PTE in surficial sediments from Sečovlje Salina tend to be very low. To use surficial sediments from Makirina Bay and Sečovlje Salina for therapeutic treatments more detailed studies are needed, to better understand mobility and availability of PTE and their effects on the human skin.

Keywords: Makirina Bay, Sečovlje Salina, healing mud, mineral composition, potentially toxic elements

TERMOMINERALNE VODE IZ LIPIKA (HRVAŠKA)

THERMOMINERAL WATER OF LIPIK (CROATIA)

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Lipik thermal water was used since Roman times for healing sick and relaxation of healthy people. First analysis dates back in 1777. (Krantz). Spa in Lipik is around 300 years old and controlled balneotherapy starts in 1876. There were four natural sources and today the water is used from 234.7 depths with 17.4 l/s flow. Based on geological research Lipik thermal water is approximately 37000 years old.From 1860 Lipik starts to develop as a spa. In past, therapeutic effect of thermo mineral water was assigned to temperature and iodide. Water was used for drinking, bathing, and inhalation, enrichment of mud ceiling and as evaporated Lipik spa salt. Today, main indication is neurological diseases, post-traumatic conditions, rheumatic diseases and condition after operation of the movement system. According to balneology analysis water is characterized by temperature, amount of fluoride and content of dominant ions sodium, bicarbonate and chloride. Nowadays Lipik spa is reconstructing buildings with the wish to gain appearance that existed before war in Croatia.Continuity of the mineral content in water is shown from the first analysis. Temperature is between 31-64oC, amount of fluoride from 5.5-11.2 mg/l, mineralization is now around 3100-3200 mg/l and the amount of natural carbon dioxide is from 331.4 to 1251.7 mg/l. Concentration of iodide is interesting, because first analysis were indicating relatively high results from 35 mg/l until resent 0.123 mg/l, and water has no longer iodide character. According to balneological classification made in 2009 the water in Lipik spa is mineral, fluoride, sodium-bicarbonate-chloride, hot water.

Keywords: thermo mineral water, Spa Lipik, balneology,

JEAN BAPTISTE LALANGUE LUKSEMBURŠKI IN VARAŽDINSKE TOPLICE

JEAN BAPTISTE LALANGUE OF LUXEMBOURG AND THE SPA VARAŽDINSKE TOPLICE

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Jean Baptiste Lalangue (1743-1799) is the best known Croatian physician of the 18th century. He was born in Matton, Luxembourg, but from 1772 to his death, he was governor's (local term ban) and county physician in Varaždin. As the county physician, Lalangue was in charge of the entire healthcare system, including prevention and treatment, but most of all of controlling infectious diseases. He was particularly interested in the use thermal waters, as he, soon upon arrival, realised the potentials of Croatian spas, which were visited by many, but were in a state of neglect. He also measured the temperature of thermal waters, and classified them according to their therapeutic value. He tried to introduce state-of-the-art-medicine to the spa Varaždinske Toplice, which he held particularly dear. Lalangue's interest in the spas was a part of his attempts to enlighten common Croatian people and raise health care to the public level. He believed that one of the major causes of diseases was hard physical labour and that knowing the occupation of the patient would help to understand the cause of the disease. Before the patient should carry on with work, she or he was to get cured. Lalangue was well informed about the long and glorious history of Varaždinske Toplice, which goes back to the ancient times of the Illyrian tribe Jasi. He authored the first Croatian medical book Medicina ruralis - Illiti Vrachtva ladanyszka, za potrebochu musev, y sziromakov horvatczkoga orszaga y okolu nyega, blisnesseh meszt (Rural medicine for the need of men and the poor in Croatian lands and nearby places, 1776), which captures the rural life of the second half of the 18th century. The book makes the first attempts to coin Croatian medical terms alongside the Latin and the German. Lalangue published a number of other popular works, including a textbook for rural midwives Kratek navuk od meštarije pupkorezne (translates to A brief review of the craft of obstetrics, 1777). Jean Baptiste Lalangue came to Varaždin with the intention to stay for the time necessary to do the job, but remained there until his death on 20 May 1799. Allegedly, he was buried in the graveyard by the church of St. Vitus, but the graveyard was moved to the central cemetery a hundred years ago, and his grave has been lost. There is no portrait of his, so no one knows what he looked like. What is known about him are his valuable writings.

Keywords: thermal waters, Jean Baptiste Lalangue of Luxembourg, spa Varaždinske toplice

BIODIVERZITETA GLIV IZ SEČOVELJSKIH SOLIN

BIODIVERSITY OF FUNGI REVEALED IN SEČOVLJE SALTERNS

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Research on fungal biodiversity in Sečovlje salterns started in 1996 as different research projects, bachelor, master and PhD theses, in collaboration with several recognised foreign scientists. The most extensively sampled habitat within the salterns were brines of different salinity, later followed by investigation of fungal presence and diversity on wooden frames of salt ponds, microbial mat petola, fango and saline soil. Hypersaline waters in the salterns, which can harbour up to 4000 CFU/L of fungal propagules, were identified as a natural ecological niche for taxonomically very diverse fungi, spread all over the Fungal kingdom. Approximately 1000 isolates, currently stored in EX Microbial Culture Collection (MRIC Mycosmo, Biotechnical Faculty, University of Ljubljana) were either accommodated in already described taxa or recognised as new species. In total, 107 different fungal species belonging to 35 genera were isolated from Sečovlje salterns. Later their presence was recorded also in other salterns in the Mediterranean (Spain, Italy, Israel, and France), and in tropical salterns (Puerto Rico, Namibia). In addition, 16 fungal species were described as new and accommodated in 4 genera (*Cladosporium, Eurotium, Trimmatostroma, Wallemia*). An important contribution represented the recognition of a new classis Wallemiomycetes and order Wallemiales described within phylum Basidiomycota, accommodating extremely rare, truly halophilic species within the genus *Wallemia*. Interestingly, none of the known species of marine fungi was encountered in salterns. We can conclude that the brines are a rich semi-natural source of (i) extremely halotolerant and halophilic species, serving as important model organisms for the study of halotolerance (e.g. *Hortaea werneckii, Wallemia ichthyophaga*), (ii) industrially important producers of different metabolites (e.g. *Aureobasidium pullulans* – polysaccharides), (iii) fungi with active enzymes at high salt concentrations (e.g. *Trimmatostroma salinum*, *Wallemia* spp.), (iv) xerophilic fungi from genera otherwise known only as contaminats of preserved foods and feeds (e.g. *Aspergillus, Fusarium, Penicillium*), (v) opportunistic human pathogenic fungi (e.g. *Hortaea, Aspergillus, Penicillium*), (vi) fungi with yet unexplored active metabolites, produced primarily at low water activity. Identified fungi display some distinctive features that help them to adapt both to high and low salt concentrations. They are able to survive periods of extreme environmental stress in a viable, resting state. When conditions change, they respond immediately with increased metabolic activity, growth and propagation. Their pleomorphism and adaptive halophilic behavior enable a continous colonization of salterns.

Keywords: fungi, halophily, halotolerance, bioactive metabolites

HORTAEA WERNECKII – SKRAJNOSTNA HALOTOLERANTNA ČRNA KVASOVKA IZ SLANIC

HORTAEA WERNECKII – EXTREMELY HALOTOLERANT BLACK YEAST LIVING IN SALTERNS BRINES

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Extremely halotolerant black yeast *Hortaea werneckii* is originally known as the causative agent of tinea nigra – human skin disorder on hands and soles, exclusively known from tropical and subtropical regions. As a saprobe it is also known from temperate regions, inhabiting natural and semi-natural hypersaline environments worldwide: brines of salterns, saline lakes, sea water and adjacent habitats. The species was detected in Sečovlje salterns in 1996. Using classical cultivation techniques, its population dynamics in saline water of selected ponds was followed through entire year. Since it was found throughout the entire sampling time and because the positive correlation between its appearance with increasing salinity was evident, saltern brine was assigned as its natural habitat. The species became important model organism to study halotolerance in Eukarya. *Hortaea werneckii* (Teratosphaeriaceae, Capnodiales, Dothideomycetidae, Dothideomycetes, Pezizomycotina, Ascomycota) is currently known as one of the three species in the genus, comprising plant saprobes and inhabitants of extreme environments. The diverse ITS rDNA sequences within the species suggested the existence of a species complex. Isolates from different extreme environments from all over the world, stored in EX Culture Collection of Extremophilic Microorganisms, were compared on phenotypic (study of halotolerance, morphology) and genotipic level (sequences of a household gene – translation elongation factor 1alpha). The results showed (i) that almost all strains are growing in the range of 0 to 25 % NaCl, (ii) that extreme morphological plasticity is a response to different salinities, and (iii) that the diversity among the elongation factor sequences is similar to ITS, which supports a single species rather than species complex.

Keywords: fungi, halotolerance, ITS rDNA, elongation factor, polymorphism

PRIDELAVA SOLI V SEČOVELJSKIH SOLINAH V ČASU MAUNDERJEVEGA MINIMUMA

SALT HARVESTING DURING THE MAUNDER MINIMUM IN SEČOVLJE SALTPANS

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Production of salt by solar evaporation from sea water is highly dependent of weather. Unseasonal and seasonal rainfall and an extended winter as well as lower summer temperatures could cut down the production of salt. This article presents the harvest of sea salt in the former Piran Commune from 1637 to 1744 under the rule of the Republic of Venice. The period from 1645 to 1715 coincides with so called Maulder minimum (the "Little Ice Age") when a minimum solar activity was detected. As the indicator of solar activity during the period of interests the Sunspot number were used. Paper also reviews different climate historical records and presents the results of empirical analysis of relationship between solar activity during Maulder minimum and salt production and price. Although numerous studies have reported that relationship between solar activity and terrestrial climate (temperature, weather, monsoons etc) exists, our results indicate very weak correlation, suggesting that the production of sea salt in Sečovlje saltpans during the Maulder minimum was not significantly influenced by reduced activity in the sun.

Keywords: Maulder minimum, sunspot number, solar activity, terrestrial climate, salt production, Sečovlje Saltpans

OGLJIK, DUŠIK, FOSFOR IN SILICIJ V SEDIMENTU SOLNIH POLJ SEČOVELJSKIH SOLIN

CARBON, NITROGEN, PHOSPHORUS AND SILICON IN SEDIMENT OF THE SEČOVLJE SALTERN EVAPORATION PONDS

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The aim of the present work was to determine the contents and role of biogenic elements C, N, Si and P in surface sediment of the Sečovlje saltern (northern Adriatic, Slovenia) on the growth of stromatolite (»petola«) and the impact of »petola« on geochemical properties of the saltern sediment. The sampling of surficial sediment was conducted in the period May-September 2007, approximately biweekly, down to the depth of 10 cm. Firstly, brines (supernatant) were separated from sediments, the sediment cores were anoxically sliced and pore waters extracted by centrifugation. In the Marine Biological Station laboratory, the brine and pore water samples were analyzed for salinity, NH_4^+, $NO_2^- + NO_3^-$, PO_4^{3-}, SiO_4^-, dissolved N-tot and P-tot and DOM. In sediment solid phase, the contents of Corg, Ntot, Ptot, Porg and biogenic Si as well as the δ^{13}Corg and δ^{15}N values were determined. We found that the nutrient concentrations in brine increased with increasing salinity. This is most probably due to the evaporative concentrations of seawater, increasing organic matter content and bacterial activity and, hence, organic matter degradation. »Petola« from Sečovlje saltern with prevalent cianobacterial and diatom communities is developing during early evaporation stage but it survives also during high salinity and halite crystalization. The high $\sum$Nanorg/PO_4^{3-} ratios observed in lower salinity brine suggest that the primary production in Sečovlje saltern is probably phosphorus limited while in higher salinities the limitation turns to nitrogen and then again to phosphorus. The important role of phosphorus is supported by low sediment δ^{15}N values that are an indication of cianobacterial N_2 fixation. The microbes adapted to lower salinity are decomposed at higher salinities and the remineralized N and P nutrients are relesed from surface pore waters to brine. The relationship between phosphorus regeneration and uptake is mostly dependent on Corg/Porg ratio of »petola« and sedimentary organic matter which is in Sečovlje saltern very high. While the phosphate in the sediment pore waters is mostly originating from organic phosphorus remineralization in the deeper sediment layers the authigenic formation of fluoroapatite probably occurs. The increasing silicate concentrations in brine with increasing salinity is probably the result of dissolution of diatom frustules. In pore waters, the silicate concentrations is decreasing with increasing salinity probably due to increasing microbial uptake and precipitation of silicates. The possible extension of the present work would encompass the study of primary production of »petola« and the role of other elements, for example iron, in order to decode the functioning of complex saltern ecosystem.

Keywords: Cyanobacteria, Sečovlje Salina, nutrients, stromatolites, hypersaline environments

PORTOROŽ KOT ISTRSKA KLIMATSKA IN TERAPEVTSKO UGODNA ZDRAVILIŠKA DESTINACIJA V LUČI PUPINIJEVE STROKOVNE ZAPUŠČINE

PORTOROŽ (PORTOROSE) AS FAVORABLE CLIMATIC HEALTH RESORT DESTINATION IN ISTRIA AS REPRESENTED IN ORAZIO PUPINI´S PROFESSIONAL HERITAGE

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Among the first professional prints characterised as homeland studies for the area between Piran and Savudrija peninsula which combines spa tourism in the light of the geographical, geological, climatological and medical rehabilitation as well as balneological factors, we can rank "Portorose and Istrien: klimatisher Kurort, See-und Solbad "(1910) – book written by dr. Orazio Pupini (1865-1917). The latter as the leading medical expert - doctor in medicine - worked at the Administration of Austrian Railways - also operated within the framework of therapeutic balneologists associations where he published professional articles. He has been engaged also in person at his house in Portorož (sanatorium founded in 1908) where he led spa health and wellness activity. His work provides a detailed chemical analysis of brine, seawater and saline mud used for therapeutic purposes. In addition his climate-health activities may be classified as popular, professional and scientific. Details of given chemical analysis – as iodide and magnesium contents in brine water and saline mud for example suggest further studies of in salt ponds located healing natural resources.

Keywords: Portorož, wellness, Sečovlje Salina, spa, brine water, thalassotheraphy, heliotherapy, iodide, magnesium, chemical analysis

RAZISKAVE MAKROZOOBENTOSA V LAGUNI NARAVNEGA REZERVATA ŠKOCJANSKI ZATOK (KOPER, SLOVENIJA)

MACROZOOBENTHOS SURVEY OF THE ŠKOCJAN INLET NATURE RESERVE (KOPER, SLOVENIA) LAGOON

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Škocjan Inlet is a brackish environment near the town of Koper, which achieved the status of a protected coastal wetland in 1998 due to the outstanding ornithofauna and peculiar halophyte vegetation. Afterwards, the Nature reserve Škocjan Inlet was studied also from other aspects such as entomofauna, reptiles and amphibians, mammals and others. The lagoon fauna deserved little attention. In 2007, prior to the restoration (deepening of the central lagoon) first comprehensive samplings of benthic macrofauna took part. During the years 2009 and 2011 a sampling of soft bottom macrozoobenthos with Van Veen grab was repeated at very same in summer and winter seasons in order to assess the possible structural modifications of benthic macrofauna after the deepening in 2008. The four major groups, mollusks, polychaets and insect larave represented the great majority of all species. The dominant mollusks were *Abra segmentum*, *Cerastodema glauca* and *Hydrobia* sp. Among custaceans the dominant species was Corophium orientale, while the polychaets were mostly represented by species of genus Polydora and family Capitellidae. Five non-indigenous species were also recorded, the bivalves *Crassostrea gogas*, *Arcuatula senhousia*, *Ruditapes philippinarum,* the gastropod and the polychaet *Ficopomatomus enigmaticus*. The density of specimens of *A. senhousia* rapidly increased in comparison with previous years. The greatest portion of the lagoon was characterized by the prevalence of *C. glauca*, *A. segmentum* and hydrobiids, which fit well with the class IV of the lagoon zonation according to Guelorget & Perthuisot (1992). The use of biotic index AMBI revealed the improvement of the benthic community after deepening works in the lagoon, which manifested the appropriateness of the planned action.

Keywords: soft bottom, macrozoobenthos, Škocjan Inlet, lagoonar fauna, Slovenia

SEČOVELJSKE SOLINE: UČILNICA V NARAVI

SEČOVLJE SALINA: NATURE'S CLASSROOM

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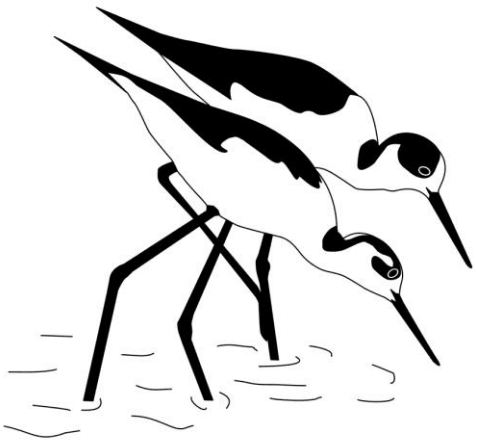
Sečovlje Salina is located in the Sečovlje Salina Nature Park (KPSS) that covers about 650 ha along the Slovene-Croatian boundary in the south western part of Slovenia. Salt is still produced in the traditional way, originating from the 14th century, using classical salt-making techniques and traditional tools. The crucial element for manual harvest of salt is the stromatolitic microbial mat named "petola" (basin's base). Besides this particular feature the Sečovlje Salina is best known for its natural and cultural heritage. The Sečovlje Salina Nature Park is today an important tourist attraction and educational destination. The Sečovlje Salina Nature Park (KPSS) within its working unit "The permanent visitation of the parks" from the project CLIMAPARKS has established a monitoring of the park's visitors, starting on the 1/11/2010. The analyses of the archive data (since 2006) and the visitation data of the KPSS obtained within the monitoring, show an increasing trend. In the period between 2006 and 2011 222.743 visitors has visited the KPSS. Children that are school groups, represent an important share of visitors (about 50% of the guided tours). In the Sečovlje Salina educational contents, for home and foreign university students, are regularly carried out as well. Therefore, is extremely important how the contents are given. Nowadays, the teaching forms oriented to the student, his activity and his direct connection with the educational contents are getting more important. For this reason, the modern education is including programs, where the experiential learning is emphasized. Accordingly, learning on the basis of experiences is a very suitable way of working, since the main theory of experiential learning says that the best way of learning something is doing it. At that point the motivation for learning is high; therefore, students easily memorize the subject matter and keep it in mind for a longer time. By experiential learning students develop the interest for exploring the world around them, the attitude toward nature and living creatures, creativity and critical thinking. Furthermore, they develop different scientific procedures as perception, classification, comparison, drawing conclusions are not least, the experiential learning has a long tradition and allows direct experiencing, observation and learning the environment. It educates for a lasting development and a responsible attitude toward the natural resources. From this aspect, the territory of the Sečovlje Salina gives many opportunities of realizing them.

Keywords: Sečovlje Salina, Sečovlje Salina Nature Park (KPSS), education, experiential learning, nature's classroom



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HABIT-CHANGE: Adaptive management of climate-induced changes of habitat diversity in protected areas
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