ISBN 978-9940-9613-2-9

COBISS.CG-ID 3330896

DOI 10.5281/zenodo.2614428

International Conference
Adriatic Biodiversity Protection
AdriBioPro2019

7–10 April 2019, Kotor, Montenegro

Book of Abstracts

Institute of Marine Biology,
University of Montenegro

Kotor, Montenegro
2019

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THE CONFERENCE

The 2019 International Conference: Adriatic Biodiversity Protection – AdriBioPro2019 provided updated scientific, decision-making and policy-relevant information across a broad array of different Adriatic issues, marine biology and related scientific disciplines. Emphasis will be on how state-of- the-art research on Adriatic biodiversity protection, conservation of coastal and marine areas and sustainable use of marine resources can contribute to policy- and decision-making. Particular focus was put on the development opportunities which marine biotechnology can offer in the Adriatic. Organized to include plenary and breakout sessions covering both disciplinary and interdisciplinary perspectives, Conference results will be used in shaping future marine science priorities and policy in Montenegro and other Adriatic countries.

Background

The Institute of Marine Biology of the University of Montenegro is granted by the Norwegian Ministry of Foreign Affairs to implement a project "Marine Biodiversity Conservation Center "Boka Aquarium" (MonteAqua)" in cooperation with the Center for Fisheries and Biodiversity Conservation of Inland Waters, Institute of Biology and Ecology, Faculty of Science, University of Kragujevac. The International conference "Adriatic Biodiversity Protection" is final project event, dedicated to gather all relevant national and regional stakeholders and to secure closer regional cooperation in the Adriatic Sea region.

According the UNEP, the Mediterranean Sea is subject to tremendous pressure from multiple human uses and climate change. Recent research results indicate the cumulative impacts of human activities in the Mediterranean, ranking it as a hotspot of marine biodiversity, and one of the most heavily impacted marine regions worldwide. One of the most intensely used and severely degraded regions of the Mediterranean is the Adriatic Sea. It implies a necessity of developing appropriate and effective policy-responses including adaptation actions, enhancement of resilience and implementation of mitigation activities. The Conference will address alterations of Mediterranean ecosystems, with particular focus on the Adriatic Sea and its biodiversity and analyse widespread conflict among marine users. By presenting the latest science, the Conference will facilitate, synthesize and summarize the science-policy dialogue.

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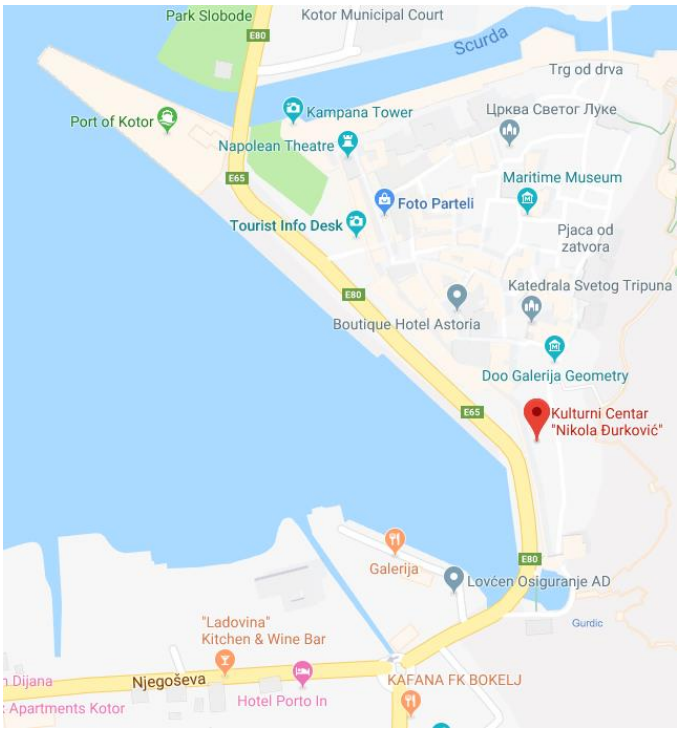
PinnaSPOT The study, protection and possible breeding of pen shell (Pinna nobilis) in the Boka Kotorska Bay

NORWEGIAN EMBASSY

This project is financially supported by The Royal Norwegian Embassy in Belgrade www.norveska.org.rs
Realizaciju projekta finansijski je podržala ambasada Kraljevine Norveške u Beogradu www.norveska.org.rs

CONFERENCE VENUE



Cultural Center (Kulturni centar) "Nikola Đurković", Ulica 2 (sjever-jug), 85330 Kotor (The Old Town), Montenegro

Center has multi-functional conference halls which can accommodate up to 300 participants. Conference will be held in five Center's units, each marked with one colour:

Gallery, ground floor
Theatre hall
Multimedia hall
Gallery, upper floor
Foyer

Topics Addressed

1. Marine biodiversity conservation
2. Conservation of coastal and marine areas
3. Preventing marine pollution
4. Rare and endangered species in the Adriatic Sea
5. Marine invasive and alien species
6. Roles of aquaria
7. Sustainable use of marine resources
8. Marine biotechnology
9. Freshwater biodiversity conservation

SCHEDULE

Sunday, 7 April 2019		
	Arrivals	
18:30	Conference exhibition - “Hidden Beauty of the Sea” opening with cocktail	
Monday, 8 April 2019		
9:00	Registration, Networking, Poster setting-up	
10:00	Opening session (OS): Adriatic Biodiversity Conservation 2019	
10:45	Panel discussion (P1): Setting the framework: Why Adriatic Biodiversity Matters?	
11:30	Boka break - refreshments	
12:00	Marine biodiversity conservation (T1)	Freshwater biodiversity conservation (T9)
13:30	Boka flavours cocktail lunch	
14:30	Conservation of coastal and marine areas (T2)	Rare and endangered species in Adriatic Sea (T4) [Pina spot event]
16:00	Boka break - refreshments	
16:30	Poster sessions (PS)	
17:30	Kotor City Tour	
Tuesday, 9 April 2019		
9:00	Networking	
10:00	Panel discussion (P2): Setting the framework: Why Aquarium Boka?	
11:30	Boka break - refreshments	
12:00	Preventing marine pollution (T3) and Marine invasive and alien species (T5)	
13:00	Boka flavours cocktail lunch	
14:00	Sustainable use of marine resources (T7) and Marine biotechnology (T8)	
15:00	Poster sessions (PS)	
16:00	Boka break - refreshments	
16:30	Closing session (CS): Sustainable use of Boka Bay nature resources	
17:30	Networking	
19:30	Montenegro sounds and tastes - Conference gala dinner (Venue: Poslovni Centar Vukšić - D event)	
Wednesday, 10 April 2019		
11:00	Conference excursion: Boka Kotorska Bay cruise with buffet lunch (Vodena Kočija-Le Coche d'eau)	

ABSTRACTS

Abstracts are sorted against Conference topics (T). Author's index is given at the end.

T1: Marine biodiversity conservation

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Presentation title

Colonization of bacteria and diatoms on artificial substrate (glass) in the marine lake Mrtvo more (Island of Lokrum, the southeastern Adriatic Sea coast) during the period of significant anthropogenic influence

Abstract

The initial colonization of bacteria and diatoms in the periphytic community and development of diatom assemblages on a immersed artificial substrate were examined in a shallow marine ecosystem Mrtvo more (Dead Sea) on Lokrum Island near Dubrovnik (South Adriatic, Croatia). The taxonomy, ecology and colonization features of periphytic diatoms were studied using glass slides as an artificial substratum on a weekly basis from April to October 2016, a period when this area is under significant anthropogenic influence by swimmers. The objectives of this study were to determine (i) the quantitative composition of bacteria and diatom, (ii) the weekly difference in abundance and composition of benthic diatom community and (iii) the effect of temperature, salinity, TIN – total inorganic nitrogen, phosphate (PO_4^{3-}), silicate (SiO_4^{4-}), oxygen saturation (O_2/O_2') and chlorophyll *a* concentrations on diatom colonization rate of artificial substrate exposure. Water temperature ranged from 18.3°C (May) to 27.3°C (July); salinity from 26.6 (October) to 37.0 (August); O_2/O_2' from 0.58 (September) to 1.3 (June); TIN from 0.96 (May) to 10.2 (September) µM; PO43- from 0.11 (May) to 0.58 (July); and SiO_4^{4-} from 3.923 (May) to 13.02 (July) µM. Average number of bacteria per cm^2 during study was 42 114 with the peak (69 268 bacteria/cm^2) in the beginning of June. Despite its small dimensions and a level of seasonal anthropogenic disturbance, the Mrtvo more hosts a diatom flora with high total species richness. An increase in species diversity index from middle of July was noted and the maximum occurred in August 2016. The results of this study indicate the affinity of diatoms as a major fouling community to a studied artificial material and show the outcome of glass debris in the marine environment. Additionally, results reveal in particular diatom colonization rate of artificial substrate during the period of significant anthropogenic influence.

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Presentation title

The next step in biodiversity conservation – active restoration of marine habitats

Abstract

Today, human impact on the living world in the sea manifests through significant loss of marine habitats and species. Besides increasing biodiversity loss, degraded marine habitats can no longer provide goods and services important for the biosphere and the mankind. The MERCES project ("Marine Ecosystem Restoration in Changing European Seas", http://www.merces-project.eu/), approved under the EU Horizon 2020 "Research and Innovation action" program, is the first European project focused on the development of tools and solutions for the restoration of degraded marine habitats, especially seagrass meadows, habitats on shallow hard bottoms, mesophotic habitats and deep-sea ecosystems, and the recovery of their biodiversity and functions. The Faculty of Science of the University of Zagreb (PMF Zagreb), as one of the partners in the Project, is involved in the design, testing and improvement of marine habitat restoration protocols and here we will present our work on the settlements of protected engineering species (seagrasses and noble pen shell) on infralittoral sedimentary bottom and their interaction through two transplant pilot projects as well as the research on the restoration of mesophotic habitats, especially the coralligenous community and characteristic species within (e.g. gorgonians) in the northern and central Adriatic.

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Presentation title

Coralligenous assemblage dominated by *Paramuricea clavata* along the Eastern Adriatic Coast

Abstract

Coralligenous assemblages are hotspots of biodiversity in the Mediterranean that exhibit great structural complexity, provide habitat for several species of commercial interest and offer a diving attraction. These ecologically, aesthetically and economically valuable bioconstructions are facing major threats and have been identified as a priority habitat type "1170 Reefs" by the EU Habitat Directive (92/43/EEC). However, coralligenous assemblages in the Adriatic Sea have been understudied and there is a lack of knowledge on the patterns of their variability over different spatial and temporal scales. Such information is crucial for the effective management and conservation of this valuable habitat. In this study, we carried out photographic sampling at 9 sites on three locations (Kvarner, Kornati and Vis) along 250 km of the Eastern Adriatic Coast and have examined structure and biodiversity of sessile macrobenthos within one of the most representative facies of coralligenous habitat, a *Paramuricea clavata* assemblage. Our results reveal significant variability in taxa composition and abundance at all spatial scales examined, but similar structural complexity within location. On the basin scale, adoption of common methodological approaches would enable direct intra- and inter-regional comparisons and thus, it would propulse immensely our understanding of the coralligenous biodiversity.

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Presentation title

Promoting biodiversity enhancement by Restoration Of Cystoseira Populations – ROC Pop Life project

Abstract

The genus *Cystoseira* C. Agardh, brown algae belonging to the order *Fucales*, is distributed along the Mediterranean and Atlantic coasts from the intertidal to the lower sublittoral. This genus is ecologically relevant as ecosystem engineer, and plays a key functional role in controlling spatial habitat heterogeneity, productivity, and nutrient cycling in temperate rocky reefs. Currently, some *Cystoseira* populations (depending on species and location) are declining/lost throughout the Mediterranean, largely due to multiple human impacts such as urbanization, overfishing and climate change, emphasizing the urgency to develop an active intervention to restore this endangered habitat. ROC Pop Life project aims at triggering the recovery of *Cystoseira* populations in two Natura 2000 sites: the Marine Protected Areas (MPAs) of Miramare (Northern Adriatic Sea) and Cinque Terre (Eastern Ligurian Sea), where this taxon was present, as proven by museum and scientific literature records. Disappearance causes have been presently removed and the protection is guaranteed by the MPAs. The project will develop non-destructive and eco-compatible protocols, which include an innovative outplanting approach that consists in the production of germlings in the laboratory to be introduced in the areas to be restored, starting from small portions of macroalgae fertile apexes. This approach, particularly convenient in terms of time, costs and ecological impact, will cause no harm to donor populations in Landscape Park Strunjan, Slovenia (for N Adriatic) and Portofino MPA (for Ligurian Sea), which is essential given the critical conservation status of the species. The proposed process is appropriate to large-scale application and replication in other Mediterranean areas is desirable in a project capitalization perspective. Preliminary results about the restoration experience during summer 2018 will be presented.

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Presentation title

Spatial distribution of fish community in the Eastern Adriatic

Abstract

The difference in the assemblages, species richness, abundance and biomass of the infralittoral fish community was examined to determine the variability on a large spatial scale. The study was conducted in several areas along the eastern Adriatic coast in the warm part of the year with underwater visual census (UVC) method. The UVC was performed with standard transect dimensions (25x5 meters) but using of closed circuit SCUBA diving equipment. Bubble-free diving enables the diver to collect more reliable data. Recording of timid species and larger individuals is more frequent using this noise-free approach. On 600 km of coastline, the research was conducted on 10 sites. Research has been conducted on habitat types that are transitional forms of posidonia meadows and rocky reefs. We tested the hypothesis on value of protected areas as areas of higher fish abundance and biomass, as well as the existence of a pattern in the community descriptors (species richness, abundance, biomass) depending on north-south geographical positioning. The relationship between fish communities and habitat types as an important environmental factor has been studied, and results showed it is responsible for a large portion of the observed variability. The analysis have shown that the total abundance and biomass of several target species reach a higher average value within protected areas. In addition, the regional variation among sites, which can be attributed to differences in local carrying capacities and hydroclimatic conditions, is also observed and seen through the studied area. The most notable difference is regarding species not native to the Adriatic e.g. *Thalassoma pavo*, *Sparisoma cretense*, *Siganus* spp. Long-term spatial and temporal research, as well as orientated research on particular species are needed to determine the spatial distribution and to monitor the community of infralitoral fish through the changes that climate change bring.

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Presentation title

Underwater biodiversity of Silba reefs

Abstract

This study presents an inventory of marine species as a part of the project "Underwater biodiversity of Silba reefs" conducted by Biology student association BIUS. Silba reefs are a small island group in northern Dalmatia. Together with the surrounding sea, they are listed in Natura 2000 protected areas as a landscape of great importance for the diversity of habitats and species. Twelve locations around the reefs were investigated by scuba-divers and snorkelers on depths from 0 to 30 m. The inventory was made referring to standard handbook for marine species of the Adriatic and extended literature for the Mediterranean. The species were identified visually on site or filmed with a Go-pro camera. All the species that were easy to identify from a video recording were identified afterwards. The list of species for each site was drawn in GIS maps. Prevailing communities were seagrass meadows of Posidonia and rocky reefs with photophilic algae. In total, 137 species were identified, of which there were 16 macro algae, 1 seagrass, 84 invertebrate, 5 tunicate and 31 fish species. In order to keep this area from degradation and negative anthropogenic impact, adequate conservation and management measures are needed. Considering that the last inventory in the area was made in 1998 and 2000, with data lacking important marine species groups, there is apparent need for new scientific evidence on which any further conservation plans and actions could be based. Therefore, this study could contribute to understanding the importance of protecting this area as a hotspot for marine biodiversity and help build the expert base for conservation and management plans.

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Presentation title

Recent changes in scyphomedusan fauna in the Boka Kotorska Bay (southern Adriatic)

Abstract

There are various indications and claims that jellyfish have been increasing at a global scale in recent decades. Schyphomedusa species are a conspicuous, but they are generally little studied along the eastern Adriatic coast. In this study we present the results of five year monitoring (2013-2017) on the Boka Kotorska Bay scyphozoans fauna. Data were obtained on the basis of reports organized through the actions of "Citizen Science", and by scientists of the Institute of Marine Biology, Kotor. The earliest commonly seen jellyfish *Aurelia* spp. was very rare. On the other side, we noted considerable increasing abundance of *Discomedusa lobata*, *Chrysaora hysoscella* and *Cotylorhiza tuberculata*. The first bloom of *D. lobata*, estimated at 100 individuals per 10 m^2, was in April 2014, with another in mid-May. The latter lasted two days, after which no individuals were observed. An extremely dense bloom at the end of March 2015 occurred in a shallow area influenced by spring water. These findings were the first insight into the mass occurrence of this species in the Mediterranean. The mass occurrence of *C. hysoscella* was found in spring time of 2014, 2015 and 2017. These blooms lasted between 3 and 10 days, but specimens were presence up to 30 days. Jellyfish *C. tuberculata* was previously rarely seen in the Boka Kotorska Bay. From the end of July to the mid of September 2017, it was constantly present and often in a large number of individuals. All these phenomena could relate with a sea-surface temperature global warming.

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Presentation title

New findings of a rare bentho-pelagic copepod *Mesaiokeras hurei* Kršinić, 2003

Abstract

The small-size copepod *Mesaiokeras hurei* Kršinić, 2003, was recorded for the first time in the Kotor Bay (Montenegro) in October 2018. This is the second finding of this species in the Mediterranean Sea, as well as generally in the world. It had been found before only in an isolated marine lake on the southern Adriatic island of Mljet (Croatia). The monogeneric family Mesaiokeratidae (Copepoda: Calanoida) is exclusively bentho-pelagic and comprises nine small hyperbenthic species. In the Kotor Bay. *M. hurei* was found in the depression of 63 m depth which slopes down from a depth of about 20 m. Samples were taken with a 5-L Niskin bottle, each 5 m from the surface to 60 m depth. *M. hurei* was noted below 40 m, and abundances increased toward the bottom with a maximum of 13 ind. L^{-1}. An average value for 40-60 m depth layer was 4.40±4,93 ind. L-1. We assume that *M. hurei* could be a common species of specific coastal depression with stable hydrographic conditions. The small size and specific habitats could be the main reason for lack of knowledge of the copepods in the Mediterranean Sea.

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Presentation title

Biology and age structure of the Common Guitarfish, *Rhinobatos rhinobatos* (Linnaeus, 1758), in the Levantine marine waters of Lebanon

Abstract

The Lebanese population of the Common Guitarfish *Rhinobatos rhinobatos*, an endangered species according to the International Union for the Conservation of Nature (IUCN), has been studied while focusing on its morphological measurement, sexual maturity and age composition. A total of 68 individuals were collected using longline fishing gear along Tripoli coastal region between October 2016 and July 2017. The specimens were caught by local fishermen at depth ranging from 10 m to 30 m. The measurements were taken for each individual before dissection. The gonads and vertebrae were extracted for the sexual maturity classification and age determination. Age determination was carried out using vertebral sections for the first time in Lebanon. Alcian blue dying techniques were used to evaluate the visibility of the vertebral bands, which were visible for all the individuals. Male and female Common Guitarfish ranged in age from 0 years to 5 years and 1 years to 8 years, respectively. The total length ranged from 22.5 to 96.5 cm. The most common TL classes ranged between 60 and 80 cm. The total mass of the specimens ranged from 15.6 to 3325 g. A total of 33 males and 37 females were collected and the sex ratio was not significantly different from 1:1. Sexual maturity stages ranged from 1 to 3b for males and from 1 to 3d for females with a significant difference in the gonadosomatic index between the different stages for both sexes. The mass and TL relationship showed a negative allometric growth (b=2.9508 and R^2=0.95), and the length ± SD at which 50% of the individuals were sexually mature was 75.16 ± 1.70 cm for both sexes. This study will provide important data for a better determination of the present status of this endangered elasmobranch in the Lebanese waters. Thus, a conservation plan could be conducted for the *Rhinobatos rhinobatos* by managing a sustainable exploitation for this fish for a better conservation of this species population in Lebanon.

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Presentation title

Biological aspects of *Pagellus erythrinus* in Lebanese waters, Levantine basin

Abstract

Pagellus erythrinus is an appreciated fishery resource in the Mediterranean and Atlantic waters. It is also a suitable species for aquaculture in the Mediterranean. This species is also of commercial importance and has been captured by gill or trammel nets, longlines and trawlers. In Lebanon, it is being exploited by Lebanese artisanal fisheries and basic biological data is needed for its sustainable management. Monthly biological *Pagellus erythrinus* data has been collected since 2015 by the National Center for Marine Sciences – National Council for Scientific Research in the framework of the FAO-Eastmed project. Data from 2015, 2016, and 2017 will be used to assess the growth and biology of the latter species along the Lebanese coast. This data will be essential to understand the growth rate, population structure and other biological aspects of population dynamics that will be beneficial for future management of this fish stock.

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Presentation title

Diversity of pelagic fish assemblages in purse seine landings in Tripoli region, north Lebanese coast

Abstract

In the aim to study the biodiversity of pelagic fish caught by purse seines along the Tripoli coast and the variation in species abundance, monthly samples were collected. The number of species collected was 17 with *Engraulis encrasicolus*, *Sardinella aurita*, *Herklotsichthys punctatus* and *Sardinella maderensis* being the most abundant species throughout the sampling. European anchovies dominated the summer season whereas *Sardinella maderensis* dominated in fall. The length-weight relationship (W=aLb) showed positive allometry for *Engraulis encrasicolus* and *Herklotsichthys punctatus*, but negative allometry for *Sardinella aurita*. The negative allometry for *Sardinella aurita* is related to the abundance of juveniles in the catch. The existence of juvenile *Lagocephalus sceleratus* is extremely poisonous if eaten because it contains tetrodotoxin in its ovaries and to a lesser extent its skin, muscles and liver and could be lethal if they are consumed.

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Presentation title

On the occurrence and abundance of the common bottlenose dolphin (*Tursiops truncatus*) in Montenegrin waters

Abstract

The first dedicated photo-identification study of the common bottlenose dolphin (*Tursiops truncatus*) population in Montenegrin waters took place in the period May to September 2013. The research area spanned the coastline from the border with Croatia in the north, to the border with Albania in the south. In total, 27 boat-based surveys were completed and a total of 21 groups of common bottlenose dolphins were encountered. Based on the photographs of dorsal fins, 74 distinct individuals were identified, of which 11 were calves. The overall linear density was 0.057 individuals km-1. The weighted mean encounter rate, calculated from 10x10 km grid cells with sufficient effort (>14,14 km per cell), was 0.045 groups km-1. Using the mark-recapture model for closed populations and the Mth estimator of Chao, abundance was estimated to 95 individuals (SE=14.3, LCI=77, UCI=136). Based on the results, the Montenegrin waters seem to host a relatively small bottlenose dolphin population. The presence of calves indicates the importance of this area for all life stages.

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Presentation title

Recent state of the resources of the Chondrichthyes in the central and north Adriatic Sea (GSA 17) through the MEDITS survey

Abstract

The MEDITS (International Bottom Trawl Survey in the Mediterranean) survey represents an uninterrupted series of exploration of the Mediterranean demersal resources that began in 1994. In this paper, the results of the surveys are shown for the class Chondrichthyes and the data are summarized by the list of the species, the spatial and temporal distribution, distribution of the biomass index and the abundance and demographic structure of the most important economic species. The proportion of Chondrichthyes in the overall catches oscillated from 25 % in 1996 to 5 % in 2011. showing a negative trend. Similarly, there is a significant difference in the share of Chondrichthyes in the total catches in the Croatian territorial waters (from 14 % in 1997. to 6 % in 2012.) and in the rest of the Adriatic (from 45 % in 1997. to 2 % in 2017.). During the study, 28 species of the class Chondrichthyes were recorded: 12 species from the order Squaliformes, 15 species of the Rajiformes and 1 species of Chimeriformes. Although most of the explored species are widespread throughout the Adriatic Sea, population density is significantly higher in the eastern coast of the Adriatic Sea and in shallow areas. Because of their biological characteristics (weak reproductive power, slow growth, large body dimensions, etc.) and high vulnerability to fishing gear, these species are significantly endangered by fishing and most populations show negative trends in biomass and abundance indexes, frequency of occurrence and in the demographic structure of the population. The situation is considerably worse for species of the order of Rajiformes than from the order Squaliformes. Bearing in mind the poor state of the population, as well as the fact that the Chondrichthyes are indicators of the good state of the resources, it is necessary to take adequate restrictive measures to regulate fisheries with the aim of bringing the exploitation level into proportion with the state of resources in the sea.

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Presentation title

Quantitative and qualitative composition of Veneridae (Bivalvia) in Boka Kotorska Bay, South Adriatic Sea

Abstract

Family Veneridae is large family of Bivalvia with a world-wide distribution (Pope & Goto, 2000). It counts 680 different species, which inhabits different marine ecosystems (Huber, 2010; Popović, 2012). This study was carried out in autumn 2017 and spring 2018 on six localities in Boka Kotorska Bay area (south Adriatic Sea). Sampling was done by SCUBA diving along a 200 m^2 transect on each locality. Collected material was identified according to Poppe & Goto (2000) and Huber (2010).

Total of 1754 individuals (empty shells) were collected, belonging to 14 different species, among which five species were commercially important. The highest number of species, 11 was on localities Sv. Stasije and Morinj, while the lowest number was on Njivice, represented with 6 species. On each locality species *Venus verrucosa* was present with the highest number of individuals except on IBMK where that was *Polititapes* spp. Dominance (d) and constancy (F) are calculated for each species. Eu-dominant species group ($d \geq 10\%$) included: *Venus verrucosa*, *Pitar rudis*, *Venerupis* spp. and *Gouldia minima*. The same species belonged to eu-constant species group ($75\% \leq F \leq 100$) including also *Ruditapes decussatus* in this group. Abundance (ind./m^2) of Veneridae species was the highest on locality Sv. Marko, 2 ind./m2, and the smallest on Njivice, 1.1 ind./m^2.

Diversity index (Margalef (M), Shannon-Wiener (SW) and Simpson (S)) were calculated in Primer 6 program for each location. Values of all three were the highest for locality Sv. Stasije (M=1.80; SW=1.78; S=0.80), and the smallest for locality Njivice (M=0.93; SW=1.18; S=0.60).

The results of the present study indicate that Boka Kotorska Bay is an area with high Veneridae diversity.

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Presentation title

Diversity of Amphipoda (Crustacea) in the Bay of Boka Kotorska (Adriatic Sea, Montenegro)

Abstract

The Boka Kotorska Bay is deeply inserted into the coast of Montenegro and characterized by various types of bottom (mud, sand, rocks, seagrass meadows (*Posidonia*, etc), algaes, sublacustrine sources of freshwater, mouth of numerous coastal torrents and springs, etc., and all of them are settled by various species of Amphipoda (Crustacea, Malacostraca). Fauna of Amphipoda in the Boka Kotorska Bay was studied mainly by G. Karaman during many years, and several new species have been described from this bay (Autonoe karamani Myers 1976, *Leptocheirus mariae* G. Karaman 1973, *Maera sodalis* G. Karaman & Ruffo, 1971, *Leucothoe oboa* G. Karaman 1971, *Ampelisca dalmatina* G. Karaman 1975). Various other interesting new species described from coast of Italy and France have been discovered also in the Boka Kotorska Bay (*Harpinia karamani* King 2004; *Rhipidogammarus karamani* Stock 1971, etc). The intense anthropogenic activity caused degradation of fauna of Amphipoda in Boka Kotorska Bay.

T2: Conservation of coastal and marine areas

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Presentation title

River Basin Management Planning – the concept of conservation of freshwaters, transitional and coastal waters

Abstract

With introduction of the EU Water Framework Directive (2000/60/EC - WFD) in the management practice of the waters in the European Union, the new concept of monitoring and status assessment has been implemented to address the conservation of freshwaters, transitional and coastal waters. This framework document, together with related directives, largely contributes to introduction of a common, synchronized and controlled approach to general management of European water bodies (WB). In this work, we will present our vision of the advantages that have been introduced with this new approach to water management. River Basin Management Planning (RBMP) implies a complex procedure from identifying and characterising WBs of a target area (it could be a river basin of different size addressed on national level, or an international basin that is addressed on a bi- or multilateral level), via assessment of status of water bodies, identifying data gaps, mitigation measures, addressing future infrastructure works related to water, up to economic analyses. One of the most important advantages of the RBMP concept is a more reliable and standardised monitoring of the status of all target WBs by the standardised assessment of ecological and chemical parameters. We would like to emphasize that ecological status assessment is based primarily on biological monitoring of obligatory elements – algae (phytoplankton and phytobenthos), aquatic macrophytes, aquatic macroinvertebrates and fish. This approach enables a more reliable assessment of the state of aquatic ecosystems, since it involves different levels of bioindicators, which reflect the functionality of the whole system. Together with biological quality elements (BQE), it is obligatory to observe the so-called supporting elements – selected physico-chemical parameters and level of hydromorphological degradation. Thus, the procedure clearly reflects and accounts for the inter-relationship of different parameters, which contributes to the comprehensive, confident status assessment.

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Presentation title
International Legal Protection of Bioresources of the Caspian Sea

Abstract
While the Adriatic Sea is a semi-enclosed water basin shared by six European states, the Caspian is a land-locked sea having no connection with the World Ocean and is shared by five states of Europe and Asia. Both seas differ significantly by their natural geographic and oceanographic conditions, but the problems they face are common to a great extent. The Caspian basin possesses unique world reserves of sturgeons producing 90% of the world black caviar output. At the same the Caspian holds considerable hydrocarbon reserves – 12 billion tons of oil and natural gas. At all times the use of two kinds of natural resources – biological (fishing of valuable fish species) and hydrocarbon (development of offshore deposits) competed here.

Therefore, special attention has been and is still focused on environment protection, in particular, the protection of bioresources in the conditions of sharing the Caspian by five states.

In 1992 the fishery organization of four Caspian countries established the Commission for Aquatic Bioresources of the Caspian Sea (in 2002 it was joined by the fishery organization of Iran).

In 2013 the Caspian states signed the Agreement on Preservation and Rational Use of Aquatic Biological Resources of the Caspian Sea. In August 2018 after 22 years of common efforts the Caspian states signed the fundamental international agreement based on consensus and mutual account of interests of all countries – the Convention on the Legal Status of the Caspian Sea. This convention states that the parties to this agreement are granted the right to harvest aquatic bioresources within 25 nautical miles of their territorial waters: national sovereignty extends to 15 nautical miles plus 10 nautical miles of fishery zone (Articles 7 and 9).

The main area of the water surface of the Caspian remains in common use of the parties, while the seabed and subsoil are delimitated between adjacent countries into sections as agreed between them with due regard to the international law. The shipping, fishery, researches and construction of main pipelines shall be conducted following the rules agreed among the parties. This document also states that implementation of large-scale sea projects shall take into account the environmental factor.

This fundamental document creates the new legal regime of the Caspian Sea satisfying all present-day requirements. This convention is called to improve protection of the Caspian Sea from natural and technical

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Presentation title
Conservation effects of Prvić island special reserve (NE Adriatic Sea) on littoral fish communities

Abstract
Prvić Island was declared a special reserve in 1972 primarily owing to the rare botanical and ornithological features. However, for the most part (79%) the reserve extends to the surrounding marine area for which there are no specific fishing regulations. Effectiveness of reserve in conservation of littoral ichthyofauna was studied by comparing trammel net catches and – underwater visual census observations between the sites within and outside the reserve as there were no historical data for comparison. Both research methods showed no significant protection effects as species richness, abundance, biomass, composition and structure of ichthyocommunities are similar in Prvić Island reserve and the surrounding unprotected areas. The whole research area, regardless of protection, is characterized by marked resource depletion and, especially, species of high commerical value are rarely seen or caught with populations dominated by small, immature individuals. Currently the reserve provides no benefits and since the allowed types of fishing gears and intensity of fishing cannot contribute to the conservation and sustainable use of coastal fishery resources, the recommendation is to limit the fishing effort by adopting additional measures of fishing regulation.

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Presentation title
No-take zones in Croatia – future success stories?

Abstract
Establishing Marine Protected Areas (MPAs) human activity is limited for conservation of areas of great importance. Number of established MPAs is steadily increasing. A special category of MPAs are no-take zones. They proved to be the most effective protection tool due to the significant increase in the density, abundance and biomass of economically important species, especially fish. Emigration of subadult and adult fishes to the surrounding area (spillover) could result in the recovery of reduced populations that are heavily affected by overfishing. „How effective are these areas?“ and „What are the key components that determine their effectiveness?“ are one of the major questions while planning and preparing the establishment of no-take zones. Observing positive or negative trends within MPAs and no-take zones is usually done by monitoring community status, e.g. community structure: composition, abundance and biomass. Having these data before the establishment, to have the BACI (before-after control design) effectiveness monitoring, is important but, even with these design there are numerous problems that later lead to errors in estimating effectiveness. Major constraints are lack of knowledge and baseline data on habitat, species, food- web dynamic; possible lack of connectivity between areas; inadequate control stations; poorly prepared protocols, choice of assessment type; small surface areas that are not considering distance adult fish individuals take on a regular basis and lack of surveillance. On the positive side, all Croatian Nature and National park have plans for establishment of MPAs, and some are even considering implementing no-entry zones.

This research will present the advantages and disadvantages of current plans and how the data on the structure of fish communities in five Croatian MPAs collected through multi-year research points them out, as well as, how can we improve them before the establishment.

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Presentation title

Assessment of the state of macrozoobenthos and benthic habitats in the Karaburun Peninsula (Albania)

Abstract

A study on macrozoobenthos and benthic habitats of the Karaburun Peninsula is presented in this paper, focusing on the species composition and quantitative characteristics of benthic macroinvertebrate populations, as well as in the assessment of their ecological and environmental state. Sampling in the shallow rocky shore were carried out in three seasons, spring, summer and fall 2015 on the eastern coast of the peninsula, while the study of benthos in deeper water, at the infralittoral, was conducted by an underwater expedition in June 2015 on both eastern and western coasts of the peninsula, as well as in the whole Karaburun – Sazan MPA. Assessments of species composition, population density, and some indexes of biodiversity and environmental state were done for each sampling site and season. In the underwater communities of midlittoral and infralittoral, the habitats' diversity and benthic species diversity were assessed in general, while special assessments were done for fish species richness and fish biomass, as well as the cover and shoot density for the seagrass meadows of *Posidonia oceanica*. Species not reported earlier for Albania, threatened species at national and international levels, as well as alien species for the Mediterranean Sea were recorded during this study. Despite the diversity of habitats and species, algal cover, Posidonia cover, its shoot density and fish species richness in Karaburun are the highest compared to the whole Albanian coast, the degradation of benthic habitats and environmental quality in the studied area is easily evident. The environmental impacts are mainly related to the uncontrolled tourism and urban development in the Vlora Bay, on the eastern side of Karaburun peninsula, as well as aquaculture and illegal fishing, occurring also within the MPA borders.

This situation of environmental degradation needs a special attention from the relevant administration and management authorities, as Karaburun peninsula is part of the Karaburun – Sazan MPA, stated by international experts as the most important area for marine biodiversity in Albania, with a special importance in Mediterranean level, too.

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Presentation title

Temporal trends in abundance, biomass, diversity and structure of eastern middle Adriatic coastal fish assemblages

Abstract

Coastal waters are highly structured and valuable marine ecosystems recognized as productive areas used by several fish species for reproductive activities, foraging and shelter. Many of valuable coastal habitats are under increasing environmental and human pressures. In last decades, climate change and fisheries have driven significant changes in ichthyocommunities in term of distribution, abundance and biomass. The aim of the study is to investigate temporal changes in the composition and structure of littoral juvenile fish assemblages through their response to environmental and anthropogenic factor. Samples were collected on monthly basis in 1991 and from March, 2017 to February 2018 on seasonal basis in area of cove Sovlja near Šibenik. The individuals were caught using a special constructed small shore seine (L = 25 m; minimum mesh size 4mm) same construction and technical features that used in sampling before. A total of 17216 fish weighing 19.399 kg, comprising 25 families and 70 species were recorded in 1991 and a total of 9887 fish weighing 11.260 kg, comprising 20 families and 55 species were recorded in 2018. The Sparidae and Gobiidae were the most important families in 2000 and 2018. During the whole study the most abundant and frequently observed species were the bigscale sand smelt, *Atherina boyeri*, which was present with 52% of total catch and 69.4 % of shore seine sampling (2018) and the Mediterranean sand smelt, *Atherina hepsetus*, which was present with 26% of total catch and 50 % of shore seine sampling (1991). These results clearly indicate that the littoral fish assemblages in cove Sovlja changed continuously during the study period. Multivariate community analysis of these data may shed light on temporal changes of fish species through response to human-induced factors such as fisheries and habitat modification due climate changes.

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Presentation title

Preliminary assessment of *Diplodus vulgaris* (Sparidae) nursery grounds along the eastern coast of the Adriatic Sea

Abstract

A large assessment of *Diplodus vulgaris* (Sparidae) nurseries along the eastern coast of the middle Adriatic was conducted during 2017 by locating and quantifying nursery microhabitats and estimating the settlement pattern. In total, 23 locations (3 replicas) of the 925 km-long shore were monitored and D. vulgaris were recorded on 22 areas (75.9%). Their main characteristics, shallow, soft, transitional habitats sheltered within coves, covered partially with seagrass meadows, made them vulnerable to human-induced habitat modifications. *D. vulgaris* settled along study area at the end of November. Maximum density observed reached 52 ind./haul in June (river Cetina Estuary) and 47 ind./haul in June (Primošten). The settlement rates were spatially variable. At a regional scale, higher settlement rates were observed within centre zones of study area (Šibenik: Sovlja cove and Primošten) compared to those observed in the north (Zadar area, particularly Maslenica) and south (Mala Neretva). Suitable nurseries along this shore, particularly in Šibenik area seems sufficient for the replenishment of adult populations in the nearby open waters. These results show that it is necessary to protect these scarce, small and vulnerable local nursery habitats and manage other nearby nurseries to ensure the survival of juveniles and their recruitment into adult populations.

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Presentation title

Responses of Ammonia species to euxinic conditions in a seasonally stratified, marine Rogoznica Lake (Croatia)

Abstract

Hydrology, chemistry, benthic metazoans and plankton communities in seasonally stratified, marine Rogoznica Lake (Eastern Adriatic coast, Croatia), have been studied extensively in the past two decades, but not the benthic protozoan community (mainly foraminifera) occurring on- or in- the sediment. Depending on the meteorological conditions, the lake fluctuates between meromictic and holomictic anoxic conditions. It provides site where the redoxcline is situated in the euxinic water column and in the sediment. The short cores collected from the depth of 9 m and 13 m in 2010, revealed well preserved assemblages of benthic foraminifera. Sediment cores were sliced for geochemical and biological studies with 2 cm resolution down to bottom of the core in order to follow the environmental changes in time. Foraminiferal tests occur in all studied samples and their number vary along the cores. The studied foraminiferal assemblages are composed of endopelic Ammonia species. Specimens of *Ammonia parkinsoniana* (d'Orbigny) and *Ammonia tepida* (Cushman) dominate. Tests are with lobate and smooth outlines and of the same size (6-7 chambers in the last whorl). The abundance of species shows positive correlation to the concentration of redox sensitive trace elements (vanadium and molybdenum in interval 16 to 20 cm and 18 to 22 cm, respectively) confirming that these species live and reproduce under euxinic conditions. In the same zone accumulation of TOC and total S content were found which all together indicate history of anoxic holomixis appearance in the water column of the lake.

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Presentation title

Coastal monitoring networks of cabled video-observatories and stand-alone Cameras

Abstract

The Mediterranean Sea displays high species diversity and represents a key area for study of the impacts of natural and anthropogenic changes on biodiversity and its consequences on ecosystem. Habitat destruction, over-fishing, contaminants, eutrophication, introduction of alien species, and climate changes are causing increasingly evident changes in community structure and biodiversity of this warm and miniaturized ocean. Yet, Mediterranean fish biodiversity is undergoing rapid changes due to the rise of water temperature and the increasing success of thermophile biota. In this context, the analysis of continuous long-term and multiparametric data offers a new and promising opportunity to ecologists to understand those processes which regulate marine biodiversity and may also contribute to define possible strategies of conservation and ecosystem-based management. Coastal-cabled video observatories such as the Observatory of the Sea (OBSEA; www.obsea.es) off Vilanova i la Gertrù (Spain) have been indicated as innovative and challenging technological tools for monitoring fish assemblages in marine systems. In

addition, these devices can be successfully employed to monitor and help to understand the responses of fish species to both, environmental drivers and human stressors, as also invoked by the EU Marine Strategy Framework Directive. These multiparametric intelligent platforms represent one of the key elements for Blue Growth development policies. Cabled, fixed and permanent observatories are being worldwide-distributed within growing geographic networks. They provide long-term monitoring of several characteristics (oceanographic, biological etc.) of the seabed and water column at various depths, in a synchronous and highly integrated fashion. Here, we describe how are the video monitoring actions introduced and applied at the OBSEA within the framework of RESBIO Spanish National Project and the resulting experience transferred to a cabled video station in Šibenik, Croatia.

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Presentation title

Contribution of the GEF project "Promoting Protected Areas Management through integrated Marine and Coastal Ecosystem protection in Coastal Area of Montenegro" to better conservation of coastal and marine ecosystems in Montenegro

Abstract

Article presents contribution that GEF project "Promoting Protected Areas Management through integrated Marine and Coastal Ecosystem protection in Coastal Area of Montenegro" shall provide to better conservation of coastal and marine ecosystems in Montenegro. Expected results of project activities are summarized for (2) project components, (19) outputs and (44) activities. Identified challenges and perspectives for critical project activities in inception and starting implementation phases are presented, as well.

T3: Preventing marine pollution

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Presentation title
Distribution of bisphenol a in the Adriatic Sea

Abstract
Bisphenol A has recently received significant attention in the environment due to its behavior as an endocrine disrupting compound. Due to its toxicity, BPA is included in the list of candidates for priority substances according to WFD (2000/60/EC) and in EQS Directive as a substance under review for possible identification as "priority or priority hazardous substance". There are scarce published data on the levels of BPA concentrations in surface sediments of the Adriatic Sea and the aim of the present paper was to estimate the level of BPA pollution in the surface sediments of the coastal and open Adriatic Sea (Croatia). Furthermore, in order to determine the parameters in sediments that are potentially related to BPA, granulometric composition, sediment organic matter and carbonate content, organic carbon and phosphorus content in the sediment were analyzed. BPA mass fractions were determined in the sediments of 35 sites (channels, bays, open sea and city harbours). Mass fractions of BPA in sediments ranged between 1,05 μg kg-1 and 69,99 μg kg-1. The highest BPA mass fractions were found in areas under anthropogenic impacts: in Kaštela Bay, Split city harbour, Bakar Bay and Krka River estuary. Monthly analysis of BPA distribution indicated no seasonal oscillations of BPA mass fractions in sediments. The research revealed the lack of a direct link between the fine grain fractions in the sediment and the mass fractions of BPA, as was expected following the usual relationship between the proportion of organic matter, organic carbon, phosphorus and fractions of silt or clay. The reason is probably the different origin of BPA and its chemistry in the sediment that is significantly different from the cycle of biogenic elements in the marine ecosystem.

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Presentation title

Changes in biochemical markers as early indicators of adverse biological responses to chemical stressors at the Montenegro Coast

Abstract

In this study, estimation of hepatic biotransformation and antioxidant enzyme activities in *Mullus barbatus* Linnaeus, 1758 (Red Mullet) have been used to assess the level of anthropogenic pressure on two location at the Montenegro coastal area – the Boka Bay and the open sea. The study has been performed in November and December 2016 (fall) and May and June 2017 (spring). The analysis of xenobiotic- detoxifying enzymes included the phase-I biotransformation enzyme CYP1A and the phase-II biotransformation enzyme glutathione S-transferase (GST). Moreover, hepatic antioxidant enzyme activities of catalase (CAT) and superoxide dismutase (SOD) and metallothionein (MT) expression levels were also examined in this comparative study. We observed that the hepatic activity of SOD and CAT in *Mullus barbatus* were higher in the open sea locality, while Boka Bay locality had a higher level of GST activity and higher expression level of CYP1A and MT at both seasons suggesting a higher impact of xenobiotic and metal pollution in the bay. Detected levels of CYP1A and MT in both examined locations were higher in spring suggesting that temperature alters the physical and chemical properties of water. Obtained changes in biochemical markers indicate that the individuals from the Boka Bay are more exposed to chemical stressors that those collected from the open sea.

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Presentation title

Preliminary results of seafloor monitoring of marine litter in the Natura 2000 sites (Vis and Pakleni islands, Croatia)

Abstract

This research has been carried out within the framework of project ML-REPAIR supported by Interreg Italy –Croatia Standard+ programme that has as overall objective to prevent and reduce the input and dispersion of marine litter (ML) in the Adriatic Sea. Part of activities are related to seafloor monitoring of ML of the chosen Natura 2000 sites, suspected to be significantly loaded with ML due to touristic activities, maritime transport, coastal outputs and transboundary litter. Pilot-actions were carried out in Natura 2000 sites of Island of Vis (HR3000469; HR3000096) and Pakleni islands (HR3000095). The data were collected by SCUBA diving along a linear transect 25x4 m, four transects at each location, a total of 16 locations. In the end, 1259 litter items weighing 380 kg were collected. A significant difference in the type of litter among the investigated areas was found. At Pakleni Islands dominated category was glass/ceramics (63% of total number, 82% of total weight), while at Island of Vis artificial polymer materials (plastics) dominated (72% of total number, 42% of total weight). Those differences indicate possible differences in the source of contamination. Glass/ceramics is likely to be local input while plastics due to its long-lasting floating capability can be brought with currents, waves, and wind away from the source. Accordingly, the amount of litter per seafloor unit area varies considerably depending on the exposure to currents and prevailing wind (jugo) and also depending on the pressure of nautical tourism.

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Presentation title
Implementation of Fishing for litter (Ffl) activity in Croatia; lessons learned and further necessary actions

Abstract
Fishing For Litter (Ffl) is simple initiative that aims to reduce marine litter by involving one of the key stakeholders, the fishing industry. It is effective way to clean up the sea by removing solid waste from seabed, which poses a threat to marine life and has negative economic and social impacts on coastal communities and tourism. This scheme is based on the assumption that the activity must be as simple as possible for fishermen, without any costs for them. They provide fishermen with bags to store litter onboard and ensure that land disposal facilities are easy to reach. Involved vessels are bottom-trawlers since most of the litter is on the seabed. Ffl has two main aims; the direct removal of litter and to raise awareness about the marine litter issue amongst the fishermen and the general public, resulting in a change in attitudes and behaviour. Before the DeFishGear project started in 2013, Ffl was unknown practice in the Croatia. One of the aims was to investigate, through the pilot projects, the feasibility of developing this scheme and to prepare guidelines. The implementation in two fishing ports Hvar and Tribunj show a strong fishermen willingness to collaborate, being aware of their unique role in the active removal of litter from the sea. However, due to a lack of an overarching National law addressing marine litter management, its legal status was not defined. Existing Law on Sustainable Waste Management do not specifies how to handle with the litter collected. More should be in a separate regulation that applies only to marine litter, but it has not been adopted to the present days. Thus, marine litter was temporarily classified as urban waste by the hosting Municipalities and the municipal waste management company was in charge of disposal. Ffl activity can be easily implemented in Croatia, but is necessary to improve the legislation about marine litter, to examine deficiencies and gaps in these policies, and suggesting options for improvement.

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Presentation title

ML-REPAIR - Reducing and Preventing, an Integrated Approach to Marine Litter Management in the Adriatic Sea. A new contribution for a cleaner Adriatic Sea

Abstract

The presence of anthropogenic debris in the marine ecosystems represents a relevant negative impact on marine water quality and life, also impairing socio-economicalfruition of natural resources. The Italy-Croatia Interreg ML-REPAIR Project (2018-2019) aims to prevent and reduce input and dispersion of marine litter (ML) in the Adriatic Sea, so contributing to an environmentally sustainable growth of tourism andthe fishery sector by supporting behavioral changes through raising awareness activities about ML issues. The project, capitalizing the results of the previous IPA-Adriatic DeFishGear Project (DFG), is focused toward a joint governance of ML management in Italy and Croatia. The main project activities are being focused on testing innovative educational tools for raising awareness of tourists and youth population of local communities in coastal areas, and supporting strategies for ML monitoring in a participative approach involving the fishing communities. The DFG activities selected to be capitalized in this project are specifically: a) the Fishing for Litter (FfL), based on the principle of removal and correct disposal of

ML recovered during fishing activities; b) the monitoring of abandoned, lost or discarded fishing gear (ALDFG) and ML on the sea floor; c) the dissemination of available information about ML and d) evaluation of plastic debris ageing, degradation and potential generation of microplastics. The experience gained by partners in DFG will be specifically spent to spread further the implementation of good FfL practices in the fishery sector, increasing the number of boats and ports involved in this activity in Italy and Croatia.

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Presentation title
Marine litter characterization in the South Adriatic Sea

Abstract
Marine litter is one of the main problems regarding the anthropogenic pollution of the marine ecosystem, rising concern at international scale. In particular a rapid modification in litter composition occurred by the increasing economic development. Indeed, consumption patterns more and more oriented towards highly packaged products, which are designed for short-term use before disposal and a very weak attitude to recycling, determined the spread of the litter, composed by plastic, glass, paper/cardboard, textiles.

This work aims to describe marine litter composition in the Southern Adriatic Sea (GSA18 sensu FAO-GFCM) obtained by the standardised collection of marine macro-litter data in the MEDITS trawl surveys (2013-2017) (DCF EU-Reg. 1004/2017). Marine litter was catalogued using 8 categories and 25 sub-categories (following the MEDITS protocol). Plastic results the most abundant marine macro-litter category in terms of occurrence (94.5% of the 445 hauls surveyed were positive to plastic litter). In particular, the more affected depth strata are those ranging between 10 and 200 m. Considering the large dominance of plastic in marine macro-litters this category was also analysed considering its sub-categories composition. The most abundant sub-categories are bags, bottles and food wrappers that represent 74.9% of the total plastic wastes. Moreover, plastic seems to be ubiquitously distributed. Future modelling approach could be determinant to clarify marine litter accumulation in this area.

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Presentation title

Preventing marine pollution

Abstract

This paper presents a cross-section of existing scientific data and recommendations on the impact of pollution of the sea from ships, ballast waters; floating litter and pollution caused by accidental situations (oil spills). The recommendations of preventive measures and improvement of the situation were given by analyzing the data of numerous scientific researches and recommendations of international conventions.

Very extensive sources of pollution, types and characteristics of pollutants, the range of impacts to marine environment and humans, causes the whole range of measures and recommendations with the aim of reducing additional environmental pressures.

In addition to respecting of international conventions and implementation of best practices in the field of waste reduction, preventive measures in reducing the risk of oil spills, action at local level is of greatest importance. One of the proposed measures is the persistent training of young people and general population, referring to risks of marine pollution to human health and the environment; media support in promoting the preservation of the sea and the ocean as the basis for a healthy and sustainable future. Also, since in many countries there is no legal framework that recognizes specific types of pollution (such as marine litter pollution), the impact on decision-makers and authorities is crucial to seriously and safely addressing pollution issues.

Since marine pollution doesn't recognize the territorial boundaries, in addition to the importance of reduction of local factors of marine pollution, international cooperation and contribution to the international framework and data sharing have been recognized as an indispensable measure in resolving marine pollution issues.

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Presentation title

Recent trends in application of shell waste from mariculture

Abstract

Today, commercial mollusk farming is an essential component of the global aquaculture industry with a share of 23% of the world's total production and the tendency of continual growth. Small investments and low energy consumption make this production a globally interesting source of cheap, healthy food rich in proteins, vitamins and essential elements for the growing population of people on the planet. However, since shells can account for up to 75% of total bivalve body weight, contamination of the ecosystem by bivalve shells is one of the major problems that can endanger sustainable growth and development of this industry branch. Seashell waste, such as oyster, mussel and scallop shells, produced in vast quantities around the globe, is often dumped in landfill or in the sea. This waste piles up at coastal areas and causes many environmental problems including pollution of coastal fisheries, issues in public water management, damage of natural landscape, health/sanitation problems and unpleasant odor due to the decomposition of meat residues, and endangering native plant and animal species as a result of intensive depositing of shells on the sea bottom. In response, special measures for dealing with this type of waste, including collection, treatments and reuse options, have been prescribed by European regulations.

In the Boka Kotorska Bay, Montenegro, commercial mussel farming began to develop in the second half of the 1980s while commercial oyster farming began in 2009. Currently, there are approximately twenty active shell farms with annual mussel production of about 180 tons and about 13 tons of oysters farmed only at the two of them. Although bivalve farming in the Boka Kotorska Bay is at a relatively low level in comparison with leading countries in this sector, a mild growth over the past few years and the natural potential are promising for future development of the Montenegrin aquaculture. It is estimated that roughly 100 tons of shell waste is generated annually, with a projection of continuous growth.

This paper aims to draw attention to the problems and risks from seashell waste and to discuss the solutions which would potentially be a step towards mitigating the environmental burden. European Union directive has vigorously enforced the development of new technologies that exploit waste as resources and contribute to the concept of sustainable development. In this regard, recent trends in shell waste applications have been reviewed, as novel ideas for reducing the waste accumulation and valorizing of shells to achieve both ecological and economic incentives.

T4: Rare and endangered species in the Adriatic Sea [PinnaSpot event]

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Presentation title

Effects of a glyphosate-based herbicide on *Fucus virsoides* (Fucales, Ochrophyta)

Abstract

Fucus virsoides C. Agardh, a glacial relict endemic to the Adriatic Sea, was a common species in the intertidal zone with its southern range limit situated in Albania. In the last five years, *F. virsoides* almost disappeared from the Adriatic Sea as result of anthropogenic and climatic disturbances. Only recently, herbicides widely used in agriculture, forestry, invasive species management, and ready-to-use products for the home and garden have been recognized as sources of water pollution. Currently, *F. virsoides* is no longer present along the Slovenian coasts and just one small patchy population persists in the Gulf of Trieste (Italy). We tested the effects of a glyphosate-based herbicides on *F. virsoides*, potentially exposed to herbicides carried at sea by runoff, erosion, and drainage from land, with two laboratory experiments using ecophisiological and metabolomic approaches. We investigated the effect of a continuous exposure (6 days) and the potential of recovery after a short exposure (24 h). Our study highlights the detrimental impact that GBHs can exert in the marine environment. This recognition is an opportunity to reconsider the importance of concretely incorporating land-sea connections in present environmental monitoring.

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Presentation title

Whether the populations of fan mussel *Pinna nobilis* (Linnaeus 1758) in the Bay of Boka Kotorska, Montenegro, are endangered?

Abstract

The fan mussel *Pinna nobilis* (Linnaeus 1758) is the largest endemic Mediterranean bivalve and is on the lists of rare and endangered species. The shell can grow up to 120 cm. In the area of the Boka Kotorska Bay in the last 10 years, its populations are extremely dense. While in many locations throughout the Mediterranean a massive death of this shell is evidenced in the Bay of Boka it shows a tendency to spread. At one studied site in the Tivat Bay on the area of 100 m^2, were calculated 174 specimens. This density is one of the largest in the Mediterranean. Measurement of the morphometric parameters shows that the shell's length ranged from 22.53 cm to 68.16 cm, which is comparable to the values at other sites in the Mediterranean. Research is performed by SCUBA diving in April 2018. Shell density is counted along 100 m line and one meter wide. Measurements of interest to estimate maximum shell length (Ht) of Pinna nobilis are unburied length, maximum and minimum width.

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Presentation title

Macroalgal biodiversity of Shoal of Jabuka

Abstract

The area around Shoal of Jabuka, 2300 m west of Jabuka Islet (central Adriatic Sea), has rarely been investigated for macroalgae. The most historical research was done during the 1950s. Comparison and supplementation historical data with our preliminary studies demonstrate that this area has a unique composition, a large number of species and high biomass of macroalgae. Our research was carried out in September 2016 and May 2017. Samples were collected along transects in NE-SW direction by scuba diving up to 35 m deep. From the samples collected in the fall, we identified 171 taxa. Biomass was dominated by the populations of Fucales (Cystoseira spp. and Sargassum spp.). Dense vegetation of infralittoral algae reached up to 40 m deep. Four taxa of Cystoseira and two of Sargassum was recorded. In the whole Mediterranean, including the Adriatic, there has been a recent decline and disappearance of these species due to anthropogenic impact, overgrazing of sea urchins, native and alien herbivorous fish. All Cystoseira species that were found on the Shoal of Jabuka are listed on the list of protected species in Annex II (Barcelona Convention). Among them, we identified very rare species such as *Cystoseira jabukae* and *Sargassum hornschuchii*. Natura 2000 network doesn't include the Shoal of Jabuka in any category of protection. The large number, density and specific composition of macrobenthic flora, would serve in the evaluation of this area as a unique area and hotspot of biodiversity for macroalgae in the Adriatic Sea.

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Presentation title

First monitoring of *Cladocora caespitosa* (Anthozoa, Scleractinia) in the Boka Kotorska Bay (Montenegro)

Abstract

The scleractinian coral *Cladocora caespitosa* (Linnaeus 1767) is a colonial, long-lived and reef-building coral. It is endemic for the Mediterranean Sea, protected by national and international legislation and recently included in the IUCN Red List as an endangered species. This study reports preliminary results on the first monitoring of *C. caespitosa* populations on 3 locations (Verige, Sv. Nedjelja and Sv. Đorđe) in the Boka Kotorska Bay (Montenegro). Along 11 transects (each 50 m^2) in total 98 collonies were intercepted and measured (minimum and maximum diameters, and height of the colony). Great majority (71%) of measured collonies were found in the depth range from 10 to 15 m depth. Diameter of collonies was varying from 1.5 cm up to 35 cm, but collonies are generally small, 7.9 cm on average and a degree of sphericity (IS index) was 0.6. Unfortunately, many collonies were partially or completely dead and bleaching was observed on all three locations.

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Presentation title

Draft genome and comparative genetics study of the endangered Pinna nobilis populations

Abstract

As part of the PinnaSpot project that aims to improve knowledge on the emblematic Mediterranean endemic bivalve *Pinna nobilis*, tissues from adult pen shells present at various sites of the West part of the Mediterranean and Adriatic Seas (Montenegro, Spain, Monaco and France, including Corsica) were collected. Overall, 93 individuals were sampled and genomic DNA from all tissues was extracted. One genomic DNA sample was submitted to an NGS protocol (Illumina platform) in order to obtain the first insight into the genome sequence of the fan mussel. De novo assembly of the obtained genomic sequences was conducted using all data from the sample. Preliminary analyses indicate that the genome is very AT-rich. The total number of contigs is 97633 with an average length of 6007 bp and the total length of the assembled genome is 586482772 bp. In absence of other experimental procedures to assess the genome size of *P. nobilis*, this 586 Mb sequence represents at the moment the first draft genome of this emblematic bivalve. The assembled genome obtained here is a prerequisite for future analyses regarding the determination of an advanced comparative population structure we envisage using a RadSeq approach. This could also give us clues on the possible genetic adaptation of the peculiar *P. nobilis* populations from shallow waters as they are found in the Brusc lagoon (Les Embiez) and in the bay of Kotor (Montenegro).

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Presentation title

Habitat characterization of the endangered fan mussel *Pinna nobilis* living in Posidonia oceanica and Cymodocea nodosa.

Abstract

The fan mussel *Pinna nobilis* is an endangered Mediterranean endemic listed under the European Council Directive 92/43/EEC since 1992. It is also included in the ANNEX II of Barcelona Convention. In late 2016 a massive mortality event was detected in the western Mediterranean Sea, caused by the protozoan parasite Haplosporidium pinnae. The parasite kills almost 100% of individual in populations where it is detected. Fan mussels can live in a variety of environments, provided that they do not have excessive exposition to waves or sediment instability. However, the optimum environmental characteristics for the thriving of this species have seldom been studied. The main goal of the present study is describing the range of environmental characteristics where *Pinna nobilis* lives, showing the adaptability of the species to environmental extremes and the best environments for its populations. The information will be fundamental for future habitat protection plans and for the development of restoration programs with resistant individuals in optimum environments, in the context of the present mass mortality. On this regard, the population dynamics and environmental parameters were studied in habitats mainly colonized by *Posidonia oceanica* and Cymodocea nodosa meadows, showing variable hydrodynamic, sedimentary and oceanographic characteristics among them. Starting in September

2016, monthly to by-monthly data was obtained during one year from four different locations: Orahovac and Sveta Nedjelja (Montenegro) living within a meadow of C. nodosa, and Sveti Stasije (Montenegro) and Calpe (Spain) living within a meadow of *P. oceanica*. In the present study, the results of Physicochemical parameters such as water temperature (ºC), salinity (p.s.u.) and dissolved oxygen concentration (mg/l) taken with a multiparemetric prove, ambient parameters such as soil texture, sedimentation (g and cm) taken with sediment traps and SediMeterTM, sediment organic matter content (g), cover and density of the meadows (shoots/m 2) and population dynamics parameters such as number (individuals/100 m^2) and size (cm) of *Pinna nobilis* are shown.

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Presentation title

Larval harnessing and monitoring of the growth of *Pinna nobilis* recruits in Les Embiez Island (France), Calpe Bay (Spain) and in the Boka Kotorska Bay (Montenegro)

Abstract

The capture of natural seeds with collectors can provide a valuable insight on the species reproductive cycles. If combined with circle exploration for natural recruitment estimates, extra information on larval ecology (behaviour, survival rates, etc.) could be obtained. Also, seeds can be grown in protected cages and used for the recovery of endangered populations or to research the viability of repopulation policies. It would be advisable to combine seed collection with the study of some oceanographic parameters as water temperature and density, termocline formation, dissolved O2 concentration, etc. Previous experimentation has shown that seed collection is very variable among years, probably reflecting a subjacent variability of the reproductive effort invested by Pinnids, instead of

the consequences of hydrodynamics. From data available of western Mediterranean climate and *Pinna nobilis* gonad maturation, it is advisable to deploy the collectors around June-July, to recover them on October-November. Each collector is composed by a drag of 50-60 kg, a buoy of 4-5 l to keep the line floating and several "onion bags" filled with two onion bags. The onion bags are attached to the line at one meter intervals. If seeds are grown in protected cages, care must be taken in order to choose a suitable place to deploy them. As far as possible, the place should be unpolluted, with good water renewal, but also sheltered and with sediment stability, for young *Pinna nobilis* are very vulnerable to sediment burial. Depending on number of individuals, juveniles could be separated in individual compartments, or grouped in the same room. Isolation also permits "individualized" growth studies. The present study shows the comparative results of larvae collecton during three years in France, Spain and Montenegro. The works have been funded by the Prince Albert II of Monaco Foundation to the project BF/HEM 15-1662 «The study, protection and possible breeding of pen shell (*Pinna nobilis*) in the Boka Kotorska Bay».

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Presentation title

Pen shell (*Pinna nobilis*) parasite gets closer to Montenegrin coast – status quo and future perspectives

Abstract

The mass mortality of the pen shell *Pinna nobilis*, caused by protozoan parasite *Haplospridium pinnae* sp., is spreading throughout the Mediterranean. Apart of Spain, it has been already observed in Greece, Cyprus, France, Italy, and Tunisia. Before the occurrence of this event in 2016, we have started implementation of the project "The study, protection and possible breeding of pen shell (*Pinna nobilis*) in the Boka Kotorska Bay" – PinnaSPOT. The main research area was Boka Kotorska Bay in Montenegro, data obtained by the common methodology in Calpe (Alicante) – Spain and Embiez Island – France was compared. Exceptionally high density of P. nobilis on Sv. Nedjelja site, with higher percent of young individuals was observed. We collected 3-year data on larval recruitment and monthly measurements of juvenile's growth rate. Physiological adaption of specimens on sudden salinity stress was carried out ex situ. All the specimens survived non-invasive experimental treatments and were successfully returned to their natural habitats, which gave us valuable experience on transplantation and maintenance of *P. nobilis* in laboratory conditions as an important step for the rescue in case of emergency. Habitat structure of *P. nobilis* populations based on oceanographic parameters, sediment re-suspension, granulometry, percent of organic matter and covering of *Posidonia oceanica* and Cymodocea nodosa meadows revealed very specific seasonal variations. Genetic study

on tissue samples from Montenegro, Spain, France and Monaco led to the first draft genome of *P. nobilis*. Data obtained in these various activities focused on pen shell will contribute to general knowledge and protection of this endangered species in southern part of the Adriatic Sea and in case of threat to their survival, will be used as a tool for preparation of the rescue program.

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Presentation title

Two years after: spread of Pinna nobilis mass mortality and measures taken to counteract it

Abstract

Fan mussel (*Pinna nobilis*) populations are being decimated by a mass mortality (MM) produced most probably by an Haplosporidian (Haplosporidium pinnae) protozoan. The first reports of the MM occurred in September 2016 in southeast Spain, and since then it has spread throughout Spanish coasts. By late summer 2018 the MM had killed all Spanish populations, except those of Delta del Ebro (Catalunya) and Mar Menor Lagoon (Murcia). Also, the illness had spread to other Mediterranean countries reaching at least France, Italy, Tunisia, Cyprus and Greece. For practical effects, 100% of the fan mussels that are affected die (only 6 survivors are known in Spain from tens of thousands of individuals). Additionally, the life cycle of fan mussels is slow, needing up to 4 years to mature. Furthermore, fan mussel juveniles endure strong mortality, because it is a specialised species that mainly relies in the survival of the large adults. As a consequence, natural recovery of *P. nobilis* populations from the few resistant individuals would be constrained by the strong virulence of the illness and the biology of the fan mussels. In the present talk, information about the parasite, the spread of the MM since its first detection and the efforts undertaken to fight it up to date, are described.

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Presentation title
Biometrical and growth analysis of rare pelagic fish species Blue jack mackerel *Trachurus picturatus* (Bowdich, 1825) in the Adriatic Sea

Abstract
The Blue jack mackerel *Trachurus picturatus* (Bowdich, 1825) is a benthopelagic marine fish species that inhabits Atlantic area between Southern Bay of Biscay and Mauritania including Azores, Canaries, Madeira and Western part of Mediterranean. In the Adriatic Sea its presence was noted for the first time in 2011 when only 4 specimens of Blue jack mackerel were collected in the area of Northern Adriatic for the first time (Bolognini et al., 2015), although its rear appearance within the Adriatic ecosystem was mentioned in the checklists of Jardas (1996), Lipej and Dulčić (2010) and Relini and Lanterni (2010). Biometrical analysis of ten morphometric and five meristic characters of Blue jack mackerel was presented in this paper. All analysed specimens (N=157) were collected during the MEDITS survey, which was on July 2018 covering the eastern side of Adriatic, precisely Croatian fishing ground. The total length (TL) and weight (W) of all observed specimens ranged from 9.2 to 33.7 cm (12.16±2.94 cm) and from 5.79 to 384.94 g (17.73±39.18 g), respectively. All calculated length-length relationships approved linear regression with very high values of coefficient of correlation ($r > 0.923$). Sex was determined only on two larger specimens ($28 \text{ cm} < TL < 32.8 \text{ cm}$) which were females, while all the other specimens were most probably immature ones. In the length-weight relationship, positive allometry was established ($b=3.1775$). Obtained phenotypic characteristics of this quite rare fish species might help us define this population that obviously entered Adriatic over the last decade.

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Presentation title
Red coral (*Corallium rubrum* L. 1758) in Montenegro - past and present

Abstract
Precious corals refers to about thirty species that belong to the Corallium and Paracorallium genera. Red coral (*Corallium rubrum* L.) is endemic to the Mediterranean and adjacent Atlantic waters of Western Africa. It is well known since antiquity and because of its intense and permanent colour it has been used for jewellery, different religious and social purposes. Unfortunately, because of slow grow and long tradition of commercial, very destructive, harvesting by dredging stocks nowadays are overharvested. Because of that *C. rubrum* is listed as protected species under different national and international legislative documents.

Data on this valuable marine resource in Montenegro almost doesn't exist. However, in Kotor Historical Archive several documents of administrative-political acts (1686-1892) testify about collection of precious coral in Montenegrin waters. A permission to coral harvesting outside of the Boka Kotorska Bay to Vito Valentino dated on 4th January 1686 is the oldest found document on this topic. After this one, there are several documents from 1717, 1745, 1746, 1748, 1759 and 1892 testifying about permissions for collection as well as different social conflicts provoked by this lucrative activity. Review of all scientific papers and technical reports for the area of Montenegro has shown only one recent reference (Stjepčević et al. 1986) indicating presence of very few, small colonies of *C. rubrum* in the Boka Kotorska Bay. Unfortunately, during last 20 years this finding or any other is not confirmed by our SCUBA diving field work and presence of *C. rubrum* in Montenegrin waters is questionable, especially up to the 40m depth.

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Presentation title

Negative interactions between common bottlenose dolphins (*Tursiops truncatus*) and fisheries in the eastern Adriatic Sea

Abstract

Coastal waters of the Croatian Adriatic Sea are heavily utilized by diverse types of fisheries. This presents a risk for the common bottlenose dolphins (*Tursiops truncatus*) inhabiting these waters, as their interactions with fisheries can have negative consequences: entanglements in fishing gear and intentional retaliatory injuries. We used data systematically collected in the Kvarner region, northern Dalmatia and central Dalmatia, coupled with anecdotal evidence, to describe the occurrence, types and outcomes of negative interactions with fisheries. From 2010 to 2018 five cases of entanglements and two cases of intentionally inflicted wounds were recorded. Of the five entangled dolphins, two were rescued by humans, one survived the incident unassisted, and two are presumed to have died as a consequence of entanglement. In both cases of intentional injuries, dolphins were shot with a spear gun harpoon. One animal died shortly afterwards, the other survived for at least 9 months. Of the five cases of entanglements, four were recorded in northern Dalmatia and one in the Kvarner region, possibly reflecting differences in predominant fishing tools utilized in those areas. The results indicate the need for systematic monitoring of negative interactions with fisheries. Such data can be integrated into mark-recapture population dynamics models to detect effects at the population level. Furthermore, setting-up response teams trained to handle entangled dolphins may increase effectiveness of rescue attempts, whereas a clearly defined criteria for euthanization can reduce animals' suffering when appropriate.

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Presentation title

Rare and Endangered Fish Species in the Adriatic Sea and Proposal for Marine Flagship Species

Abstract

Fish are among the most endangered marine species due to their high economic importance for humanity, which is why they are the subject of fisheries, and in most cases under overfishing. According to the last census in the Adriatic Sea there were 407 fish species and subspecies recorded (Jardas, 1996). Meanwhile, 42 species that were previously unknown in the Adriatic were recorded, so that the number of species has grown to 449, which is about 66% of all species and subspecies recorded in the Mediterranean (Dulčić & Dragičević, 2011). Based on a two legal documents governing protection status of fish in Montenegro (Law on Nature Protection (Official Gazette of Montenegro 18/16) and Law on Marine Fisheries and Mariculture (Official Gazette of Montenegro 56/09, 47/15)), IUCN Red List of Threatened species for the Mediterranean, European Red List of marine fishes (Nieto *et al.*, 2015) and Red Book of Marine Fishes of Croatia (Jardas *et al.*, 2008), a list of Adriatic species was prepared. Fifteen species are listed as Critically Endangered both in IUCN and Croatian Red list, while *Acipenser sturio* is considered Regionally Extinct in the Adriatic, according to Croatian Red list, and fifteen species have the status of Endangered species in the Adriatic and Mediterranean. According to Croatian Red list, 29 species in Croatia have Nearly Threatened status, while, according to IUCN Red list, the Nearly Threated status in Mediterranean is assigned to 11 species. Other species listed are listed as a species with Least Concern or Data Deficient status. As one of the newer approaches to protection of species in the last decades, the concept of "Flagship species" became more popular, aiming to promote public awareness and to raise funds for conservation with the end purpose of protecting biodiversity. John Dory (*Zeus faber*) has been chosen as a "Flagship species" for Aquarium Boka based on a questionnaire's with relevant stakeholders.

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Presentation title
Exploring a deep-sea Vulnerable Marine Ecosystems: the *Isidella elongata* (Esper, 1788) assemblages in the Southern Adriatic Sea

Abstract
Deep-sea corals play an important role in marine benthic ecosystems as biodiversity hot spots and also provide Essential Fish Habitats for commercial fish and invertebrate. The bamboo coral *Isidella elongata* (Esper, 1788) is a near-endemic species of the Mediterranean Sea, also recorded along the Spanish and Moroccan coasts of the Atlantic Ocean. The species is distributed on the bathyal soft bottoms, mostly deeper than 500 m, where it characterises a typical facies. *I. elongata* is currently considered "Critically Endangered" by the IUCN Red-List and the mud facies with this species is also included in the list of Vulnerable Marine Ecosystems (VMEs) by FAO. *I. elongata* is often associated with the red shrimps *Aristaeomorpha foliacea* (Risso, 1827) and *Aristeus antennatus* (Risso, 1816), which are the main targets of the deep-sea trawling. The structure and distribution of *I. elongata* assemblages were mostly explored in the western Mediterranean, while no comprehensive studies on these VMEs are available so far for the Southern Adriatic Sea (GSA18 *sensu* FAO-GFCM). In this work, a 5 year time-series of data (2012-2016) collected in the framework of MEDITS (Mediterranean International Trawl Survey) project was used to localise the presence of the bamboo coral and to characterise the VME hot spots and the associated megafauna.

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Presentation title

Overview of the situation of *Pinna nobilis* in the Mediterranean and Mass mortality events

Abstract

Mass mortality events of the endemic bivalve *Pinna nobilis* (pen shell) have been recorded in the whole Mediterranean over last two years. They first occurred in the southeast of the Iberian Peninsula and Balearic Islands in late 2016 and have been rapidly spreading since, causing the mortality of around 99% of all the pen shells in the infected populations. Recent reports show that this mortality has been spreading to other Mediterranean areas. Descriptions from the observations carried out in these sites indicate that similar causes could be behind.

This presentation will provide an overview of the current knowledge of the situation and the current approaches and science needs ongoing to spur a group discussion with participants.

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Presentation title

Rare and endangered species along Montenegro´s coastline and the urgent need for their protection

Abstract

During our project funded by Jugopetrol AD in 2013-2015, we registered the semi-submerged marine caves (Annex I, 92/43/EEC) of Montenegro from cape Arza to cape Đeran. During our surveys, the endangered fauna and flora in and around these caves were also registered (listed in one or more of the following legal frameworks: Montenegrin Regulation on protected and endangered species Official Gazette no. 61/08; CITES, Bern and Barcelona Conventions; EU Directive 92/43/EEC). We registered 87 marine caves more than 5m long and recorded a total of 19 endangered species: 1 Mammalia, 5 Aves, 2 Mollusca, 1 Porifera, 2 Cnidaria, 3 Echinoderms, 3 Algae and 2 Angiosperms. No evidence of the endangered Mediterranean monk seal, *Monachus monachus*, was registered; however, 13 verified monk seal sightings by locals (1985 – 2010) were recorded. The rapid touristic development along the Montenegrin coasts will obviously cause a severe loss in habitat (i.e. marine caves) and species biodiversity. One marine cave has already been destroyed by construction works in the bay of Traste. The urgent need for protection and management of the sites hosting a wide variety of endangered coastal fauna and flora as also various endangered habitats such as marine caves in Montenegro is evident. Protected marine caves are also extremely important for the conservation of the monk seal and the eventual (re)colonization of the coasts of the Adriatic Sea. Montenegro has five terrestrial and aquatic National Parks but not a single MPA for the preservation of its rich marine biodiversity. The establishment of an MPA in the area of Platamuni, has also been recommended by UNEP-MAP/RAC-SPA. Considering the touristic development along Montenegro´s coastlines, the establishment of this specific MPA would greatly contribute to the protection of numerous protected marine and terrestrial species and habitats.

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Presentation title

Monitoring the highly threatned bivalve pen shell (*Pinna nobilis*) in France from the coastline to the local scale with a focus on the potential safe habitat in the Brusc lagoon (Var-France).

Abstract

The marine biodiversity of the Mediterranean Sea is nowadays facing substantial structural changes in flora and fauna. Such changes were recorded in the Adriatic Sea, as well. During the last few decades, various factors such as climate change, anthropogenic activity and „lessepsian migration“ have altered the composition of Adriatic ichthyofauna. Extensive investigations carried out in the last decades allowed us to recognize species previously not recorded or reported from this area. Majority of alien fish species recorded in the Adriatic Sea are lessepsian migrants of Indo-Pacific origin. Out of 14 recorded lessepsian fishes, *Lagocephalus sceleratus*, *Fistularia commersonii* and *Siganus luridus* were the only species recorded multiple times and with geographically scattered records suggesting successful invasion. The common lionfish Pterois miles is showing a rapid geographical expansion in the Mediterranean Sea since 2012. The recent record of this species from Sicily could be a warning sign for the Adriatic Sea. Even if the current abundances of P. miles are still below the threshold of a “true invasion” there is an urgent need to take action and to promote control measures. The impact of successful colonizators on the native communities in the Adriatic Sea is unknown yet. However, the relatively fast pace of the invasions suggest that their effects may become relevant in the near future.

T5: Marine invasive and alien species

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Presentation title
Exotic Fish in the Mediterranean / Adriatic: „Great Four“ - Are There Reasons for Concern in the Adriatic Sea?

Abstract
The marine biodiversity of the Mediterranean Sea is nowadays facing substantial structural changes in flora and fauna. Such changes were recorded in the Adriatic Sea, as well. During the last few decades, various factors such as climate change, anthropogenic activity and „lessepsian migration“ have altered the composition of Adriatic ichthyofauna. Extensive investigations carried out in the last decades allowed us to recognize species previously not recorded or reported from this area. Majority of alien fish species recorded in the Adriatic Sea are lessepsian migrants of Indo-Pacific origin. Out of 14 recorded lessepsian fishes, *Lagocephalus sceleratus*, *Fistularia commersonii* and *Siganus luridus* were the only species recorded multiple times and with geographically scattered records suggesting successful invasion. The common lionfish Pterois miles is showing a rapid geographical expansion in the Mediterranean Sea since 2012. The recent record of this species from Sicily could be a warning sign for the Adriatic Sea. Even if the current abundances of P. miles are still below the threshold of a “true invasion” there is an urgent need to take action and to promote control measures. The impact of successful colonizators on the native communities in the Adriatic Sea is unknown yet. However, the relatively fast pace of the invasions suggest that their effects may become relevant in the near future.

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Presentation title

Accessing fishermen's knowledge to investigate the occurrence and the historical trends of indigenous and non-indigenous species: an Adriatic experience

Abstract

The transnational collaboration set among researchers of Adriatic countries, Croatia, Montenegro, Slovenia, Albania and Italy within the framework of the FAO AdriaMed Project, has been focused on investigating the increasing occurrence of non-indigenous species and other contemporary alterations in fishery resources through a Local Ecological Knowledge approach (LEK). LEK is being increasingly recognized as an innovative and valuable source of information to track environmental changes acting at both small and large spatial scales. By means of semi-structured interviews with professional and recreational fishermen (n=175), we reconstructed 613 temporal trends of abundance over

100 taxa perceived as increasing or decreasing the most in the respondent's fishing areas. Perceived abundances were recorded over a unipolar scale with 6 degrees, ranging from "absent" to "dominant". Species were classified as "Northward-Expanding Species" (NES), "Non-indigenous Species" (NIS) and "Other indigenous species" (OIS). Break-point analysis revealed significant jumps in the reconstructed historical trends. Overall, NES were reported to have mainly increased their abundance in 1993 and in 2007 and NIS in 2007 and 2015. Our findings, collected over a large sample of expert observers, provided new data on the poleward shifts of warm-adapted indigenous taxa, such as the bluefish *Pomatomus saltatrix*, and on the geographical expansion of invasive species such as the Atlantic blue crab *Callinectes sapidus*. These results, collected at low cost and through the spontaneous collaboration of local fishermen, highlight the LEK as a powerful way to reconstruct ecological processes at the sub-regional scale. This system is also suitable to provide early detection and to set the basis for a proper management in the course of rapid historical modifications.

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Presentation title
First record of *Abudefduf vaigiensis* from the Adriatic Sea

Abstract
Occurrences of alien fish species in the Adriatic Sea have increased in the last decade. Various factors such as climate change, anthropogenic activity and lessepsian migration have contributed to this phenomenon. Here we present the first record of *Abudefduf vagiensis*, a fish of Indo-Pacific origin, from the eastern Adriatic Sea. On 13th September 2018, a specimen of *A. vaigiensis* has been observed swimming near the shore in Split, Croatia. A recreational spearfisher shot a high quality underwater video of the fish swimming at a depth of 3 meters among rocks and schools of native pomacentrid *Chromis chromis*. Quality of still photographs extracted from the video footage was sufficient to allow us identification of the species and exclude possible confusion with closely related species, *A. saxatilis*. In its native range, *Abudefduf vaigiensis* is distributed from the Central Pacific, to the eastern coast of Africa including the Red Sea. Presence of this species in the Mediterranean Sea has been documented in Italy, Maltese Islands, Israel and Lebanon. It's presence in the Adriatic Sea raises questions on the possible means of introduction of this species.

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Presentation title
First record of American lobster (*Homarus americanus*) in the Adriatic Sea

Abstract
The occurrence of American lobster (*Homarus americanus*) was reported by the fisherman on the western coast of Istria, Adriatic Sea. In January of 2018 one specimen of American lobster was caught on north-western part of Istria (45°30.502'N, 13°28.656'E) with trammel nets at a depth of 20 m. Specimen was identified, measured, weighed, photographed and tissue sample was taken for genetic analysis. Total length (TL) of the caught female specimen was 25,8 cm, carapace length (CL) was 9,5 cm, second abdomen segment width was 4,9 cm and specimen weighed 499 g. Visual identification was later confirmed genetically. American lobsters (*Homarus americanus*) are native to the east coast of North America and Canada. They have been imported live into Europe through seafood trade. Findings of *H. americanus* in European waters are result of the intentional or unintentional release. In several European countries live *H. americanus* has been captured in the marine waters. This has raised concerns about possible impact on stocks of the native European lobster (*Homarus gammarus*), as well as on other native crustacean species. These introductions present potential risks of disease transmission, hybridization, and/or competition for resources.

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Presentation title

Alien mollusks in Slovenian coastal sea (northern Adriatic)

Abstract

Adriatic and Mediterranean seas are facing substantial changes which have an influence to marine biodiversity. Certain changes are related to arrival of non indigenous species (NIS) which are introduced more and more frequently. Despite the long tradition in marine research, marine NIS in Slovenia deserved only poor attention in comparison with neighbouring areas. Among NIS, mollusks are one of the most abundant taxon. In the Slovenian coastal sea, which covers the southern part of the Gulf of Trieste, 17 NIS mollusks were up to date recorded. Among them 8 are bivalves and 9 gastropods. Among gastropods 8 are opisthobranchs. The great majority of NIS mollusks, recorded in Slovenian coastal wetlands, could be considered as established ones and thus occurring on a regular basis. Only two species, *Melibe viridis* and *Aplysia parvula* were found on a single occasion. Three of NIS mollusks, *Magallana gigas*, *Arcuatula senhousia* and *Haminoea japonica* are invasive species and *Teredo navalis* is considered as cryptogenic species. Only two species, *Magallana gigas* and *Bursatella leachi* were found almost everywhere along the Slovenian coast, whereas other species are restricted to certain areas such as shellfish cultures, harbours and coastal lagoons. From the bionomic point of view many recorded NIS among mollusks were found in two biocoenoses: the biocoenosis of the lower mediolittoral rock and the euryhaline and eurytherm biocoenosis. One of the most important such biocoenosis is present in the coastal lagoon, the Nature Reserve Škocjan Inlet. This area, characterized by brackish waters, seems to be a recipient for NIS mollusks, suitable to colonisation, due to the connection of the lagoon with the harbour of Koper.

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Presentation title

Alien bryozoans in Slovenian coastal sea

Abstract

Alien bryozoans are one of the most commonly found macroinvertebrates in the fouling communities. The two, planktonic and sessile, life phases enables them to enter either the ballast waters as larvae or to attach themselves to the boat hulls of ships and other hard substrates as adults. In the Slovenian sea three alien species of the bryozoans have so far been recorded. All of them have erect body form, which allows them to harbour a variety of other, potentially alien invertebrates. *Amathia verticillata*, a ctenostomatid bryozoan is widely spread along the Slovenian coast in harbours and marinas. It provides habitat for some alien crustaceans (*Caprella scaura* and *Paracerceis sculpta*) and sea slugs (*Okenia zoobotryon* and *Polycerella emerthoni*). *Bugula neritina* is one of the two alien bryozoans of the order Cheilostomatida and it is established to the same extent as *A. verticillata* in similar habitats. It is found in two colour morphs in Slovenia and provides food for *Polycera hedgepethi*. The second cheilostomatid *Tricellaria inopinata*, which has only recently been recorded in Slovenia coast, was found in all three Slovenian mussel aquaculture localities and in one harbour. Its taxonomic status and ecological significance in the Slovenian sea is still unclear. Since the total number of alien bryozoans in the Mediterranean is high and rising, more alien bryozoans are expected to be found in the Slovenian coastal sea in the future.

T6: Roles of aquaria

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Presentation title

Algae in the aquariums of the Center for fishery and biodiversity conservation of inland waters - Aquarium Kragujevac

Abstract

Algae are an integral part of the aquarium and it is impossible to get rid of them completely, most commonly they are unwanted phenomena. The increased concentration of phosphate and nitrates is responsible for the occurrence of excessive amounts of algae in aquariums. The appearance of algae is essentially influenced by the intensity of the light and the length of the aquarium's exposure to light. The research of the algae was carried out at the Center for Fishery and Biodiversity Conservation of Inland Waters - Aquarium Kragujevac, Faculty of Science. The survey covered a total of 18 aquariums (1 marine, 4 tropical and 13 coldwater). The periphyton from all aquariums, was collected by scraping from glass, stones, by pipette along the sand surface, at plants and corals (in marine aquarium). In the marine aquarium, algae have been successively developed and belonged taxa were from: Cyanobacteria, Rhodophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Chlorophyta. Immediately behind forming in the marine aquarium *Licmophora* sp. was observed and after that *Trichodesmium erythraeum* (Ehr.) ex Gom. was dominant. It covers almost the entire bottom of the aquarium, as well as the surface of many corals. All algae have formed macroscopic aggregations on different types of substrates (*Vaucheria litorea* Hofman ex C. Ag., and *Phymatoliton* sp.). The results of the algae analysis at tropical aquarium indicate the presence taxa from: Cyanobacteria, Bacillariophyta and Chlorophyta. The most dominant species in the period of investigation of tropical aquariums is *Achnanthidium exiguum* (Grun.) Czarn. Algae from the genus *Oedogonium* and *Cladophora* was also dominate next to the species from Bacillariophyta. In coldwater aquariums, there was a different situation, it was detected taxa from Cyanobacteria, Xanthophyta, Bacillariophyta and Chlorophyta, but the most dominant taxa in the examined aquariums were Cyanobacteria. Algae in aquarium are an undesirable occurrence, if they have already appeared it could be removed by different methods (mechanical, biological and chemical).

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Presentation title

Role of the Center for fishery and biodiversity conservation of inland waters Aquarium "Kragujevac" in ex situ protection

Abstract

The Center for fishery and biodiversity conservation of inland waters Aquarium "Kragujevac" on an area of about 500 m², was started on December 1, 1999. In this area more than 250 aquariums with more than 60 000 liters of water are exposed, divided into two parts: the exhibition part and the scientific research part. In the exhibition part there is a rich collection of freshwater organisms of our country, the Balkan Peninsula, Europe, Asia, Africa, America and Australia. An experimental hatchery, a laboratory for hydrobiological research in the area of monitoring, water protection and conservation of biodiversity, as well as a center for cryopreservation belong to the scientific research part. Besides the educational and tourist-recreational role, the significance of this center is also seen in the scientific and research activity. During the twenty years of existence and long-term research of aquatic ecosystems in Serbia, a number of projects related to ex situ protection of biodiversity of aquatic ecosystems and endangered species in Serbia have been successfully implemented. The results of such projects are reflected in numerous activities related to the ex situ protection of the European mudminnow (*Umbra krameri*) and the revitalization and repopulation of the tench (*Tinca tinca*). These species were cultivated and reproduced in the Aquarium laboratory, and then reintroduced into their original habitats. Similar ex situ conservation experiments were also performed with endangered species of warty newt (*Triturus cristatus*), a fire salamander (*Salamandra salamandra*) and noble crayfish (*Astacus astacus*). Projects also have been implemented in which the successful cryopreservation of salmonid fish species (*Hucho hucho*) products was successfully performed with the aim of preserving the biodiversity of indigenous species. The aquarium as an ex-situ expos of biodiversity protection primarily serves to preserve a part of nature, bring nature closer to man and meet nature.

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Presentation title
Aquarium Boka concept design

Abstract
Concept design of Aquarium Boka is developed as main input for setting up Marine Biodiversity Conservation Center "Aquarium Boka" and Sea Turtle Rescue Centre in the Institute of Marine Biology in Kotor, Montenegro, financially supported by the Norwegian Ministry of Foreign Affairs through the project "MonteAqua" grant (http://www.aquariumboka.ucg.ac.me/). Concept design is developed as a first stage of the Executive project of comprehensive building reconstruction and construction of Aquarium Boka and Rescue Center.

Concept design of Aquarium Boka envisages 16 tanks, each with particular theme: (1) Mediterranean rare fish; (2) Flagship species; (3) Invasive species (Splash tank); (4) Allochthonous algae and invertebrates; (5) Shallow littoral; (6) Mid littoral; (7) Deep littoral; (8-9) Endangered species; (10) Mediterranean moray; (11) Sharks and raja; (12) Boka Kotorska Bay (Touch tank); (13) "Vrulja" (underwater spring); (14) Tropical corals; (15-16) Invasive species and tropical fish.

Theme tanks are grouped in four sections: (1) Entrance section – exhibiting the World Sea and Mediterranean Sea life (tanks 1-4), (2) Central section – exhibiting the Adriatic Sea biodiversity (tanks 5-11), (3) Special section – exhibiting the Boka Kotorska Bay sea-life (tanks 12-13), and (4) Exit section – exhibiting tropical seas life (tanks 14-16). All sections are connected by the open space, while exhibit pathway represents interconnection among seas, sea currents, and vertical profile of the sea – from coastal area to the open sea.

Concept design presents the public aquarium which is opening possibilities for closer cooperation between science and business entities, particularly those engaged in fishing, as well as aquaculture, production of fish and seafood products. Aquarium Boka is designed with goal to strengthen the position of Montenegro in regional and international scientific cooperation in the conservation of biological marine resources.

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Presentation title
Center for Adriatic Biodiversity Conservation

Abstract
The Center for Adriatic Biodiversity Conservation is designed within the project "Marine Biodiversity Conservation Center "Boka Aquarium" – MonteAqua", which is implementing by the Institute of Marine Biology of the University of Montenegro in cooperation with the Center for Fisheries and Biodiversity Conservation of Inland Waters, Institute of Biology and Ecology, Faculty of Science, University of Kragujevac, under the grant provided by The Royal Norwegian Embassy in Belgrade. Setting up the Center is main MonteAqua project activity, planned for the period from December 2017 to June 2020.

The Center is designed with two main units: Aquarium Boka and Rescue Center. The Aquarium Boka is designed as first Montenegrin public aquarium and conservation advocacy center. Its role will be to promote implementation of marine protected areas in Montenegro and all means of marine biodiversity protection. Particular role will be in promotion of sustainable seafood choices. It is expected that Aquarium Boka will become main player in conservation and restoration of key threatened marine wildlife species in Montenegrin Adriatic, and beyond. The Rescue center is designed with four main roles: (1) Animal welfare: short-term shelter, care and rehabilitation center with the goal of finding a more suitable placement of threatened species for longer-term stay elsewhere; (2) Law enforcement: receiving confiscated animals, providing expert testimony, helping the police, customs, and wildlife authorities pursue the prosecution of traffickers and animal abusers; (3) Raising awareness; and (4) Nature conservation and biodiversity.

Setting up the Cetner is enabled by several major inputs, secured by MonteAqua project funds: (1) Adaptation of ground floor of Institute for Marine Biology (reconstruction and restoring the Aquarium), (2) Installing set of aquaria, and (3) Setting up Rescue Centre for Water Wild Flora and Fauna.

Expected outcome is increased capacity in the field of environment, which will create projected impact: Enhanced Montenegrin EU integration process in Chapter 27: Environment.

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Presentation title
Aquarium Boka public outreach

Abstract
The Aquarium Boka is designed as unit of the Center for Adriatic Biodiversity Conservation within the Institute of Marine Biology of the University of Montenegro. Its establishment is enabled by the grant provided by The Royal Norwegian Embassy in Belgrade for implementation of the project "Marine Biodiversity Conservation Center "Boka Aquarium" – MonteAqua" (http://www.aquariumboka.ucg.ac.me). Considering the concept of the Aquarium Boka as first Montenegrin public aquarium and conservation advocacy center, several activities were performed since start up of setting up the Aquarium in December 2017.

Two methodologies were tailored for the Aquarium to enable efficient public outreach: Stakeholder analysis and Public opinion assessment. Stakeholder analysis resulted in the list of important stakeholders which were invited on four workshops, organized from May to November 2018. All workshop participants were invited on MonteAqua e-platform, based on 9mCollab platform (https://9mcollab.com/), which is organization, collaboration and knowledge management tool for integration of new communication and conclusion making models with a goal to accelerate efficiency and knowledge base for organizations and teams. As of 31 May 2018, MonteAqua 9mCollab platform had 107 users, out of which 58 were active. They were discussing on 96 topics, creating 16 conclusions. E-platform as main public outreach tool is continuously growing. In March 2019 it had 210 users, 115 active, distributed in 50 groups, discussing on 117 topics, and creating 24 approved conclusions.

Platform enabled pilot assessment of public opinion on Adriatic biodiversity among platform members. Results indicates that respondents have well-developed awareness and knowledge about the importance of biodiversity. However, as 93% of the respondents are highly educated, living in the city, the future activities of the Aquarium should be dedicated to the promotion of importance, protection and vulnerability of biodiversity in rural areas and among the less educated population.

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Presentation title

Experiences of the Dubrovnik aquarium in keeping and breeding of sea organisms

Abstract

The growth of the human population and its activities are damaging the environment and, therefore, biodiversity, so many organisms become endangered or extinct. Aquariums play an important role in preserving nature through education and research aimed at maintaining organisms under controlled conditions. The Dubrovnik Aquarium is part of the Institute for Marine and Coastal research which was established in the early 1950s. It is located in a protected cultural monument and displays life in the Adriatic Sea. Seawater supply is secured from the ground below the aquarium. Previously, seawater was supplied directly from the surrounding sea but due to frequent pollution and high summer temperatures it was changed.

Numerous fish species, crabs, cephalopods and other organisms are successfully held in the Dubrovnik Aquarium. Beside protected species such as sea horse *Hippocampus ramulosus*, green wrasse *Labrus viridis*, noble pen shell *Pinna nobilis*, triton trumpet, *Charonia tritonis*, giant tun *Tonna galea*, loggerhead sea turtle *Caretta caretta*, in the aquarium are successfully maintained some alochtonous species that have appeared in our waters such as blue crab, *Callinectes sapidus* and dusky spinefoot *Siganus luridus*.

For feeding of aquarium organisms we are using live and artificial foods. Aquarium organisms are procured by our own catch, purchased from fishermen or from fish farms and in exchange with other aquariums.

During the past years, research in aquarium has been focused on breeding and maintaining of protected species, new species in mariculture and on monitoring the occurrence of new species in the Adriatic Sea. The future of aquariums is to overcome the maintenance of new species, breeding protected, endangered and rare species, exploring species of interest for mariculture and adapting the offer in response to visitor requests and available resources.

T7: Sustainable use of marine resources

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Presentation title

Evaluation of the biological potential of Marine Sponge Dysidea avara extracts obtained by supercritical fluid extraction- Potential and Opportunities for Discovery of Bioactives

Abstract

The marine sponges (Porifera) are certainly the richest sources with about 4851 compounds, contributing to almost 30% of all marine natural products discovered so far, but their pharmacological potential has not been fully exploited. In order for this potential to be better utilized for drug discovery it is required their broad assessment for different bioactivities. In this study, was to investigate the potential biological activities of extracts of the Marine Sponge *Dysidea avara* obtained by supercritical fluid extraction, collected from the Adriatic coast, Montenegro. The extraction process was carried out on laboratory scale high pressure extraction plant (HPEP, NOVA, Swiss, Efferikon, Switzerland). The cytotoxicity was examined on three human cancer cell lines HeLa, A549 and K562 as well as normal MRC-5 cells using the MTT test. Cell cycle distribution were assessed by flow cytometry. Anti α-glucosidase activity was determined using α-glucosidase inhibitory activity test. The examined extract showed a strong cytotoxic activity in all tested malignant cell lines (the IC 50 values were in the range of 17.53 ± 0.31 µg/ml to 20.33 ± 1.11 µg/ml), however, there was no selectivity. Also, the results of the cell cycle analysis confirm that there was accumulation of cancer cells in the sub G1 phase. *Dysidea avara* had the best anti-α-glucosidase (IC50 = 27.95 ± 0.57µg / mL) versus standard antidiabetic drugs acarbose (IC50 = 131.57 ± 0.34 µg / mL) activity. In this study, we have shown that marine organisms can be a powerful source of bioactive substances. On the other hand, it is necessary to emphasize the necessity of including marine biotechnology as a strategic research field aimed at sustainable exploitation. Thus, many modern approaches such as aquaculture of marine organisms, tissue cultures and genetic engineering as well as combinatorial chemistry techniques can be of great importance in the future.

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Presentation title

Implementation DCRF (Data Collection Reference Framework) for Sustainable use of fisheries resources in Montenegro

Abstract

Montenegro is a member country of the General Commission for the Fisheries in the Mediterranean (GFCM). As a member country, it partakes in the policy for responsible fisheries through various working groups for stock assessment. Within that framework, one of the obligations is collection of data in marine fisheries.

The official data on the catch of marine fish by species in Montenegro is collected, processed and published by MONSTAT (Bureau of Statistics). Such data also include the production in privately-owned fish and shellfish farms. The estimation of the catch is done using the approximation method, data for which are collected in municipalities. The approximate data refer to landing, do not include species with landings of less than one tonne, and do not include data on fishing gear and fishing effort.

Institute of Marine Biology is the only institution in Montenegro that collects biological data related to marine fisheries. Fishery-independent data are collected since 2004 within the frame of AdriaMed Trawl Survey. Biological data are also collected through MEDITS and MEDIAS programmes.

The Institute is responsible for the national monitoring of small-scale fishery resources, demersal resources on the continental shelf and the territorial waters and pelagic resources for Ministry of agriculture and rural development. Data collection on the catch of economically important species (pilchard, anchovy, hake, red mulled, deep-water pink shrimp, squids, and cuttlefish) is collected in the monitoring. Biological data are collected for all listed species: length, weight, sex and gonad maturity stages. Age determination is done only for pilchard and anchovy. The data are collected on a monthly basis, each month in a different port. The collected data is used to perform stock assessment on AdriaMed and GFCM working group sessions.

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Presentation title

Application of oxygen isotope geochemistry for growth analysis of the commercially important bivalve *Venus verrucosa*

Abstract

Bivalve shells serve as an important archive of data to analyse growth dynamics and/or reconstruct environmental variations at the time of shell formation. Warty venus (*Venus verrucosa*) is a relatively short-lived (~14 years) commercially important bivalve species that is common and widely distributed in shallow coastal waters in the Adriatic and Mediterranean Seas. Due to increasing market demands, this species is under overharvesting threat. Although previous studies showed that *V. verrucosa* has a clearly visible annual growth lines, still there is no information on the timing and rate of its growth or potential impacts of rising ocean temperatures affecting growth dynamics. Specimens we used were collected alive by SCUBA diving from two sites (1) near Barbariga in the eastern side of North Adriatic (10-11 m), and (2) in Kaštela Bay located in the central region of eastern Adriatic (2.5-4 m). Daily values of salinity and temperature data for each of the locations were extracted from previously validated the 3D ocean model of the Adriatic Sea. Prior to drilling, the shell surface was grounded using series of different wet silicon carbide papers. Shell powder (50–120 µg per sample) was obtained by micromilling on the outer shell surface of the right valve along the axis of maximum growth. Sampling was performed with a Dremel® Fortiflex drill equipped with a 0.3 mm cylindrical SiC drill bit. Powder samples were analysed with a Thermo Finnigan MAT 253 continuous flow – isotope ratio mass spectrometer, coupled to a GasBench II. Outer shell surfaces were photographed and the distances between individual sample swaths measured with the software Image Pro Primer 9.1. Seasonal $\delta^{18}O_{shell}$ cycles were observed in all studied specimens. Growth line deposition coincided with $\delta^{18}O_{shell}$ maxima. The $\delta^{13}C_{shell}$ values varied strongly between years and among specimens. Results were compared to oxygen isotope data of other studies using bivalves.

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Presentation title

Seasonal analysis of the surface circulation in Boka Kotorska Bay as derived from satellite-tracked drifters

Abstract

Boka Kotorska Bay is a small but complex system consisting of 4 interconnected bays connected to the Adriatic Sea. As can be seen in this article, local surface circulation is highly influenced by winds and orography, as well as other factors. Although modest in time-span (four 10-12 day operations from September 2016 till September 2017 consisting of series of short experiments) and means (6 MetOcean Iridium Self Locating Datum Marker Buoy (iSLDMB), a CODE style drifting buoy complete with sea surface temperature (SST) sensor and GPS) these measurements and analysis represent the first objective attempt ever of the seasonal approach on the surface circulation of the entire Boka Kotorska Bay. During the experiments, drifters were in regular connection to the Iridium Satellite Constellation, actively sampling and communicating their positions and other data in highest available temporal resolution (every 10 minutes) to the network. Network data were also available to researchers in real-time and were used to plan and execute the collection and repositioning of drifters, whether for saving the equipment in perilous situations (e.g. being adrift, passing to Croatian territorial sea or going off-shore)or for the start of the next experiment. The same data were used to calculate (the average distance and) the average velocity between the locations of their signals. All in all, considering means and time-scope available as well as limitations, data coverage was satisfactory to describe general velocity field characteristics of the whole Boka Kotorska Bay. As equipment had to be preserved, this analysis does not include extreme situations.

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Presentation title
Small purse seine catch and bycatch

Abstract
Purse seine net „oližnica“ is surrounding fishing gear targeting sand smelt (*Atherina hepsetus* and *Atherina boyeri*) and operating above sandy and mud bottom, with the mesh opening of 14mm. For this study, sampling on purse seine net „oližnica“ was done during 2016 and 2017 in warmer (from May to September) and colder part of the year (October to April) on four ships operating in the Istria area (Croatia) with a goal to describe, qualitatively and quantitatively, catch composition.

Target species (*Atherina boyeri* and *A. hepsetus*) proportion in overall catches seasonally varied from 35% in warmer and 88% in colder part of 2016 to 70% in warmer and 91% in colder part of 2017. On the other hand, bycatch was composed of different fish species with different proportion in a different season. Namely, in the warmer part of 2016 Trachurus mediterraneus (21.8%), Sarpa salpa (40.0%), Boops boops (10.7%) were the most abundant ones in bycatch. In colder part of 2016, bycatch was mostly structured of T. mediterraneus (40.8%), Liza aurata (16.1%) and Belone belone (15.1%). In warmer part of 2017 bycatch was composed of Sardina pilchardus (29.6%) and Diplodus vulgaris (0.1%), while In colder part of the same year T. mediterraneus (2.0%) was dominant in bycatch along with B. boops (1. 9%) and *Oblada melanoura* (1.2%).

Official catch composition for the whole fleet operating in the warmer and colder season of the 2016 and 2017 was also recorded and compared with collected one. The difference was noted in the ratio between target species and bycatch which in official statistics were in favor of bycatch (from 72 to 99%) and in sampling mostly in favor of target species (from 35 to 91%) pointing to the possible lacking in the sampling scheme and/or in fisherman misreporting.

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Presentation title

Biological and physicochemical parameters reflecting rearing conditions in the fish farm in the Eastern Adriatic Sea

Abstract

Phytoplankton are planktonic, photosynthetic microorganisms which grow in euphotic part of the oceans and seas. Their growth is connected to concentration of nutrients and other abiotic factors in the environment (temperature, salinity, oxygen concentration, organic matter, sea currents etc.). Although phytoplankton is at the base of trophic levels in aquatic environments, their overgrowth (phytoplankton blooms) can cause many problems in aquaculture environments, as well as economic losses. Hence, regular monitoring of fish farms is recommended to assess the potential eutrophication of such aquatic environment. In February 2017 and May 2018 sampling was conducted at one commercial fish farm of sea bass (*Dicentrarchus labrax*) and sea bream (*Sparus aurata*) in the central part of the Eastern Adriatic Sea. Physico-chemical properties of the water column were measured in situ (Secchi depth, temperature, salinity, oxygen concentrations, pH and ORP). Phytoplankton samples were taken with Niskin sampler at 3 depths (0,5m, 7,5m and 18m) and sediment samples were collected by diver. Phytoplankton samples were analyzed quantitatively by Utermöhl method. Several parameters were determined for chemical analysis of sediment: pH and ORP, carbon, hydrogen, sulfur, inorganic matter and total phosphorus. Phytoplankton as biological parameter gave indication of water quality, with high percentage on nanophytoplankton versus microphytoplankton, showing tendency to oligotrophic status and good mixing of water column. Also, potentially toxic species were rarely identified and in low abundances. Results of physico-chemical properties confirmed stable abiotic conditions, with well oxygenated water column despite aquaculture production. Results of sediment analysis concur with good trophic status of the water in the sea bass fish farm.

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Presentation title

Life history traits of the thornback ray, *Raja clavata* Linnaeus, 1758 in the Southern Adriatic Sea

Abstract

Slow growing rates and low fecundity are peculiar biological traits of Chondrichthyans that are responsible of the low rates of the potential population increase, making this group of fish particularly threatened by overfishing. The thornback ray, *Raja clavata* is currently included in the IUCN Red-List as a "near threatened" species and represents, among the Rajids, one of the most commonly landed species in the Mediterranean basin. The Adriatic Sea is not an exception, given its particular wide shelf and sandy-muddy bottoms, where trawl fishing is commonly practiced. Some knowledge gaps still exist about reproductive biology and growth pattern of this species, making difficult stock assessment and proper fishery management. Analytical stock-assessment models require indeed growth and maturity parameters as input data.

The aim of the present study is to deepen the knowledge on life history traits of thornback ray in the Southern Adriatic Sea (GSA18 *sensu* FAO-GFCM).

A total of 984 specimens were collected from 2012 to 2017 during the MEDITS scientific trawl surveys and the commercial landings and discard monitoring (DCF EU-Reg. 1004/2017, formerly EU Reg. 199/2008). For both sexes the length at first maturity and reproductive pattern were assessed. Moreover, on the 361 specimens with a length range between 11.9 and 89 cm (206 female and 155 male) thin sections of *vertebrae* were analysed to determine the age and the von Bertalanffy function's growth parameters. The *vertebrae* marginal analysis was also used as a semidirect validation of the ageing analysis.

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Presentation title

Development of the ims strategy and risk management in conditions of the uncertain and limited marine resources

Abstract

Based on the previously obtained research results, the goal has been defined related to the use of modern scientific methods and approaches, with the development of IMS strategy, in risks management in conditions of the uncertain and limited marine resources. The subject of research is maritime services, and especially port services, by defining the basic long-term goals of the maritime company with the allocation of resources necessary for the accomplishment of these objectives.

Key words: Integrated management systems (IMS), key performance indicators (KPI), risk management, business performance management, marine resources

T8: Marine biotechnology

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Presentation title

Ion-exchange fibers in a function of aquarium water filtration

Abstract

Aquarium seawater is complex a solution containing different metallic ion, such as potassium, calcium, sodium, magnesium, as well as ions ammonium, nitrate, phosphate, chloride, sulphate, carbonate. Accumulations of these chemical species are characteristic of closed system aquariums and must be controlled by proper maintenance and filtration. Marine animals produce ammonia as a metabolic waste. Also, ammonia may be accumulated by decomposition on uneaten food. The input of ammonia into aquarium water is constant, and ammonia is toxic to marine animals.

Ion-exchange fiber can exist in form of cation- and anion-exchange fibers. Ion exchange fibers are the effective tool for some metal ion, as well as ionized ammonia, nitrate, phosphate, removal from solution. In our Laboratory, ion exchange polyacrylonitrile (PAN) fibers with ion-exchange capacity (IEC) 1,4-1,7mmol/g are obtained. Results shown that ion-exchange fibers has significant sorption ability of ammonium, nitrate, nitrite and phosphate ions.

Fibrous ion exchangers are preferred because of their geometric shape, which allows varying conditions and apparatus solutions of the ion exchange process. Ion-exchange fibers in a function of aquarium water filtration will be shown in this paper.

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Presentation title

New approach for express isolation of chitin from demosponges of the order Verongiida

Abstract

Marine sponges are sustainable sources of diverse biologically active secondary metabolites as well as of biocompatible and biodegradable biological materials (spongin, collagen, chitin) which are of great interest for biomedical applications. In 2007, it was shown for the first time, that chitin, as the second most abundant polysaccharide, can be isolated from selected demosponges including species habituating in Adriatic Sea. At this time only one extraction method has been developed to isolate chitin in the form of unique three dimensional scaffolds with their confirmed applications in tissue engineering of chondrocytes and human mesenchymal stromal cells. The method includes step-by-step demineralization (both decalcification and desilicification) as well as deproteinization and depigmentation of the sponge skeleton by alternating acidic and alkaline treatment with 20 % acidic acid and 2.5 M sodium hydroxide solution at 37°C. Until now it was possible to isolate chitin from 17 different demosponges species of the order Verongiida using this method. However, this well recognized method takes up to 14 days to isolate naturally prefabricated poriferan chitin. Consequently, our task was to develop new methods for a faster isolation of this structural polysaccharide. Thus, we have showed that combining the acidic and alkaline treatment with selected microwave exposure can save over 98.3 % of the standard treatment time. The isolated in this way material has been identified as alpha-chitin by Calcofluor white staining, chitinase digestion test, ATR-FTIR- and Raman-spectroscopy. Furthermore, the examination of the isolated chitin scaffolds using scanning electron-, light- and fluorescence microscopy shows, that the new method leads to a surface enlargement and surface modification. We conclude that such sponge chitin scaffolds with new surface properties are promising for the application in the field of extreme biomimetics and tissue engineering.

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Presentation title

The rule of bivalve hatcheries in the assurance of sustainable use of marine resources and biodiversity protection

Abstract

Aquaculture production of bivalve mollusks in Eastern Adriatic is limited to European flat oyster (Ostrea edulis) and Mediterranean mussel (*Mytilus galloprovincialis*). Beside cultured species, several autochthonous bivalve mollusk species (*Venus verrucosa*, *Ruditapes decussatus*, *Chamelea gallina*, *Arca noae*, *Pecten jacobeus*, *Chlamys varia*, *Chlamys opercularis*, *Modiolus barbatus*, etc.) are harvested for the market from their natural populations. The growing demand for healthy food sources has significantly increased the consumption of fish and shellfish in the last decade. As traditional bivalve farming technology in Eastern Adriatic is entirely based on the spat collection from the natural environment, it is very difficult to assure sustainable and strategically planned increase in production, because the initial phase of production (spat collection) is strongly affected by unpredictable and varying number of larvae available from the nature. On the other hand, increased demand for bivalves from natural stocks leads to their overfishing. The development of bivalve hatcheries in Eastern Adriatic presents the necessary step in assurance of adequate quantities of spat for cultivation, as well as protection of biodiversity of natural populations. Production in the hatchery can be based on obtaining the larvae from adult oysters matured in the natural environment, or on the broodstock conditioned in controlled conditions within the hatchery. Properly designed hatchery should include: algae production facility, broodstock conditioning facility, larval and post larval rearing facility. Facilities for larval and post larval rearing can be designed as a stationary, flow through or close recirculating system. Besides assuring optimal water quality, it is necessary to establish production of microalgae as the live food. Experience of artificial bivalve spawning in hatchery in Eastern Adriatic as well as different larval and post larval system designs are presented in this paper.

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Presentation title

The use of recirculation aquaculture systems - a tool for sustainable and environmentally friendly development

Abstract

Intensive and sustainable Recirculating Aquaculture Systems (RAS) provide an alternative to traditional resource-intensive and climate depending technologies of raising fish. The recirculation technology provides a stress free environment, ensuring conditions for optimal growth, high product quality, and biosecurity. It minimizes land requirements and water usage, reduces feed consumption and provides for complete control of fish inventory. Enclosed, properly designed recirculation systems prevent escape of cultured stock protecting natural populations and biodiversity. They have also demonstrated their potential for producing a fresh, unpolluted and continuously available product, without the requisite water resource requirements and geographic restrictions of traditional aquaculture methods. Therefore, well designed recirculation system cut the pollution and disease that occur in current fish farming operations and is now seen as the future of the industry. Limited volume of wastewater can be economically treated for the removal of both, solid and dissolved waste. By the integration of various unit processes to recycle and reuse the culture water, both freshwater and marine recirculating aquaculture systems are able to provide for sustained water quality control and enclosed secured environment for different fish species. Water quality control is provided by effectively co-engineered systems for clarification, biofiltration, de-gassing, oxygen/ozone injection, and water movement technologies. In comparison to traditional technologies RAS construction is more demanding, requiring the integration of sophisticated and carefully designed hardware and technologies with co-developed management techniques in order to reach optimal economical sustainability. The principal components of design as well as basic design criteria are described in this paper.

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Presentation title

Vibrio populations and preliminary assessment of health status of European seabass from two marine fish farms in eastern Adriatic Sea

Abstract

Aquaculture is an important industrial sector for both Montenegro and Croatia. Marine fish culture in both countries is dominated by European sea bass (*Dicentrarchus labrax*). Development and appearance of diseases among cultured fish is the result of the interactions among host, pathogens and environment. Microbiological survey in the two marine fish farms with intensive aquaculture of European seabass was conducted in Montenegro and Croatia in the spring and autumn of 2017/2018. All bacterial isolates affecting the farmed fish during these two periods were investigated, with focus on the identification and antimicrobial resistance. The microbial counts were carried out on two media: heterotrophic bacterial count on the Marine agar plates and Vibrio counts on the Thiosulfate Citrate Bile Sucrose (TCBS) plates. Isolates from Marine and TCBS agar plates were identified using MALDI TOF MS, whereas antimicrobial resistance was analyzed using disc diffusion method on the Muller Hinton II agar. The highest percentage of isolates were the members of the genera Vibrio and Photobacterium. Finding of these opportunistic pathogens in geographically distinct fish farms is important regarding sea bass health status issue, particularly by the fact that resistant strains of these bacteria could be widespread via currents. The study reveals the presence of opportunistic bacterial pathogens as part of the bacterial community of farmed European seabass and surrounding marine water.

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Aquaculture is an important industrial sector for both Montenegro and Croatia. Marine fish culture in both countries is dominated by European sea bass (*Dicentrarchus labrax*). Development and appearance of diseases among cultured fish is the result of the interactions among host, pathogens and environment. Microbiological survey in the two marine fish farms with intensive aquaculture of European seabass was conducted in Montenegro and Croatia in the spring and autumn of 2017/2018. All bacterial isolates affecting the farmed fish during these two periods were investigated, with focus on the identification and antimicrobial resistance. The microbial counts were carried out on two media: heterotrophic bacterial count on the Marine agar plates and Vibrio counts on the Thiosulfate Citrate Bile Sucrose (TCBS) plates. Isolates from Marine and TCBS agar plates were identified using MALDI TOF MS, whereas antimicrobial resistance was analyzed using disc diffusion method on the Muller Hinton II agar. The highest percentage of isolates were the members of the genera Vibrio and Photobacterium. Finding of these opportunistic pathogens in geographically distinct fish farms is important regarding sea bass health status issue, particularly by the fact that resistant strains of these bacteria could be widespread via currents. The study reveals the presence of opportunistic bacterial pathogens as part of the bacterial community of farmed European seabass and surrounding marine water.

T9: Freshwater biodiversity conservation

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Presentation title
Length-Weight Relationship And Condition Factor Of The Cactus Roach (*Rutilus Virgo*) In The Perućac Reservoir (Serbia)

Abstract
The length-weight relationship and condition of 35 individuals of the cactus roach, caught in June 2017 in the Perućac reservoir, were analysed. The average length (± SD) of the sampled individuals was 29.8 ± 6.1cm and the average weight (± SD) was 334 ± 215 g. Age ranged from 2+ to 5+ years, and almost half of individuals were aged 2+. The regression coefficient of the length-weight relationship was $b > 3$, which indicates a positive allometric growth. The Fulton's condition factor ranged from 0.94 to 1.27, with the mean value (± SD) of 1.09 ± 0.09. Allometric condition factor ranged from 0.49 to 0.62, with the mean value (± SD) of 0.56 ± 0.04.

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Presentation title

Diversity and structure of epilithic diatom community in Crno Lake (Montenegro)

Abstract

In case-study of Crno Lake composition and structure of eplithic diatom community was investigated for the first time in Montenegrin lakes following directions of the Water Framework Directive. Crno Lake is glacial mountain lake, located in the northern part of Montenegro. Samples were collected in summer of 2016. and 2017. from six selected sites. A total of 304 diatom taxa (from 59 genera) was identified; 43 taxa were recorded for the first time in Montenegro and 183 taxa were new for Crno Lake. Most of the registered diatom species were cosmopolitan taxa adapted to moderate alkalinity and oxygen-saturated water. The most numerous were diatoms from low-profile guild. *Achnanthidium minutissimum*, *Cocconeis euglypta*, *Encyonopsis microcephala*, *Epithemia sorex*, *Navicula cryptocephala*, *Navicula cryptotenella*, *Psedostaurosira brevistriata* and *Staurosirella pinnata* were present as dominant diatom taxa (with >5% relative abundance in at least one sample). In order to relate the diatom assemblages to water quality, diatom indices were calculated using OMNIDIA (6.0.1) software. Most of the indices showed high to good ecological status, especially in deeper and more isolated part of the lake named Malo Crno Lake.

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Presentation title

Identification of the most important freshwater habitats for the conservation of threatened decapod crustacean, freshwater mussel and dragonfly species in Republic of Macedonia

Abstract

In the Republic of Macedonia, there is one freshwater decapod crustacean (*Austropotamobius torrentium*), one freshwater mussel (*Unio crassus*), as well as six dragonfly species (*Coenagrion mercuriale*, *Coenagrion ornatum*, *Cordulegaster heros*, *Leucorrhinia pectoralis*, *Lindenia tetraphylla*, *Ophiogomphus cecilia*), listed on the Annex II of the EU Habitats Directive. However, these species like the habitats in which they are encountered receive relatively limited publicity and conservational attention in the country, despite their key role in aquatic food webs and ecosystem functioning. The aim of this study is to provide information about the distribution of these species in Republic of Macedonia in order to identify freshwater habitats with high potential value for the Natura 2000 network.

Revision of the available literature data on the occurrence and distribution of the species was conducted at the beginning of the study. Once the distribution gaps were established, the hydrobiological research carried out during 2016 - 2018 on the territory of the country provided new data.

Through revising and updating the data on the presence and distribution of the threatened decapod crustacean, freshwater mussel and dragonfly species in Republic of Macedonia, the most important freshwater habitats for their conservation were identified. Therefore, we hope that the results presented in our research will serve as a valuable source of information during the processes of designating special areas of conservation (SACs) within the Natura 2000 network.

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Presentation title

Contribution to the knowledge on non-indigenous freshwater mollusks (Mollusca) in Montenegro

Abstract

The investigation has been performed during 2017 and 2018 at 40 sites in Montenegro, covering the running and standing waters of both, Adriatic and Danube Basin. During the investigation, four non-indigenous freshwater mollusks species were recorded: *Corbicula fluminea* (O. F. Müller, 1774), *Dreissena polymorpha* (Pallas, 1771), *Physella acuta* (Draparnaud, 1805) and *Ferrissia fragilis* (Tryon, 1863). *C. fluminea*, invasive Asian clam, has been recorded at the lower stretch of the Zeta River (Tunjevo) and in the Skadar Lake (vicinity of the confluence of the Morača River and near Virpazar). The invasive Ponto-Caspian Zebra Mussel *D. polymorpha* has been recorded at four sites: the Bojana River (Fraskanjel), Skadar Lake (Virpazar), as well as two sites on the Zeta River (downstream Danilovgrad and Tunjevo). North American invader P. acuta has been found at the Bojana River (Fraskanjel) and the Plav Lake. F. fragilis, also originating from North America, has been recorded at the Bojana River (Fraskanjel). It should be noted that additional taxa belonging to genus Dreissena has been found at the Skadar Lake. Due to morphological similarity, we couldn`t confirm whether the species belongs to *D. bugensis* Andrusov, 1897 or "*D. stankovici*" L'vova and Starobogatov, 1982. Beside four mentioned species, in our earlier studies, we found Chinese Pond Mussel Sinanodonta woodiana (Lea, 1834) in the Šasko Lake in 2012. Our study indicates that the Skadar Lake, the Bojana and the Zeta Rivers are under the particular influence of biological invasions.

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Presentation title

Biometry and diet of *Perccottus glenii* Dybowski, 1877 found in stagnant water nearby Veliko Gradište (northeastern Serbia)

Abstract

The aim of this study was to describe biometric and feeding characteristics of highly invasive species *Perccottus glenii* in the investigated locality. A total of 85 fish were electrofished in the drainage channel located at the vicinity of Veliko Gradište (northeastern Serbia) and preserved in the alcohol solution. In the laboratory, fish were measured (TL, ± 0.01 mm; W, ± 0.01 g), otholits and digestive tracts were removed for age determination and dietary analysis (stereomicroscope). Biometric analysis included length-frequency distribution using 10 mm class intervals; determination of average length and weight for each age group; lenght-weigth relationship; Fulton's condition factor. Ingested organisms were identified to the lowest reliable taxonomic level (mainly order) and counted. The respective ranges of TL and W of examined fish were 35-140.7 mm and 0.5-40 g. Length class 70.1-80.0 mm clearly dominated (24%). Four age groups were determined (0+-3+), and their descriptive statistics is presented. The value of allometric coefficient for the length-weight relationship (b= 3.068) indicated isometric growth. Fulton's condition factor did not differ between age groups. Empty digestive tract was found in 2 specimens. A total of 12 prey categories representing Ephemeroptera, Trichoptera, Odonata, Hemiptera, Chironomidae, Coleoptera, Gastropoda, Hirudinea, Oligochaeta, Gammaraidae, unidentified and terrestrial insects were identified in the diet. Generally, the diet is entirely composed of aquatic invertebrates, as only one terrestrial insect was found. Obtained results did not show clear difference in diet composition between age groups. However, analysis have shown that the most diverse diet characterize 2+ age. By frequency, the insect larvae were categories with highest participation regardless of age.

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Presentation title

Metal content in muscle, gills and liver tissues of the northern pike Esoxlucius (L. 1758) of three age classes in the irrigation channel of the Danube river – case study

Abstract

Northern Pike is the top piscivore and phytophilic species strongly dependent on back-waters and vegetated river areas for spawning and recruitment. The aim of the present study was to examine dependence between metal concentrations (As, Cr, Cd, Co, Cu, Fe, Sr, Pb, Zn, Hg) and examined fish tissues, as well as of fish age. In June 2013, 26 samples of pike have been collected using electrofishing (HONDA 1,2κW, 6 A). Collection was performed in irrigation Channel Vizelj, runs through the suburban section of Belgrade. The content of heavy metals was determined in samples of fish tissues of different ages using inductively coupled plasma mass spectrometry (ICP-MS). Age analysis indicated that fish belonged to age classes from 0+ to 2+. Metals As, Cd, Co and Pb were not detected in analyzed fish tissues, and Cu was not detected in muscle tissue of 2+ and 1+ specimens. The majority of the analyzed elements were found in minimal concentrations in the muscle, except 0+ specimens with high Fe concentrations. Gills of all analyzed age classes were loaded with very high concentrations of Fe and Sr. In gills of 1+ and 2+ fish were also detected high Zn concentrations while in 0+ fish were detected Fe. The highest concentrations of Cu were detected in liver of all fish age classes. The youngest age class (0+) was differentiated by higher concentrations of Cr, Cu, Fe, Sr and Zn in muscle tissue, while the oldest age class was mainly differentiated by higher concentrations for Zn and Hg in gills.

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Presentation title

Towards application of benthic diatoms in ecological status assessment: results of screening of water bodies in Montenegro

Abstract

Diatoms are dominant group in a phytobenthos community of freshwater ecosystems. Their autecological features are well known, and various diatom indices are designed to estimate changes in aquatic ecosystems. In order to develop system for ecological status assessment in Montenegro according to the principles of the EU Water Framework Directive, quantitative and qualitative composition of benthic diatoms was studied. Phytobenthos sampling was carried out during July of 2018 at the Rivers Ćehotina, Lim, Tara, Zeta, Morača, Rijeka Crnojevića, Bojana, Komarnica, as well as at the Skadar Lake. Sampling, preparation of permanent slides, identification and enumeration of diatoms were done according to the standard methods. Altogether, 107 taxa belonging to 39 genera were recorded. The most diverse genera were found to be Navicula (12), Cymbella (11), Gomphonema (10) and Fragilaria (9). *Achnanthidium minutissimum, Amphora pediculus, Cocconeis placentula var. euglypta, Encyonema minutum, E. ventricosum, Navicula cryptotenella* and *N. tripunctata* were the most frequent, while taxa belonging to *Achnanthidium* sp., *Cocconeis* sp. and *Encyonema* sp. were the most abundant in the samples. Our research revealed dominance of β-mesosaprobic taxa, as well as taxa typical for mesotrophic to eutrophic conditions. It was also confirmed that IPS index is effective metric of stress in running waters. Presented data are in accordance with previous investigations of epilithic diatoms in freshwaters of Montenegro and comparable types of rivers in Serbia, and could be successfully used for further development of ecological status assessment in Montenegro.

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Presentation title

Review of the research on red algae (Rhodophyta) in freshwater ecosystems in Montenegro

Abstract

Red algae (Rhodophyta) are important algal group in freshwater ecosystems owing to their stenovalence in relation to substrate, water temperature, water transparency, current velocity and water quality, and because of that they can be used as a bioindicators of water pollution. Degradation of their habitat (pollution, small hydropower plant, etc.) leads to that Rhodophyta are endangered in many countries or already extinct. Because of that, they have been protected by national legislation in a lot of countries. The freshwater red algae are very poorly investigated in Republic of Montenegro. From 1970 to 2009 only seven taxa of freshwater Rhodophyta were found, at eight localities of rivers and lakes (*Bangia atropurpurea* (Roth) C. Ag. – Piva River, Tara River and her tributaries; *Batrachospermum* sp. – Tara River and tributaries; *B. gelatinosum* (L.) De Candolle (as *B. moniliforme* (L.) Roth) – basin of the Piva lake; *B. turfosum* Bory (as *B. vagum* (Ag.) Sirod.) – Lim River; *Chantransia chalybea* (Roth) Bory – Tara River and her tributaries; *Ch. hermmani* (Roth) Desv. (as *Ch. violacea* Kütz. – Tara River and her tributaries; *Lemanea fucina* Bory – Tara River, Splavište locality). After 2009 no literature data is available. During 2018 we have found thalli of two rare Rhodophyta at new localities in Montenegro (*Batrachospermum* sp. in Mlinski potok stream in the National park Durmitor and *L. fucina* in the Tara River, at new locality). These new findings are very important from the aspect of knowledge of diversity, distribution and ecology of freshwater Rhodophyta.

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Presentation title

Significance of genotoxicity and toxicity evaluation of freshwater bodies

Abstract

Fish communities are excellent indicators of biological and ecological integrity due to their continuous exposure to water conditions. Freshwater biodiversity constitute a valuable natural resource but extensive pollution of freshwater can result in biodiversity decline. For that reason it is important to employ bioassays for purpose of detecting these conditions. In this work we monitored chub and bream species in 2 reservoirs, Uvac and Garasi, and 4 rivers: Dunav, Sava, Pestan and Beljanica. For assessment of metal and metalloid in fish tissues (liver, gills, gonads and muscle) we have used ICP-OES. The comet assay or single cell gel electrophoresis (SCGE) was selected as an in vivo genotoxicity assay, for measuring DNA damage in blood, liver and gills. Histopathological alterations were monitored in liver and gills.The high quality of Uvac water was confirmed by low values of DNA damage in all tissues compared to other sites. An analysis metals in tissues showed a high degree of their differentiation, as well as significant differences in the distribution of tissue elements between the sites tested. The highest concentrations of most of the analyzed metals were found in gills, liver and gonads, and the lowest in muscles at all sites. In chub, blood showed the lowest DNA damage compared to liver and gills, while in all breams DNA damage was the highest in blood cells, following gills and liver. Histopathological analysis performed on bream specimens on the Sava and Danube River revealed a higher degree of alterations in liver compared to the gills.

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Presentation title

Bioassays in assessment of environmental pollution

Abstract

Water pollution represents one of the main threats of global freshwater diversity. Untreated urban wastewaters are the source of both microbiological and chemical pollution. In exposed organisms, pollution affects different levels of biological organisation, from molecular to community level. Due to their role in aquatic ecosystems and vulnerability to pollution fish represent one of the key elements of ecosystem monitoring programs. Microbiological indicators of faecal pollution such as total coliforms, *E. coli* and enterococci are reliable indicators of the untreated urban wastewaters. They may be detected and quantified by fast and reliable enzymatic methods and most probable number (MPN) approach. Analysis of metals and metalloids concentrations in fish tissues indicate the exposure of fish to specific elements and can be used as a biomarker of accumulation. The single cell gel electrophoresis or comet assay is widely used in ecogenotoxicological studies for the assessment of the DNA damage as a biomarker of exposure to pollution. Histopathological alterations in fish tissues reveal changes at the middle level of biological organisation and are used as a biomarker of effect. Since each fish tissue responds differently to pollution it is recommended to perform these bioassays on multiple types of tissues, i.e.: blood, gills, liver, gonads, skin and muscle.

Analysis of different biomarkers response can give information about the early response of biota to pollution, before the changes in population structure and a decrease of individuals occur.

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Presentation title

Review of allochthonous fish species with the marine origin in Serbian freshwater system

Abstract

During the last decades in the freshwater system in Serbia 27 allochthonous fish species appeared, and they can be divided into two groups. In the first group are representatives of fish fauna which are originally from Asia and they are intentionally introduced into open waters and aquaculture in Serbia, while the second group represent the migrants spreading their range from the Black Sea into freshwater systems. Some of these species already have established populations. Representatives of marine fauna that inhabit freshwater systems in Serbia are: *Syngnathus abaster, Neogobius fluviatilis, Babka gymnotrachelus, Ponticola kessleri, Neogobius melanostomus, Proterorhinus (marmoratus) semilunaris, Gasterosteus aculeatus, Knipowitschia caucasica, Morone morone x Morone saxatilis*. Gobiids extended their geographical distribution outside their native range and expanded their area of distribution in throughout whole Danube River Basin, while for the other specimens there are no literature data about established populations.

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Presentation title

Freshwater fish biodiversity conservation: Proximate and fatty acid composition aspects of Carp species

Abstract

Nevertheless freshwater cover less than 1% of the globe surface, freshwater still represent hotspots which support almost 10% of all known species, as well as 1/3 of existing vertebrate species. Widespread habitat degradation of freshwaters hotspots is a result of human activities which led to, pollution, flow regulation changes, and water extraction, and the most important fish overexploitation. With the ongoing and coming multitude of freshwater extinctions, an effort should be addressed to freshwater fish biodiversity population having in mind that the fish and fish products are involved in a large percentage in human daily nutrition worldwide. One of the most used freshwater fish for human nutrition in Serbia, are the fishes from family *Cyprinidae*. Therefore the aim of this research was to evaluate the proximate and fatty acid composition of commercially important fish species (*Cyprinus carpio*, *Hypophthalmichthys molitrix*, *Hypophthalmichthys nobilis*, and *Ctenopharyngodon idella*) which were collected from retail stores in the area of Novi Sad, Republic of Serbia. The amount of protein was the highest in *Hypophthalmichthys nobilis* (18.03%) and the lowest in *Ctenopharyngodon idella* fillets (14.73%). The percentage of fat ranged from 6.1 in *Hypophthalmichthys molitrix* to 10.07 in *Cyprinus carpio*. Saturated fatty acids (SFA) were lowest in *Ctenopharyngodon idella* (28.72%). *Hypophthalmichthys nobilis* filets contained the highest percentage (33.73%) of polyunsaturated fatty acids (PUFA) while the lowest percentage was detected in *Cyprinus carpio* (20.1%). The chemical and fatty acid compositions of fish vary greatly between different species and within the same species. The quality of fish meat in Serbian retail stores is quite good but it could be improved so, therefore, is very important to preserve the biodiversity of freshwater fishes.

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Presentation title

Comet assay – a sensitive method for detection DNA damage and primary monitoring of ecosystem pollution pressure

Abstract

Untreated municipal wastewaters are one of the major negative contributors on freshwater quality, and consequently on ecosystem balance. Some compounds such as pharmaceuticals, cosmetic products, etc. could be genotoxic and lead to somatic and/or germinative mutations. This mutation should be reflected on organisms' health and reproductive potential. Comet assay is a widely used test in ecogenotoxicology for detection of primary DNA damage. In that way, this sensitive test could provide information about early warning signs of potential stressors effects before those have an impact on the population or ecosystem level.

The scope of our study was to assess the level of DNA damage of *Alburnus alburnus* specimens' gill cells and erythrocytes. Three sites on the Sava river were chosen: reference site Zabran suited upstream the municipal discharging; second at the confluence of the Kolubara river and the Sava river; and the third at the confluence of the Barička river and the Sava river. The Kolubara river and the Barička river are chosen as important recipients of untreated wastewaters. From each site, 5 bleak specimens were collected and blood and gills were taken. Tail Intensity (TI%) was chosen as a parameter for evaluating the level of DNA damage. Besides that, cell viability and extremely damaged cells - hedgehogs (HH) were determined.

The significant difference in TI% values was recorded in erythrocytes and gills cells in comparison between the Zabran (TI%=14.01±0.61 in erythrocytes, TI%=15.25±1.03 in gills cells) and the second site (TI%=18.53±0.65 in erythrocytes, TI%=22.78±1.89 in gills cells). Correlation between cell viability and HH frequency was not observed.

According to the results, we could conclude that the second site is the most affected by pollutants. Also, usage of comet assay on freshwater organisms could be appropriate for preliminary screening of ecosystem state.

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Presentation title

European eel (*Anguilla anguilla*) in Skadar Lake

Abstract

European eel (*Anguilla anguilla*) is highly endangered fish species due to several factors: overfishing of glass eel, yellows and silvers; swimming bladder parasite which originate from *Anguilla japonica*; habitat loss; riverine connectivity loss. It is still not clear whether some of those factors are curtail or it is synergetic effect of all of them. It is also possible that dramatic decrease of eel abundance is related to some climate changes in Atlantic Ocean (The North Atlantic Oscillation – NOA) which caused cyclic changes in main Gulf current which is essential for dispersal of eel larvae.

European eel inhabits the whole water mass of Skadar Lake, from its shoreline to its central part, form the small coastal springs to the depts of sublacustric wells called „oka". Desk research of European eel in Skadar Lake suggests several measures: (a) Setting up monitoring program, together with Albanian partners, of glass eel immigration and sliver eel emigration from Lake Skadar and estimation the eel biomass in the Skadar Lake; (b) Development the joint (Albania and Montenegro) Eel Management Plan for the Lake Skadar; (c) Regulation and control of harvesting of fish trap on Bojana river in Albania during downstream eel migration, in order to regulate downstream migration of silver eels and to satisfy requirements of "eel directive"; (d) Develop eel farming and using of glass eels and elevers from Bojana delta as fish farm stocking material, in order to reduce fishing pressure on eel live stock in the Skadar Lake.

Based on the importance of the Skadar Lake as huge eel habitat, eel vulnerability, global threats, biological importance, marketing potential and eel unique and mysterious life cycle as well as unique body shape, authors strongly suggest to proclaim European eel, together with pelican, as a flagship species for the Skadar Lake. As initial activity authors suggest European eel as a flagship species for the Lake Skadar Aquarium, as part of Visitors Center "Vranjina".

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Presentation title

New strategy for ichthyofaunal conservation - cryopreservation and transplantation of early stage germ cells

Abstract

The sperm cryopreservation is a well-known and useful method for the conservation of fish genetic material. Since cryopreservation cannot yet be successfully applied on fish eggs and embryos, alternative approaches are needed in order to overcome this problem.

The use of germline stem cells (spermatogonial stem cells - SSCs and oogonial stem cells - OSCs) have a high potential in ex situ conservation programs. These diploid and pluripotent cells are located in gonadal tissue with the special ability of migration and differentiation into functional gametes of both sexes after transplantation into suitable recipients. In order to make them continuously available, they can be cryopreserved and stored in the liquid nitrogen for theoretically infinite period as a specific gene bank. Preparation of any biologic material for cryopreservation is species- and tissue-specific. Thus it is always necessary to develop the most suitable protocol resulting with the highest possible survival rate of the cells for each specie. In our laboratory, we have developed protocols for cryopreservation of gonadal tissue of *Cyprinus carpio*, *Danio rerio*, *Salmo trutta*, *Salmo marmoratus*, *Thymalus thymalus*, *Silurus glanis*, *Tinca tinca*, *Carassius auratus* and *Anguilla anguilla*.

Further use of cryopreserved/thawed cells might include include intra- and interspecific transplantation, in vitro cell culture and maturation. All mentioned methods can result in mature eggs and sperm carrying the genetic material of the special interest. Until now, in our laboratory, germ cell transplantation was successfully completed for *Cyprinus carpio*, *Danio rerio*, *Salmo trutta* and *Onchorynchus mykiss.*

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Presentation title

New strategy for conservation of European eel

Abstract

The European eel (*Anquilla anquilla*) is considered a valuable product on the European markets with a high potential demand. Anthropogenic factors such as overfishing, barriers in the rivers, pollution as well as negative effects of diseases cause a hard reduction of natural stocks. In nature, reproductive difficulties such as spawning migration, limited fertility, long duration of reproduction cycle and high larvae mortality. In captivity, they face other difficulties such as long hormonal treatment, high mortality of adults, and absence of larvae feeding protocol resulting in a total offspring loss. Design of novel conservation programs and strategies that would include tissue cryopreservation and subsequent surrogate production or in vitro germ cell culture is needed.

The aim of this study was to develop of an optimal cryopreservation protocol for European eel gonadal tissue through serial experiments that would enable a progress in further application. In the first experiment, the effect of six different cryoprotectants (dimethyl sulfoxide - Me2SO, ethylene glycol - EG, propylene glycol - PG, glycerol - Gly, methanol - MeOH, 2-metoxyethanol - 2ME) on the germ cell survival was tested. Three cryoprotectants resulting with the highest survival rate were used for subsequent experiment and analysis of the effects of their different molar concentrations (1 M, 1.5 M and 2 M) as well as sugar (glucose, sucrose, trehalose) and protein (BSA and FBS) supplementation on the germline stem cell (GSC) survival. In the second experiment, the effects of different solutions used during vitrification of gonadal tissue were tested.

The results displayed that the optimal cryoprotectant was 1.5 M Me2SO which yielded approximately 55% GSC survival in males and 80% GSC survival in female gonads. Vitrification was slightly more successful as the equilibration (1.5 M PG + 1.5 M DMSO) and vitrification (3 M PG + 3 M DMSO) solutions resulted in up to 80% of viable male and female GSCs.

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