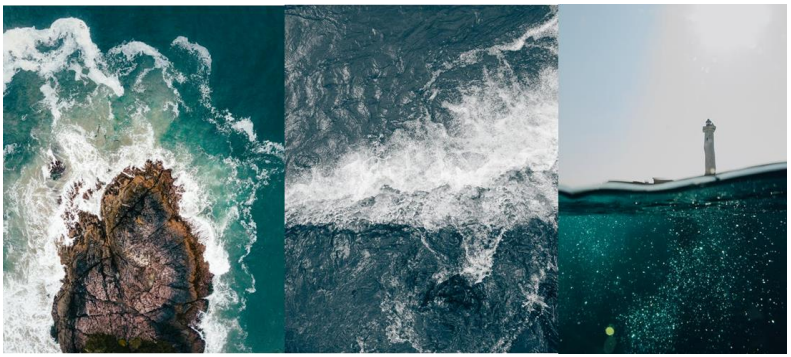
1st International Scientific Symposium Interdisciplinary Approach to the Scientific Research of the Adriatic Sea InspireAdriatic 2023

September 11-12, 2023
Ruđer Bošković Institute, Zagreb, Croatia



BOOK OF ABSTRACTS

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CONTENTS

FOREWORD

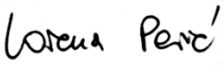
First International Scientific Symposium "Interdisciplinary Approach to the Scientific Research of the Adriatic Sea" (InspireAdriatic 2023) was perceived to bring together outstanding scientists and experts from Croatia and abroad who are engaged in research of the Adriatic Sea. Because of its extraordinary economic and cultural importance for the Republic of Croatia (more than 5.800 km of coastline, in total), the study of the Adriatic Sea has traditionally attracted great interest from the Croatian scientific community. However, tremendous anthropogenic and natural pressures driven by human activities are affecting all components of the Adriatic marine ecosystems and consequently call for a more systematic interdisciplinary approach, which is necessary to obtain a comprehensive picture of the Adriatic Sea current state as one of the most endangered coastal ecosystems. The main challenges in the research and management of the Adriatic Sea require an interdisciplinary approach, which was presented at the symposium with lectures from the fields of physics, geology, chemistry, biology and geophysics divided into Sessions:

Session 1: Geological and physico-chemical processes in the Adriatic Sea

Session 2: Biological processes in the Adriatic Sea

We would like to thank all participants for their scientific engagement, which significantly contributed to the success of the Symposium "Interdisciplinary Approach to the Scientific Research of the Adriatic Sea" (InspireAdriatic 2023). We hope you enjoyed the conference program and find it stimulating and informative. We would also like to thank our sponsors and supporters who make it possible for us to organize this event.

Ines Sviličić Petrić, dr.sc.



Lorena Perić, dr.sc.

Vlado Cuculić, dr.sc.

Organizing committee

GENERAL INFORMATION

SYMPOSIUM VENUE

Venue: Ruđer Bošković Institute (3rd wing), Bijenička cesta 54, Zagreb, Croatia

LANGUAGE

The official languages of the symposium are English and Croatian.

OPENING CEREMONY AND SOCIAL EVENTS

The opening ceremony will be held at Ruđer Bošković Institute, Bijenička cesta 54, Zagreb, Croatia (3rd wing) on September 11th at 9:15. Catering for participants and poster session will be held on Tuesday 12th from 12:15 to 14:00.

PROGRAMME

DAY 1 (3rd wing) – MONDAY – September 11, 2023

08:30-09:00	Registration of participants
09:15-09:30	Opening ceremony – IRB director general IRB; Head of Division for Marine and Environmental Research

Session 1: Geological and physico-chemical processes in the Adriatic Sea

09:30-10:00	**IS1 – Dr. sc. Mladen Juračić** How and why to organize (and finance!) long-term research in the Adriatic – past experiences and future challenges
10:00-10:15	**SS1 – Ivica Vilibić** What we know after centurial thermohaline observations in the Adriatic Sea?
10:15-10:30	**SS2 – Iva Tojčić** Kilometer-scale coupled atmosphere-ocean climate modelling in the Adriatic region
10:30-11:00	Coffee break
11:00-11:30	**IS2 – Dr. sc. Mirko Orlić** How a distinction was made between open-sea and coastal upwelling in the Middle Adriatic
11:30-11:45	**SS3 – Jasen R. Jacobsen** Ecosystem response to island trapped waves around the island of Lastovo in an idealized numerical model
11:45-12:00	**SS4 – Neven Cukrov** Anchialine caves around Krka River estuary
12:15-14:00	Lunch break
14:00-14:30	**IS3 – Dr. sc. Hrvoje Mihanović** Measurements in physical oceanography, an important aspect of interdisciplinary marine research

	SS6 – Marko Kapelj
14:30-14:45	Ocean bottom seismometers – a new way of researching the seabed in Croatia
	SS7 – Saša Marcinek
14:45-15:00	Does seasonal differences in organic matter influence copper bioavailability in Krka River estuary?
15:00-15:30	Coffee break
	SS8 – Sanja Frka
15:30-15:45	Variabilities of biochemical properties of the sea surface microlayer: Insights to the atmospheric deposition impacts
	SS9 – Nuša Cukrov
15:45-16:00	Microplastic in the Adriatic Sea, urban vs remote areas
	SS10 – Marija Parać
16:00-16:15	Conducted research about microplastics analysis in Krka River estuary and its further prospects

DAY 2 (3rd wing) – TUESDAY – September 12, 2023

Session 2: Biological processes in the Adriatic Sea

09:00-09:30	**IS4 – Dr. sc. Zrinka Ljubešić** Chasing the Holy Grail – representative marine plankton sample – myth or a truth?
09:30-09:45	**SS11 – Maja Mucko** Fine-scale changes in plankton community in oligotrophic stratified waters of Lastovo Island (Adriatic Sea) during ITW forcings
09:45 - 10:00	**SS12 – Anamarija Kolda** Plastisphere communities profile in marine wracks from central and southern Adriatic
10:00 - 10:15	**SS13 – Sunčica Bosak** Tales of Adriatic sea turtles and their microbial companions
10:15-10:45	Coffee break
10:45-11:15	**IS5 – Dr. sc. Melita Peharda Uljević** Sclerochronology research in the Adriatic Sea – what can we learn from bivalve shells?
11:15-11:30	**SS14 – Petar Kružić** Remote sensing and photogrametry in marine biology – new methods for monitoring corals in the Adriatic Sea
11:30-11:45	**SS15 – Shannen Smith** Restoration of macroalgal forests in the northern Adriatic Sea
11:45-12:00	**SS16 – Ines Haberle** Individual condition as an indicator of stock status: composite modelling to support fisheries management
12:15-14:00	LUNCH BREAK for participants AND POSTER SESSION (1st wing)

14:00-14:30	**IS6 – Dr. sc. Andreja Ramšak** Use of nucleic acid-based tools for marine biodiversity monitoring and seafood authenticity
14:30-14:45	**SS18 – Marija Purgar** Assessing the ability of existing models to predict *Vibrio* spp. abundance in the Adriatic Sea
14:45-15:00	**SS19 – Karla Orlić** Seasonal dynamics of *Vibrio* spp. and occurrence of antibiotic resistance in Eastern Adriatic bivalve aquaculture
15:00-15:15	**SS20 – Biljana Ječmenica** Presence and genetic diversity of *Campylobacter* spp. in shellfish from Istria
15:15-15:45	Coffee break
15:45-18:00	**ROUND TABLE "CHALLENGES OF THE SCIENTIFIC RESEARCH IN THE ADRIATIC SEA"**

IS = invited speaker

SS = selected speaker

INVITED LECTURES

Session 1: Geological and physico-chemical processes in the Adriatic Sea

IS1 How and why to organize (and finance!) long-term research in the Adriatic - past experiences and future challenges.

Mladen Juračić

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Croatian Academy of Sciences and Arts, Zagreb, Croatia

The presentation will show how long-term research in the Adriatic was organized and financed in the eighties of the 20th century and at the beginning of this century. The success of these projects will be discussed, and the advantages and disadvantages of "big" long-term projects will be examined. We will also refer to the beginning of the expeditionary exploration of the Adriatic at the beginning of the 20th century.

IS2 How a distinction was made between open-sea and coastal upwelling in the Middle Adriatic

Mirko Orlić

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Croatian Academy of Sciences and Arts, Zagreb, Croatia

Recently, a project entitled Middle Adriatic Upwelling and Downwelling (MAUD) was carried out in the area between the islands of Blitvenica (close to the east coast) and Jabuka (in the open sea). Along with some preparatory measurements, the project resulted in five, mostly springtime studies of vertical motions and their relationship with biogeochemical processes over the 2017–2021 interval. As an example, the measurements performed in late May 2017 are considered here. The shipborne CTD data pointed to the existence of a dense water dome with its center being located at a distance of about 15–20 km from the coast, while the vessel mounted ADCP data showed that the surface circulation around the dome was cyclonic. At the same time, a decrease of temperature close to the coast was documented by bottom probes and satellite images. During the May 2017 experiment the northern winds prevailed, implying that the observations could be interpreted in terms of simultaneous occurrence of wind-driven open-sea and coastal upwelling. The interpretation was supported by a simple theory and a combination of the meteorological and oceanographic numerical modelling.

IS3 Measurements in physical oceanography, an important aspect of interdisciplinary marine research

Hrvoje Mihanović

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Marine research today includes various scientific aspects that emphasize importance of interdisciplinary approach. The number of projects and studies that interwove different oceanographic disciplines is increasing on daily basis and the understanding between experts from those disciplines is of crucial importance. The same is valid both on global and local scales.

Field measurements will always play an important role in oceanography, complementing and building up on remote sensing techniques and numerical modelling. However, there is a general decrease in the number of "sea-going" scientists and engineers, which might significantly influence the oceanographic research in the future. This lecture will try to present one of essential interdisciplinary research ingredients; more precisely, it will focus on measurements in physical oceanography (particularly field measurements) through several examples of interdisciplinary research conducted in the Adriatic in the past decades.

Session 2: Biological processes in the Adriatic Sea

IS4 Chasing the Holy Grail – representative marine plankton sample – myth or a truth?

Zrinka Ljubešić

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Sampling campaigns at seas are demanding due to unpredictable weather conditions, limits of research vessels and equipment, and the specificity of the processes being investigated. Also, oceans cover about 70 % of the Earth's surface, bringing a new issue of the size of investigated environment. It is of essential importance to integrate multidisciplinary approaches and the use of different methods in order to meet comprehensive approach to ecosystem services assessment and an understanding of the overall ecosystem picture.

Spatial and temporal distributions of phytoplankton is defined with strong patchiness and their abundance reflect their dependence on nutrient availability, temperature ranges, light levels and water circulation. When it comes to phytoplankton, it is not just the quantity, but also the quality that matters. So, we are facing a challenge of getting a representative sample of particles that are passively driven by currents and changing all the time. How can we get the insight of the abundance of some particles that are unevenly dispersed in an ocean? Can we talk about a representative sample at all?

A success study of adaptive sampling strategy will be presented, where, for the purpose of the ISLAND project, excellent meteo-oceanographic forecasts based on high-resolution models were provided daily to the researchers on the field. Such an interdisciplinary approach, where physicists optimized the sampling and measurement of chemical and biological parameters, was implemented for the first time in the Adriatic Sea.

IS5 Sclerochronology research in the Adriatic Sea – what can we learn from bivalve shells?

Melita Peharda Uljević

Author affiliation
Institute of Oceanography and Fisheries, Split, Croatia

Sclerochronology is an interdisciplinary research field that analysis, in a temporal context, physical and chemical variations in the hard structures of marine organisms. Over the past decade, sclerochronology research has expanded in many parts of the world, including the Adriatic Sea. In a framework of Marie-Curie ITN project ARAMACC and two research projects financed by the Croatian Science Foundation (SCOOL and BiVACME), scientists have applied sclerochronology methods to investigate shells of long-living as well as commercially important bivalves. This presentation provides an overview of the recent sclerochronology research in the Adriatic, including (i) growth chronology construction from annual growth increments in shell cross-section, (ii) analysis of stable isotopes of oxygen ($\delta^{18}O$), carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) in shell carbonate material, and (iii) analysis of magnesium and barium in bivalve shells.

IS 6 Use of nucleic acid-based tools for marine biodiversity monitoring and seafood authenticity

Andreja Ramšak

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The marine environment and its rich biodiversity face numerous threats, including climate change, rising seawater temperatures, acidification and pollution. These challenges can have serious consequences for ecosystem services and the delicate balance of marine life. In recent decades, several marine observational strategies have been developed to monitor biodiversity. One particularly promising approach is the use of nucleic acid-based tools such as DNA barcoding, metabarcoding and environmental DNA analysis (eDNA). These tools have significant implications in several areas, including biodiversity monitoring, taxonomy, population genetics, seafood authenticity and food safety. This presentation will highlight key findings from case studies and provide an overview of the state of the art in the application of nucleic acid-based tools for marine biodiversity monitoring and seafood authenticity. Continued advancements in nucleic acid-based techniques will play a pivotal role in the sustainable management and conservation of marine environments and seafood resources.

ORAL PRESENTATIONS

Session 1: Geological and physico-chemical processes in the Adriatic Sea

SS1 What we know after centurial thermohaline observations in the Adriatic Sea?

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Abstract
For more than a century, the Adriatic thermohaline properties are being quantified, initially by Austrian and Italian cruises in years before The Great War, leading to the first classification of the Adriatic water mass definitions 60 years ago by Mira Zore-Armanda. However, it is a question if these definitions hold their quantities today, with the changing climate. Therefore, this presentation will evaluate the observed changes in respect to (1) trends and variability detected in thermohaline observations over different Adriatic basins, (2) consequences of these changes to the Adriatic thermohaline circulation, and (3) definitions in water masses, in particular to the North Adriatic Dense Water that is known to replace deep Adriatic waters. A glimpse to potential futures will also be presented, as coming from regional climate projections. As the recent changes in the Adriatic deep waters are occurring at unprecedent rates, it is a question to discuss and to research how these changes may and will influence the Adriatic biogeochemical cycle and ecosystems.

SS2 Kilometer-scale coupled atmosphere-ocean climate modelling in the Adriatic region

Authors
Iva Tojčić (1), Clea Denamiel (1), Petra Pranić (2), Ivica Vilibić (1)

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Abstract
The Adriatic climate is strongly affected by complex orography and ocean geomorphology, land-sea contrasts, intense air-sea interactions, etc. and is thereby extremely challenging for adequate simulation in climate models. Global and regional climate models at a relatively coarse spatial resolution (from 100 to 10 kilometers) are generally not suitable to reproduce atmospheric processes in the Adriatic, while coupling with the ocean represent another challenge in terms of numerical cost. However, coupled atmosphere-ocean models at the kilometer-scale have the advantage of better capturing critical processes such as orographically-driven variations in precipitation, winds, surface energy balance, etc., particularly during extreme events. The Adriatic Sea and Coast (AdriSC) kilometer-scale modelling suite has thus been recently developed to accurately reproduce the atmospheric and oceanic processes at different temporal and spatial scales over the Adriatic and northern Ionian Sea, ranging from the impact of climate change on extreme events to the operational forecast of extreme sea-levels along the Croatian coasts. The climate component of the AdriSC modelling suite focuses on studying long-term kilometer-scale atmospheric and oceanic processes in the Adriatic region. Two approaches were employed: (1) long-term simulations covered the 1987-2017 period for the present climate (evaluation run) and projected a far-future high-emission climate under the Representative Concentration Pathway (RCP) 8.5 scenario for 2070-2100. (2) Short-term simulations covered the 1977-2017 period for the present climate (evaluation runs) and projected future climates (RCP4.5, RCP8.5) for the 2060-2100 period, focusing on numerous extreme events to showcase the added value of the AdriSC model. The far-future simulations utilized the pseudo-global warming (PGW) method, recently extended to coupled atmosphere-ocean models. This presentation will provide an overview of the AdriSC modelling system's set up, and of its applications on studying Adriatic climate under current and future conditions. This includes the evaluation of the long-term AdriSC climate simulation, quantification of the bora wind and associated ocean cooling in the far-future climate, assessment of ocean waves during extreme bora and sirocco events in the far-future climate, and analysis of trends and variability in present and future Adriatic climate.

SS3 Ecosystem Response to Island Trapped Waves Around the Island of Lastovo in an Idealized Numerical Model

Authors
Jasen R. Jacobsen (1), Christopher A. Edwards (1), Žarko Kovač (2), Hrvoje Mihanović (3), Zrinka Ljubešić (4)

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Abstract
Observational and modeling studies of the Adriatic Sea show that in summer a near resonant condition between the diurnal tide and the seasonal stratification creates a baroclinic Island Trapped Wave (ITW) around the Island of Lastovo. The diurnal frequency of the ITW and day-night cycle suggests an interaction that elevates primary production at particular locations around the island. In this talk I will present preliminary results from an idealized numerical model of an ITW configured with the Regional Ocean Modeling System (ROMS) coupled with a simple NPZD model. These simulations suggest that as the ITW propagates around the circular island, the crest and trough of the wave are at persistent locations at noon, leading to phase relationships between nutricline vertical displacement and light intensity around the island that result in differential primary production. In addition, heterogeneous fluid convergences drive nonuniform vertical nutrient fluxes and differential primary production around the island. This talk will describe the idealized ITW configuration and resulting ecosystem response.

SS4 Anchialine caves around Krka River estuary

Authors
Neven Cukrov (1), Marija Parać (1), Nuša Cukrov (1), Željko Kwokal (1), Sandi Orlić (1), Dario Omanović (1), Branko Jalžić (2)

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Abstract
Anchialine caves and pits are speleological objects with a lake found along the seacoast, usually with an entrance above sea level. The accumulation of fresh water on the surface and the stratified water column with a pronounced halocline, as well as the connection with the sea through fractured and porous carbonate rocks make these underground objects unique natural systems. Anchialine caves, due to their interesting water environment that combines the features of an underground estuary (stratified water body) and a deep ocean (lack of light and oxygen, chemosynthesis, slow water exchange), have been the subject of increasingly frequent research in the world in last decades. In the Republic of Croatia, along the Adriatic coast and on the islands, almost a two hundred anchialine speleological objects are known, of which only a few have been partially explored. Due to the freshwater surface layer, many of them have served as a source of potable water throughout history. In the last 17 years investigations of 7 anchialine speleological objects have been carried out along the Krka River estuary (Jama pod Orljakom, Jama u Čapljina, Vodena jama na Srimi, Izvor Litno, špilja u Vidrovači, Bićinska Pećina, Mandalina). All caves were surveyed for topographic mapping and the physico-chemical characteristics of the water column were determined in all of them. Moreover, concentrations of trace metals (Hg, Cd, Pb, Cu, Zn, Ni and Co) were determined in some of them. Additionally, the concentrations of organic matter and nutrients were determined, and the aquatic fauna was partially investigated. To estimate the connections of the caves with the estuary or the surrounding sea, the movement of the water level in the caves was examined. The obtained results confirm the uniqueness and interest of the anchialine caves and pits along the Krka River estuary and point to the need for their further research.

SS5 Short-term factory with lasting consequences: Soil contamination and health risk assessment near former factory Jadral

Authors
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Abstract

When assessing the environmental condition of marine systems, inflow from various soil pollution points and from the streams and rivers in the mainland should not be ignored. Former alumina factory Jadral is located near Zrmanja River, and negative impact on the ecosystem and elevated concentrations of elements in sediment was previously confirmed. Even though the factory operated for only several years, waste material and red mud is present in the proximity even 40 years after the closure of the factory. This study aims to determine negative consequences on the surrounding soil, Zrmanja River and people living nearby due to blowing of the wind from Velebit and various pollution points from the former factory. For this purpose, a data set of major and trace element concentrations in soils in the vicinity of the factory was used and statistically evaluated. Geoaccumulation index (Igeo) and enrichment factor (EF) were calculated, as well as estimated soil administered dermal dose (ADD) and inhalation exposure factor (ADI). Calculations revealed that the soil samples were enriched with some of the measured elements (e.g. Al, As, Cd, Cr, Fe, Sb, Sn, and Zn). Calculated geoaccumulation indices were elevated for some of the mentioned elements (e.g. Al, Fe, Sb, Ti, and Zn) for all studied soil samples. Estimated dermal dose and inhalation exposure factors showed elevated values for some elements (e.g. Cr, Mn, Ti, V, and Zn), which could mean cancer risk for the subjects exposed to contamination. In conclusion, measures are needed to secure the area around the former alumina factory to stop the contaminants from spreading to surrounding area, Zrmanja river and ultimately to the Adriatic Sea.

This study has been supported by Croatian Science Foundation under the project FORtIS (IP-2019-04-9354).

SS6 Ocean bottom seismometers – a new way of researching the seabed in Croatia

Authors
Vedran Damjanović, Valentina Gašo, Stijepo Grljević, Marko Kapelj, Iva Kostanjšek, Viktorija Milec, Marko Pervan, Anamarija Tremljan, Antonio Brcković, Tomislav Fiket

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Abstract
The Republic of Croatia is a seismically highly active area and is currently insufficiently covered by seismological stations. Due to the shape of Croatia, a dense network of seismological stations is needed for more accurate earthquake analysis. One of the main goals of the CROSSNET Project carried out by Croatian Seismological Survey is to install 95 new seismological stations across the Republic of Croatia. Part of the instruments will be laid on the seabed to be able to monitor seismicity in the Adriatic Sea. Three main areas of interest have been determined, Kvarner, Jabučka Kotlina and Dubrovnik Subsea. As part of the project, a total of 10 ocean-bottom seismometer (OBS) with broad-band sensors will be installed at locations not covered with island-based stations. OBS is a seismometer that is designed to record the ground motion under oceans and lakes from both man-made and natural sources. OBS represent the most efficient earthquake monitoring technique in marine areas.Deployed OBS devices will allow us to more precisely locate earthquakes as well as study the structure of the Earth's crust, and all recorded data will be publicly available. With deployment of OBS systems Croatia is going to join the community of 10 countries in Europe that have OBS systems, which provides a unique experience in the field of marine seismology as well as opportunities for international cooperation.

SS7 Does seasonal differences in organic matter influence copper bioavailability in Krka River estuary?

Authors
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Abstract
Copper (Cu) is a naturally occurring micronutrient of eco-toxicological concern in marine waters. It is reported that more than 99% of dissolved Cu in natural waters exist in strong organic complexes which can effectively buffer the system against small changes in Cu concentration. However, if this inherent Cu-buffering capacity is exceeded, an elevated concentration of free Cu (which is toxic to most species) occurs, risking to surpass its toxicity level of 10 pM (for most planktonic species). Previous studies demonstrated seasonal variation in terrestrial input and biological production of organic matter in Krka River estuary. We have, thus, pondered if this phenomenon might impact the Cu bioavailability within this system. This consideration gains particular significance given the expected seasonal anthropogenic pressure in summer due to intensified boat traffic and tourist activities. To explore this question we identified possible sources of Cu-binding organic ligands in the estuary and assessed the potential risk of elevated free Cu in two contrasting seasons, winter and summer. In both seasons, two ligand classes were identified. Strong ligands ($12.5 < \log K'1 < 14.3$) were mainly derived from recent phytoplankton production, whereas weak ligands ($10.6 < \log K'2 < 11.1$) were attributed predominantly to humic substances. Seasonal differences in ligand concentrations and their stability constants suggested an increase in Cu-binding ligands in summer, driven by increased *in situ* production, but a decrease in their affinity for Cu in comparison to winter. Total dissolved Cu ranged from 3.5 to highest concentration of 25.8 nM measured in surface layer in summer. Estimated free Cu concentrations, however, were below the toxicity threshold in both seasons. We can, thus, conclude that seasonal anthropogenic Cu input was successfully buffered by the ambient organic matter pool. We also estimated the 'carrying capacity' of the ligand pool, which approached ~17 nM of total dissolved Cu in winter and ~33 nM in summer. Therefore, even though free Cu was successfully maintained below its toxicity threshold in both seasons, we should remain mindful that a further rise in total Cu during summer could potentially compromise the protective function of the organic matter pool against Cu toxicity. One intriguing conjecture is that estuarine biota could activate self-protective mechanisms in response to heightened Cu levels, although this hypothesis requires further investigation.

SS8 Variabilities of biochemical properties of the sea surface microlayer: Insights to the atmospheric deposition impacts

Authors
Andrea Milinković (1), Abra Penezić (1), Ana Cvitešić Kušan (1), Valentina Gluščić (2), Silva Žužul (2), Sanda Skejić (3), Danijela Šantić (3), Ranka Godec (2), Gordana Pehnec (2), Dario Omanović (1), Sanja Frka (1)

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Abstract
Atmospheric deposition (AD) of airborne particles is an important external source of nutrients and pollutants to marine ecosystems, which affect the quality and quantity of organic matter (OM) produced by phytoplankton, alter CO2 uptake, and indirectly affect the climate. To gain insight into the effects of AD on the sea surface, it is crucial to consider the interfacial processes within the sea surface microlayer (SML) that controls all exchange processes between the ocean and the atmosphere. The input of AD is particularly important in oligotrophic environments and is expected to increase in future scenarios of a warmer atmosphere with increased atmospheric particle emissions and deposition rates. While the majority of the data related to the AD impacts generated so far in the Mediterranean have been conducted on its western and eastern regions, the effects of the AD inputs to oligotrophic surface waters of the Adriatic Sea sub-basin are unknown.

We present the comprehensive dataset encompassing inorganic N and P species in atmospheric aerosol particles, wet deposition and sea surface samples, distinguishing between the SML and underlying water (ULW), obtained through intensive field measurements over a six-month period at the central Adriatic coastal area as part of the BiREADI CSF IP -2018-01-3105 project. A strong impact of local/regional open-fire biomass burning (BB) sources on atmospheric dissolved inorganic nitrogen (DIN) concentrations and deposition fluxes was observed. The atmospheric fluxes of DIN following BB events likely supplied a substantial amount of dissolved N species to the SML and promoted the development of autotrophic and heterotrophic organisms. The AD associated with BB emissions played an important role in OM enrichment in the SML. Changes in OM quality and quantity within the SML, resulting from external N supply in the coastal environment, could in turn have strong implications for a range of global biogeochemical and climate processes mediated by the SML.

Thus, potential BB impact on the surfactant's suppression of CO2 exchange at the sea-atmosphere interface was estimated, being at least 3 times higher in comparison to non-BB conditions at the Adriatic coastal area. This work demonstrates the importance of studying short-term scale interactions between the atmosphere and marine compartments, which can lead to a significant improvement in understanding of the ocean-atmosphere system, with important implications on climate.

SS9 Microplastic in the Adriatic Sea, urban *vs* remote areas

Authors
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Abstract
Plastics became indispensable part of the modern life due to their versatility, light weight, and low production coast. Owing to the high demand, the global annual production of plastics has grown significantly in recent decades, reaching 460 million tonnes in 2019. Along with the increase in plastic production and the waste generation, there is a growing concern on plastic pollution, which has become one of the major environmental issues of today. The concern is especially addressed to the microplastics, small synthetic polymer particles (<5 mm) that have been reported globally in different environmental compartments, from freshwater to seawater, from urban to remote areas, and from the beach to deep-sea sediment. The Mediterranean Sea is particularly vulnerable to plastic pollution, due to its semi-enclosed morphology, high coastal population density, intense touristic and maritime activities, and general marine circulation patterns. According to concentrations of the floating plastic, the Mediterranean is comparable to the accumulation zone of the five subtropical gyres and can be considered as an additional great accumulation zone of floating plastic debris at global scale. Thus, today the Mediterranean's plastic pollution represents a serious risk for the local environment and human health, but also for the key economic sectors that rely on sea resources and heath as for fisheries and tourism.
Adriatic Sea, as a part of the Mediterranean, is not spared from ubiquitous plastic pollution. However, there is a knowledge gap in occurrence and fate of microplastic in the Croatian part of the Adriatic Sea. To increase the knowledge

on the microplastic concentrations in the different areas of the Adriatic Sea, we studied floating plastic in the two urban areas, Zadar and Šibenik, and in the open sea, in proximity to the distant islands Svetac and Jabuka. The results have showed that the average concentrations of microplastics in seawater in two urban areas were 0,80 particles/m^3, while around distant islands (Jabuka and Svetac) particle densities were 0,06 particles/m^3. Regarding the physical characteristics, the particles were mostly in form of fibers (51%), <1 mm in size (51,7%), and transparent (48%) and blue (16%) in color, which corresponds to the type of particles most represented in studies around the world.

Acknowledgments: The presented work was supported by Croatian Science Foundation under the project lP-2019-04-5832.

SS10 Conducted research about microplastics analysis in Krka River estuary and its further prospects

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Abstract
Microplastics research has become very important worldwide since it represents a ubiquitous anthropogenic contaminant for the environment and living organisms, identified as an emerging environmental pollutant, classified as primary or secondary, based on their source. However, the lack of standardized methods (protocols) and reference materials poses as an obstacle to microplastics research, as is the lack of comparability of data from different studies. Environmental microplastics are complex for analysis due to diverse matrices in which they are found, their composition, polymer type, size, shape, and interaction with other particles and organisms in a wide spatiotemporal frame. Estuaries are recognized as hotspots and transfer pathways for microplastics entering the marine environment. Yet, knowledge about the accumulation, transport, and abundance of microplastics in estuaries remains limited. This may be due to complex hydrodynamics, including tidal cycles, salinity gradients, mixing patterns etc., and the spatiotemporal variability of estuarine systems. Most research is focused on microplastics in surface water because there is an assumption that most microplastics float due to their lower density regarding seawater. However, in estuaries, the vertical salinity gradient

cannot be ignored, which allows for different material suspension in the water column. Up to date, we conducted several sampling events and analysis of the microplastics abundance in the Krka River estuary. Unfortunately, one of the studies included visual inspection of microplastics particles, as a sole method for quantification, which could be biased. The other one included Nile Red (NR) staining method which later proved as a non-reliable method, without further spectroscopic analysis with μFTIR or Raman. Currently, without systematic research and equipment for spectroscopic analysis, we can only talk about approximations of microplastics abundance. Even so, the abundance of microplastics is severely underestimated.

Session 2: Biological processes in the Adriatic Sea

SS11 Fine-scale changes in plankton community in oligotrophic stratified waters of Lastovo Island (Adriatic Sea) during ITW forcings

Authors

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Abstract

Low productivity of oligotrophic waters around Lastovo Island (Adriatic Sea) is determined by a strong water column stratification with omitted vertical mixing and nutrient supply to the euphotic layer. This is periodically disrupted by transient thermohaline forcings that enhance nutrient fluxes possibly driven by island-trapped waves forcings (ITWs) and which can create localized hotspots of net primary production (NPP). Within this interdisciplinary study we investigated plankton diversity with high-throughput sequencing (HTS) of 16S rRNA and 18S rRNA genes of net tows collected below and above shifting thermocline, conventional microscopy, physical forcings and nutrient composition of the area. According to HTS data, bacterioplankton community

composition showed significant dissimilarity during and after ITWs and between two net fractions (200μm and 53μm), while zooplankton response to ITW was not significant in terms of community changes nor in mesh-size. Within identified ASVs, primary producers were scarce: cyanobacteria (*Synechococcus*, strain CC9902) within prokaryotes and stramenopiles (*Pelagomonas*) and chlorophytes (*Ostreococcus*) within microbial eukaryotes; while rest of ASVs were identified as class Copepoda (*Paracalanus parvus parvus, Oithona similis, Oikopleura (Coeceria) longicauda, Centropages typicus*), parasitic fungi (*Meyerozyma* spp.), mixotrophic dinoflagellates (family Peridiniales, mostly genus *Blastodinium*) and parasitic Ciliophora (Scuticociliata). Composition and abundance of zooplankton community revealed by microscopy dominated with coastal species of copepods and ciliates grazing on mostly pico-nano fractions. Significant changes in zooplankton community composition were confirmed between fractions and during and after ITW forcings. The microfraction was dominated by neritic tintinnids with a small number of deep-sea species while the composition of the mesozooplankton was represented by nearshore species. These results highlight the role of localized physical phenomena, such as island-trapped waves, in shaping community compositions of primary and secondary producers, grazers and decomposers within plankton communities in the south Adriatic archipelago. Lack of primary producers within HTS data in comparison to detected increase in NPP suggests their small cell size and short life span after nutrient influx in highly oligotrophic ecosystem where grazers and decomposers prevail.

SS12 Plastisphere communities profile in marine wracks from central and southern Adriatic

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Abstract
Marine wracks consist of mainly seagrasses and seaweeds washed ashore by storms, tides, and winds. They have fundamental role in protecting beaches from erosion and serve as an important habitat. However, due to the global plastic pollution, they are currently littered with plastics. To determine the plastisphere community from Adriatic marine wracks, 3 samplings (December 2020, May and June 2021) were conducted at 6 beaches in the central Adriatic (CA) and southern Adriatic (SA). eDNA of total of 45 samples was isolated and sent for 16S rRNA amplicon sequencing (515F–806R primers, V4 region). Bioinformatics analysis was performed on QIIME2 (v. 2023.5), with downstream statistical analysis using RStudio (v. 2023.06.1+52) and FAPROTAX (v. 1.2.7). Plastics were visually examined by Zeiss loupe and analyzed using ATR-FTIR spectroscopy. Seagrass type present in CA stations was *Cymodocea/Zoostera*, and *Posidonia oceanica* in SA stations. Sedimentological analysis determined carbonate gravel sediment type. From total of 112 randomly selected plastics, ATR-FTIR analysis determined dominantly PE composition of plastic pellets (HDPE 16.1%, LDPE 38.4%, unknown PE 26.8%) and PP (14.3%), with 4.5% undetermined. Cotton swabs were made of PP, and styrofoam particles of PS. However, there was no statistically significant connection of assembled community to plastics type. Beta analysis of bacterial community dissimilarity concluded separation of *Cymodocea/Zostera vs*. *Posidonia oceanica* wracks *vs*. seawater (Aitchison Distance, 94.54% of total community explained). In "*Cymodocea/Zostera* group", family Cyclobacteriaceae (Bacteroidetes) was dominant. "Posedonia group" was defined by Bacteroidetes genus *Arenibacter* and Gammaproteobacteria genera *Cobetia* and *Pseudoalteromonas*. This group shared several dominant genera with seawater samples: *Vibrio* (Gammaproteobacteria) and *Planococcaceae* (Firmicutes). Putative functional analysis assigned at least one functional group (FG) to 37.88 % of bacterial community, predominantly for: methylotrophy, methanol oxidation, respiration of sulfur compounds, nitrate/nitrite denitrification, fermentation etc. Furthermore, many human pathogens,

including *Staphylococcus aureus* were detected, as well as bacteria connected to human gut. Plastic degradation taxa was recorded, e.g. *Varovorax paradoxus*. To our knowledge, this is a first study of this type, providing insights of plastisphere communities impacting Adriatic beaches.

Keywords: plastisphere, marine wracks, ATR-FTIR , 16S rRNA metabarcoding, bacterial community

SS13 Tales of Adriatic sea turtles and their microbial companions

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Abstract
Sea turtles have long been recognized as hosts for a rich array of diverse microbes residing on their shells and within their gut. These microbial communities can be host-specific, thriving exclusively in association with sea turtles, or opportunistic, found in elsewhere in the turtle environment. In this presentation, we present an overview of the research outcomes from the TurtleBIOME project (UIP-2017-05-5635), conducted from 2018 to 2023, which involved plentitude of dedicated and enthusiastic participants. Our primary objective was to characterize the microbial communities inhabiting both the external (skin and shell) and internal (cloaca, oral cavities) habitats of loggerhead sea turtles (*Caretta caretta*). We selected the loggerheads due to its prevalence in the Mediterranean Sea and the significant conservation efforts centered around this flagship species. Over 120 animals were sampled from various locations, predominantly in the Adriatic Sea, including Pula, Vis, and Lošinj in Croatia, Bari in Italy, and Amvrakikos Bay and Rethymnos in Greece. Amplicon profiling using 16S, 18S, *rbcL*, and ITS molecular markers was employed to describe the prokaryotic and microeukaryotic assemblages, with specific emphasis on bacteria, cyanobacteria diatoms and fungi. Additionally, classical microscopic methods were applied to analyze the collected carapace and skin biofilm samples. Furthermore, approximately 10 cyanobacterial and 200 non-axenic diatom strains were isolated and characterized, some of which were subsequently utilized to investigate their associated bacterial communities

through cultivation and metagenomics approaches. We also gained initial insights into the fungal microbial communities associated with the loggerhead surface and guts. Through our multidisciplinary investigations, we present the first comprehensive inventory of endo- and epimicrobiota in loggerhead sea turtles. Our findings reveal remarkable microbial diversity, varying degrees of host specificity, and local biogeography of sea turtle-associated microbes. These results contribute to our understanding of the intricate relationships between sea turtles and their associated microbial ecosystems, providing valuable insights for conservation efforts and marine ecosystem management.

SS14 Remote sensing and photogrametry in marine biology – new methods for monitoring corals in the Adriatic Sea

Authors

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Abstract

There are lots of proofs that climate change is already reducing marine biodiversity in world oceans and seas and this may worsen in the future. Climate warming has already triggered responses such as shifts in species distributions, mass mortalities, extinctions and invasions. The effects of global climate change are particularly serious in areas where range shifts of species are physically constrained such as the Adriatic Sea, which is one of the coldest parts of the Mediterranean. Some species, like gorgonian *Paramuricea clavata* or colonial coral *Cladocora caespitosa* were exposed to different combinations of temperature and food concentration that cause mass mortalities in their populations. Because of the increased occurrence of warm-water biota and present mass mortalities of certain species, the whole Mediterranean Sea is under a process of, as some scientists like to say, "tropicalization". Underwater photogrammetry is a well-established technique for measuring and modelling the subaquatic environment in fields ranging from archaeology to marine ecology. This method focuses on the metric evaluation of different off-the-shelf camera systems for making high-resolution and high-accuracy measurements of coral monitoring through time. The operative advantage is related to the simplicity of the survey. Corals and coralligenous structures form excellent study

objects for the exploration of high-resolution 3D scanning and modelling methods. They are geometrically and structurally complex and present many challenges regarding 3D scanning and modelling of their intricate surface configurations. To understand the underwater reef geometry, detailed surface configurations and textures, a workflow was developed for close-range underwater coral monitoring that outputs high-precision 3D point cloud models. Utilizing the case study sites in the Adriatic protected areas, underwater data from high-resolution still images was collected of a coral community and 3D reconstructed precise point cloud models from datasets. The accuracy and reliability of both techniques by measuring objects of known size are demonstrated. A lot of data can be obtained through 3D models, coral growth, distribution, condition of corals and monitoring of negative human impacts as well as the impact of increasing sea temperatures (temperature anomalies).

SS15 Restoration of macroalgal forests in the northern Adriatic Sea

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Abstract
Macroalgal forests were once prolific throughout the Adriatic Sea, but in recent years have dramatically declined. Declines are linked to urbanisation, decreased water quality and/or increasing extreme weather events. Ecosystem restoration, however, is considered a promising way to recover and conserve lost marine forest habitat and is becoming increasingly successful around the world including throughout the Mediterranean region. In the northern Adriatic Sea, we have identified a refuge population of the declining habitat forming species, *Gongolaria barbata* that, contrary to expectation, thrives in a unique and extreme lagoonal environment. To understand the feasibility of local marine restoration, we used donor individuals sourced from this lagoon to conduct a restoration trial on the western Istrian coast where healthy *G. barbata* populations once existed. As mirrored by other restoration trials around the world, we found that refuge from herbivorous predators is crucial for restoration success. Invertebrate surveys and aquaria feeding assays however, showed that transplants are susceptible not only to sea urchin grazing as if often assumed, but also to grazing by multiple taxonomic groups, which remains the most immediate bottleneck to restoration success. In this talk, I will also discuss our efforts to promote the longevity of restored forest sites, including ongoing work to understand the

thermal tolerance of *G. barbata*. Marine forests are important for promoting biodiversity and enhancing ecosystem function in marine environments.

SS16 Individual condition as an indicator of stock status: composite modelling to support fisheries management

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Abstract
Individual condition, often expressed through condition index - a simple biometric-based measure – can be very informative in regard to individual performance dictating population's response. Standard stock assessment, however, primarily focuses on populations and generally overlooks individual condition as a main driver of population dynamics. Moreover, the lack of understanding how individual-level processes relate to population-level responses additionally hinders the adoption of individual performance indicators into current management practices. We use a process-based composite modelling approach to bridge this gap and link individual condition, expressed through condition index, to population-level status for the European sardine (*Sardina pilchardus*), a commercially important and a heavily exploited species in the Adriatic. We built a Dynamic Energy Budget (DEB) model to capture individual ontogeny as a function of food and constant temperature. The model was then integrated into an individual-based modelling (IBM) framework, allowing us to simultaneously track individual- and population-level statistics. We simulated two constant and food-limiting carrying capacities scenarios applying a range of realistic fishing mortalities, and explored the effects on both individual and population level. As expected, fishing mortality decreases stock size, however, contrary to common wisdom, it has a positive effect on individual condition, regardless of the carrying capacity. This challenges the conventional definition of poor stock, and implies that fish in very good condition could indicate an overfished stock and an imminent threat of collapse. We therefore suggest the condition index as an economical and rapid estimate of stock status, serving as supplementary information alongside standard stock assessment.

SS17 What can a model tell about a [turtle] species?

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Abstract
Ecological modelling is a powerful and versatile tool in ecology and conservation. Recent years have witnessed its increase in popularity, in large part due to the ability of well-designed models to predict and help assess the potential impacts of climate change and other stressors. Well-designed mechanistic (process-based) models can, in addition, also deepen the understanding of the species of interest.

Here, we use a model based on the Dynamic Energy Budget theory to infer physiological energetics of the loggerhead turtle (*Caretta caretta*), and gain understanding of potential pressures shaping its evolution in the Mediterranean Sea. The loggerhead turtle is the most common sea turtle of the Adriatic Sea, and is protected by national and international laws and conventions. The Adriatic Sea is, together with the Gulf of Gabes, one of the two most important areas where Mediterranean loggerheads feed, which makes these turtles our frequent guests. Using available data and ecological modeling, we assess the impact of food availability and temperature on the loggerheads life-history traits, and explore potential explanations for the differences in size and reproduction patterns observed between Mediterranean (MED) and North Atlantic (NA) loggerheads.

The results show that the amount of food in the environment has the greatest influence on the final size of the turtles, while temperature plays an important role in growth and maturation. Reproduction is influenced by both environmental factors, and the length at sexual maturity shows little variation under simulated conditions, suggesting that the variability present within the populations is due to differences between individuals (rather than the effect of the environment).

Over the course of evolution, however, differences in the Mediterranean environment did affect the physiology of MED loggerheads; reflected as differences in two specific model parameter values. Namely, individuals belonging to the MED population need to invest less energy into maturation and can therefore reproduce even at lower food availability, but need to invest more

energy into maintenance to cope with the higher salinity of the Mediterranean Sea.

SS18 Assessing the ability of existing models to predict *Vibrio* spp. abundance in the Adriatic Sea

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Abstract
The Adriatic Sea holds immense economic and cultural significance for the surrounding states. Among its many attributes, the sea's favourable conditions have fostered continual aquaculture development and a steady increase in fish production. However, sustainable fish production is now directly endangered by climate change and the emergence of pathogens, particularly *Vibrio* spp. bacteria from the *Vibrio* genus are autochthonous and omnipresent in marine ecosystems, with some species acting as disease agents for aquatic animals and/or humans. These harmful species cause vibriosis, leading to a significant negative impact on fish health and, consequently, fish production. *Vibrio* spp. associate with various biotic and abiotic surfaces and their population growth responds rapidly to changes in sea temperature, salinity, and nutrients. The ongoing climate change introduces additional complexity to environmental patterns, as it leads to a host of adverse pressures, such as increased temperature, altered nutrient levels, changing precipitation patterns, and ocean acidification. This, in turn, prolongs the seasonal period of maximal *Vibrio* concentrations and broadens habitats supporting the survival of these pathogens. Therefore, improving the ability to predict population shifts in *Vibrio* spp. is crucial for exploring future risk scenarios and developing effective mitigation strategies. In this study, we assess the performance of existing models in predicting *Vibrio* spp. abundance as functions of environmental conditions using environmentally relevant data. The results highlight the limitations of current models and underscore the importance of developing better ones and

considering organic matter loading, especially in environments such as aquaculture areas.

SS19 Seasonal dynamics of *Vibrio* spp. and occurrence of antibiotic resistance in Eastern Adriatic bivalve aquaculture

Authors
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Abstract
In Croatia, bivalve aquaculture takes place in natural environments, where the entire farming cycle of bivalves occurs in seawater. As a result, these organisms are highly susceptible to changes in their environment and seasonal variations. Furthermore, bivalve tissues become inhabited by microorganisms due to the filtration process of seawater. Among these microorganisms, *Vibrio* bacteria are of special significance due to their connection to diseases affecting both marine organisms and humans who might contract infections from consuming contaminated seafood. Apart from their potential to cause disease, there is a growing concern about the increasing prevalence of antibiotic resistance among these bacteria. Thus, the primary objective of our study was to assess the antibiotic resistance of *Vibrio* species over the course of the year. Study was conducted on two locations known for traditional bivalve aquaculture - Lim Bay and Mali Ston Bay. We sampled seawater, sediment and tissue (hepatopancreas and gills) of two most important aquaculture bivalves in Croatia - European flat oyster, *Ostrea edulis*, Linneaus, 1758 and Mediterranean mussel, *Mytilus galloprovincialis*, Lamarck, 1819 bimonthly on both locations. *Vibrio* species were isolated on *Vibrio* selective TCBS medium on 22°C and 35°C and *Vibrio* clades were identified with MALDI-TOF MS. Results show that abundance and diversity of *Vibrio* species differed throughout the year most influenced by temperature. Almost 75% of all culturable *Vibrio* bacteria belonged to Splendidus clade. Additionally, next most abundant clade was Harveyi clade and Anguillarum clade. Antibiotic resistance was reported on about 60% of all isolated bacteria with more than half of them being multi-resistant.

This study shows first report of presence of antibiotic resistance in shellfish aquaculture in Croatia. Additionally, the results indicate growing concern that with the increase in temperature, there will be an emergence of a greater number of *Vibrio* species.

SS20 Presence and genetic diversity of *Campylobacter* spp. in Istria

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Abstract
Shellfish are an important part of the human diet and an important source of nutrients. In their natural filter-feeding process, shellfish accumulate and concentrate numerous microorganisms present in surrounding water, including pathogen bacteria of the genus *Campylobacter*. Thermotolerant *Campylobacter*, mostly *C. jejuni* and *C. coli* and to a lesser extent *C. lari*, cause campylobacteriosis, the most common zoonosis in European Union. Various animals are natural hosts of *Campylobacter* but are also found in environments such as soil and water. Runoffs and watersheds are usually close to shellfish farms and they can contaminate the area, and increase the number of pathogenic bacteria such as *Campylobacter*. The aim of this study was to assess the presence of *C. jejuni* as the most common cause of campylobacteriosis and *C. lari* which is common in marine water because of a better tolerance for higher NaCl concentration. Three shellfish species: mussels (*Mytilus galloprovincialis*), oysters (*Ostrea edulis*) and queen scallops (*Aequipecten opercularis*) were examined for the presence of *Campylobacter*. The samples were collected from nine locations in the Istrian aquatory, Croatia. Isolation of *Campylobacter* was done according to the standard ISO method, and species were identified using multiplex PCR. Isolates identified as *C. jejuni* and *C. lari* were genotyped using multilocus sequence typing (MLST) to determine the potential source of contamination. Among 108 examined samples of bivalve molluscs, mussels dominated (n = 78) and were the only ones found positive for the presence of *Campylobacter* (25.6%). In total, 19 *C. lari* and 1 *C. jejuni* strains were isolated. *C. lari* isolates found in this study belong to 13 sequence types (STs), and nine of them are newly described. Two out of the four previously described *C. lar*i STs that were also found in this study were previously found in human stool. The only *C. jejuni* isolate was found to be

sequence type 1268, which belongs to ST-1275 clonal complex that is almost exclusively found in seabirds and can sporadically cause infection in humans. This suggests there is some influence of seabirds and humans on the presence of *Campylobacter* in bivalve molluscs. The fact that *C. lari* was the most commonly identified species, supports the statement of better survival in seawater.

ROUND TABLE “CHALLENGES OF THE SCIENTIFIC RESEARCH IN THE ADRIATIC SEA”

Round table topic: Challenges of the scientific research in the Adriatic Sea

September 12, 2023; Ruđer Bošković Institute, Bijenička cesta 54, Zagreb, Croatia

Moderator: Vlado Cuculić, PhD

Panelists:

Mladen Juračić, PhD , Croatian Academy of Sciences and Arts, Zrinka Ljubešić, PhD, University of Zagreb, Faculty of Science, Slavica Matijević, PhD , Institute of Oceanography and Fisheries, Split, Hrvoje Mihanović, PhD , Institute of Oceanography and Fisheries, Split, Melita Peharda Uljević, PhD , Institute of Oceanography and Fisheries, Split, Andreja Ramšak, PhD, National Institute of Biology - Marine Biology Station Piran, Slovenia.

Audience: symposium participants and other interested parties

Highlights:

- The general opinion of the participants is that there is a great need for such platforms for the gathering of scientists, such as InspireAdriatic 2023, where the latest knowledge about research of the Adriatic Sea and topics of great importance for those involved would be given.
- Interdisciplinarity of marine (environmental in general) research has become increasingly necessary and almost mandatory.
- Long-term investigations of the Adriatic Sea do not have systematic financial support from government authorities.
- Lack of coordination and communication among the numerous scientific, expert, and working bodies (national and international) represent major obstacles for the development of new scientific programs, especially in the development of long-term research.
- The lack of information from scientists along with the necessary specific requests to domestic and international authorities to ensure sufficient funds for much-needed long-term research in the Adriatic, which, unfortunately, the Croatian side seems to have completely given up on.

- Examples and practices from Croatia and Slovenia are given.
- There is an urgent need to gather marine scientists to clearly articulate their knowledge and needs to the authorities for financing and organizing needed long-term research programs in the Adriatic Sea.
- Based on the positive feedback from the large majority of the InspireAdriatic 2023 participants and requests of other interested parties, the Organizing committee has decided to continue the International Scientific Symposium Interdisciplinary Approach to the Scientific Research of the Adriatic Sea (InspireAdriatic) on an annual or biannual basis.

POSTER PRESENTATIONS

Comparison of microplastic exposure in the Adriatic sea and the krka river

Sara Šariri, Antonia Jelena Lučev, Ivana Karamatić, Tatjana Mijošek, Zuzana Redžović, Neven Cukrov, Ana Gavrilović, Tena Radočaj, Tomislav Kralj, Vlatka Filipović Marijić

Cd toxicity and its binding to microplastics as an important source of pollution in the aquatic environment

Goran Filipović, Ivana Karamatić, Sara Šariri, Želimira Cvetković, Vlatka Filipović Marijić

Application of multimodal systems in coastal water quality monitoring: the fusion of biology and engineering

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Photosynthetic performances and photoprotection strategies in life cycle stages of the coccolithophore *Calcidiscus leptoporus*

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Exploring the presence and characteristics of microplastics in sea water and drinking water via micro-Raman spectroscopy

Ana Tolić, Ekaterina Šprajc, Lara Mikac, Marinko Pleština, Tamilselvi Selvam, Vlasta Mohaček Grošev, Mile Ivanda