SEEIC 2022

2nd Southeast European Ichthyological Conference

12-15 October 2022

Supetar - Brač Island - Croatia

BOOK OF ABSTRACTS

INSTITUT ZA OCEANOGRAFIJU I RIBARSTVO SPLIT

2nd Southeast European Ichthyological Conference (SEEIC)

12 – 15 October 2022 Supetar (island of Brač)

Croatia

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WELCOME REMARKS

On behalf of the Institute of Oceanography and Fisheries, we welcome You to Supetar, Croatia to attend 2nd international Southeast European Ichthyological Conference 2022 (SEEIC 2022). We hope that over the next four days you'll get theoretical foundations, practical knowledge, and personal contacts that will help you establish long-term and fruitful communication among researchers in a wide variety of scientific fields with a common interest in investigating opportunities.

On behalf of the Conference Committees, we would like to thank all the authors and invited speakers. Their high level of expertise, enthusiasm, dedication and knowledge enabled us to prepare a high quality program and make the conference a successful event.

Once again, thank you for coming to this conference and we are looking forward to meeting you next time.

What this conference offers You…...

• 6 sessions, on topics as History of Ichthyology, Taxonomy and Phylogeny, Biology and Ecology, Biodiversity and Conservation, Molecular biology, Fisheries and Aquaculture

• Inspiring invited speeches: Jakov Dulčić from Institute of Oceanography and Fisheries, Split, Ivana Buj from the Faculty of Science, University of Zagreb, Lovrenc Lipej from Marine Biology Station Piran, National Institute of Biology, Slovenia, Murat Bilecenoglu full professor at the Biology Department of Aydın Adnan Menderes University, Turkey, Nir Stern Head of Fish and Fisheries Labratory at the Israeli Oceanographic and Limnological Research Institute (IOLR) and José Carlos Hernández Professor at the Universidad de La Laguna (Tenerife, Canary Islands, Spain) and Head Researcher of the *Marine Community Ecology and Conservation* research group.

• Plenty of opportunities for mutual conversations, improvement of future cooperation, networking.....

Prof.dr.sc. JAKOV DULČIĆ
Institute of Oceanography and Fisheries
Chairman of the Conference

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- Kalamujić Stroil Belma, University of Sarajevo-Institute for Genetic Engineering and Biotechnology, Sarajevo, Bosnia and Herzegovina

CONFERENCE GOALS AND TOPICS

This conference, which brings together a wide spectrum of ichthyologists, marine and freshwater biologists and ecologists, will allow a wide range of skills, needs and interests to be expressed during discussions in the various sessions in a pleasant and friendly environment. In this way participants, as groups and as individuals, contribute to significantly improving knowledge of ichthyology and fisheries from variety of perspectives. However, many common issues and denominators can be found in the many multilateral discussions, as they all face similar questions about how best to explore and conserve existing ichthyodiversity while using state-of-the-art technology to advance their efforts and knowledge. Currently, there are few opportunities for research scientists from southeastern European countries to come together in one place and have a fruitful discussion on common interests related to protecting and enhancing fish biodiversity in the area. The conference will provide such a forum for these groups of scientists to learn from each other, address some of their questions with expert presentations, and return to their institutions with fresh ideas.

Specifically, we defined the following goals:

1. to provide a forum at the conference for participants to draw on common biological-ecological contexts and group discussions to envision new research-technological opportunities and mutual coollaboration,

- to identify aspects of research and learning in various aspects of ichthyology and fisheries that could be improved or made more efficient through the use of new technologies,

- to explore the improvements that could be achieved through joint efforts within our scientific institutions and respective legislative bodies,

2. to lay the foundations for more intensive collective cooperation, especially in transboundary areas in matters of biological and ecological protection,

- to define the primary scientific research and other obstacles that each of us faces as individuals and as part of the various scientific communities to which we belong.

- to build stronger working relationships, within and between institutions, based on a better understanding of common goals and awareness of individual challenges.

3. to become familiar with existing technological improvements that can be implemented in Your institutions and in Your research project, and offer practical solutions that provide concrete guidelines for relevant research issues.

PREFACE

Fish and fisheries are an integral part of most societies and are important contributors to economic and social health and well-being in many countries and areas of the world. Despite this enormous importance and value, or rather because of these attributes, the world's fish stocks suffer from the combined effects of heavy exploitation and, in some cases, environmental degradation. However, healthy ecosystems are a fundamental requirement for sustainable development and biodiversity conservation. It is quite clear that only healthy ecosystems are a fundamental prerequisite for sustainable development and biodiversity conservation, because in this way they support human life and allow adaptation to changing needs and environmental conditions. However, current trends in economic development unfortunately do not usually take into account the preservation of the ecosystem, resulting in overexploitation of valuable resources. The result is an alarming degradation of many ecosystems and habitats, and a significant decline in biodiversity. Also, most of these pressures take place in developing countries and countries in transition.

The area of southeastern Europe is widely known for its extremely rich and diverse freshwater and marine fish fauna which is strikingly different from that of the rest of Europe. It is an area of exceptional geological and morphological diversity followed by a history of numerous evolutionary changes that have influenced the current development and state of the fish fauna to be so diverse and rich. Most of its freshwater species are endemic to small parts of the Mediterranean freshwater drainage, while most of the species native to the non-Mediterranean drainages of Europe are absent from the Mediterranean freshwater drainages. The geographical isolation from other European catchments by the Alps, the Dinaric and Balkan mountains, toghether with watershed discreteness and climatic conditions, appear to be the main reasons for this distinctiveness. The sea surrounding the countries of Southeastern Europe, although part of the Mediterranean Sea, is also an independent biogeographical and ecological sub-unit, which is reflected in the composition and properties of its fish communities. The richness of the ichthyofauna is reflected in the fact that many taxonomic aspects of the local ichthyofauna have changed since the past. However, despite the modern great interest in molecular phylogenetics to elucidate such relationships and the evolutionary trend of species within the area, surprisingly,

there is still a large gap in our knowledge of the comparative morphology and nomenclature of many described taxa from southeastern Europe, many of which have not yet been reanalyzed from their original descriptions.

At the same time, it is also an area of numerous changes and pressures, as well as threats at the environmental level, that pose significant threats to the existing marine and freshwater ichthyofauna. The great anthropogenic pressure, expressed in the pollution of rivers, the construction of dams and the consequent changes in aquatic habitat, evident climate changes, intensive fishery and arrival of non-indigenous and invasive species, are a load that significantly affects the existing specific habitats, many of which are located in the karst. There are many reasons for this unacceptable state of affairs, but the main reasons lie in a failure in environmental and fisheries policies in most countries.

Insufficient mutual connection on the common issue of conserving unique habitats and fish fauna, as wel as ever-increasing pressures on the environment and nature, are the challenges that united us even at our first, highly successful conference. At our second meeting, we were a bit disturbed by the COVID pandemic, but even that cannot stop us from the intention to firmly connect in a common plan; research and protection of the common environment and fish biodiversity that successfully connects us.

Considering all the above shortcomings, this conference obviously will not be able to provide clearly defined solutions, but we hope that the data presented here will offer some approaches and serve as a basis for further collaboration, studies and targeted conservation efforts. There is an urgent need for detailed ichthyological research to obtain precise data on the fish fauna of Southeast Europe, which could then be the basis for a management strategy for both marine and freshwater ecosystems.

Dr.sc. Pero Tutman

Institute for Oceanography and Fisheries, Split, Croatia

INTRODUCTORY WORDS

Dear all,

I welcome You all here in Supetar on the island of Brač, the island of stone and vines, the island of olives, the island with the most beautiful beach in Europe and possibly in the world, the island from which the stone was used to build Diocletian's Palace, the foundation of the city of Split, originates Mario Puratić, innovator and inventor of the Power block, initiator of the revolution in world fishing.

The congress was originally planned to be held in 2020, but due to the situation with the Covid-19 pandemic, it will be held in September 2022. Therefore, the Organizational and Scientific committees decided that this Conference will be dedicated to the anniversaries that we celebrated in the past two years.

2nd SEEIC marks the 90th anniversary of the Institute of Oceanography and Fisheries in Split that we celebrated in 2020 and 90th anniversary of the scientific journal Acta Adriatica in 2022. Conference also marks 40 years that respected ichthyologist and expert Prof. dr. Tonko Šoljan passed away.

And finally, I declare this Congress open and wish all participants successful presentations and pleasent and fruitfull time during the Conference!

Prof.dr.sc. Jakov Dulčić

Institute of Oceanography and Fisheries, Split, Croatia

Dear friends,

It has been five years since we met in Sarajevo, on the First Southeast European Ichthyological Conference and 15 years since the latest ichthyological conference held in Croatia (XII European Congress of Ichthyology). Interestingly, the First European Congress of Ichthyology was held also in Sarajevo, in 1973., almost 50 years ago. Nevertheless, ichthyological investigations, both in Croatia, as well as in the Southeast Europe, are of much older origin. The Nobile Jakov Sorkočević in the 16th Century Dubrovnik Republic wrote to his Italian colleague, professor Ulisse Aldrovani of the University of Bologna about the fish and shellfish of the Dubrovnik area, both marine and freshwater. Arguably, Greek ichthyology is one of the oldest sciences in the world – already Aristotle started to describe Mediterranean fish and made ichthyology a formal scientific discipline. Moreover, ichthyology, although informal and mostly descriptive, was connected with the humankind since its earliest history, since the Old Stone Age. Besides numerous benefits that humans were obtaining from fish populations, all through human history, our interest and admiration for the mysterious fish communities, never ceased.

Even though Corona restrictions have prevented us to meet and gather during the past two unfortunate years, we also never stopped enjoying the fabulous world of fish. New investigations have corroborated exceptional richness and diversity of freshwater fish in Southeast Europe. Only from Croatian freshwaters, discoveries are interesting and exciting and similar situation can be observed in all countries participating in this conference. We have traced back more ancient events in the evolutionary histories of freshwater fishes than all previously reported ones; solved several taxonomic uncertainties and revealed new species both for Croatia, as well as for science; analysed fish communities and their responses to various anthropogenically induced threats and stressors; quantified chances of their future survival and viability; and, most important of all – we were dedicated to assure that neither component of this great richness disappears for good.

At last we have the opportunity to share our findings, ideas, results, information, even our problems with our dear colleagues from various institutions in Southeast Europe and further, our like-minded friends regarding the mystic beauty of fishes, our comrades in the harsh battle for the survival of the most unique components of the European ichthyofauna. With deep gratitude to the Organizing Committee of this conference, particularly to Dubravka Bojanić Varezić, Pero Tutman

and Jakov Dulčić, I am assured that this Conference will be very successful and memorable, and am looking forward to seeing you all in Supetar.

Prof.dr.sc. Ivana Buj

Faculty of Science, University of Zagreb, Croatia

CONFERENCE PROGRAMME

12 October 2022

From 14:00 – registration of participants

Moderator: Belma Kalamujić Stroil

17:00 – 18:00 Welcome speeches

Dubravka Bojanić Varezić – Chairman of the Organizing committee of the Conference, Institute of oceanography and fisheries, Split, Croatia

Rifat Škrijelj – Rector of University of Sarajevo, Bosnia and Herzegovina

Ivana Buj – Faculty of Science, University of Zagreb, Croatia

Živana Ninčević Gladan – Director of the Institute of Oceanography and Fisheries, Split, Croatia

Chairman: Perica Mustafić, Dubravka Bojanić Varezić

18:00 – 18:15 **Tamara Kanjuh**: Brown trout (*Salmo cf. trutta*) from the Danube Basin in Croatia – genetic structure of populations

18:15 – 18:30 **Danilo Mrdak**: ddRADSeq of *Salmo trutta* Da, At and Ad lineage provide a huge number of SNPs

18:30 – 18:45 **Domagoj Ceković**: Significance and role of the Croatian Sport Fishing Association in the management and protection of freshwater ichthyofauna

18:45 – 19:00 **Branko Glamuzina**: The historical trends and recent collapse of European eel fishery in the Neretva Estuary

19:00 – 19:10 Time for discussion

19:10 – 20:30 Welcome party

13 October 2022

Session: Biodiversity and Conservation

9:00 – 9:50 Plenary lecture – **Ivana Buj**

From evolutionary ‘highways’ to diversification ‘blind-ends’ – the origin and perspective of exceptionally rich ichthyodiversity harboured inside Dinaric karstic watersheds

Chairman: Ivana Buj, Sanja Matić-Skoko

9:50 – 10:05	**Naris Pojskić**: Prediction models in the assessment of genetic diversity of ichthyopopulations in certain temporal periods
10:05 – 10:20	**Lucija Novoselec**: Genetic structure and diversity of the endangered native and invasive alien trout species in the Plitvice Lakes area
10:20 – 10:45	**Nikola Renić**: Removal of invasive fish species from the Plitvice lakes water system helps in increasing viability of native fish species and restoring natural habitat conditions
10:45 – 11:00	**Lucija Ivić**: First insight into the genetic diversity of Sterlet (Actinopteygii: *Acipenser ruthenus* Linnaeus, 1758) in Croatia with implications for its conservation
11:00 – 11:10	Time for discussion
11:10 – 11:40	Coffee break

Chairman: Nika Stagličić, Anthi Oikonomou

11:40 – 11:55	**Maximilian Wagner**: Population structure and connectivity of the triplefin blenny *Tripterygion tripteronotum* in the Adriatic Sea
11:55 – 12:10	**Mustafa Korkmaz**: Insights into climate change effects on fish biodiversity in the semi-arid Konya closed basin, Turkey
12:10 – 12:25	**Joanna Grabowska**: Functional ecology of four invasive Ponto-Caspian goby species
12:25 – 12:40	**Nenad Antolović**: Dubrovnik aquarium as conservation center for Adriatic biodiversity
12:40 – 12:50	Time for discussion
12:50 – 13:30	**Poster session – Biology and Conservation, Taxonomy and Phylogeny**
13:30 – 15:00	Lunch break

Session: Biology and Ecology

Chairman: Branko Dragičević, Nir Stern

15:00 – 15:50	Plenary lecture – **Murat Bilecenoglu** We watched them spread, invade and become part of us - overview of alien fish in Turkey

15:50 – 16:05 **Pero Ugarković**: Tracking northward expansion of groupers (genus Ephinephelus) in the eastern Adriatic (Croatian coast) using the Local Ecological Knowledge (LEK) of recreational and sport fishermen

16:05 – 16:20 **Georgios Vagenas**: Temperature unravels the variability in life-history traits observed between non-indigenous and native fish species in the Mediterranean Sea

16:20 – 16:35 **Dagmara Błońska**: Does the competition cause oxidative stress? – Influence of biotic factor on antioxidant system of invasive round goby

16:35 – 16:45 Time for discussion

16:45 – 17:15 Coffee break

Session: Biology and Ecology

Chairman: Vanja Čikeš Keč, Dragana Milošević

17:15 – 18:05 Plenary lecture - **Nir Stern**
"From eggs to adults: dynamic trends in fish and fisheries at the Israeli Mediterranean coast, Levant Basin"

18:05 – 18:20 **Sanja Matić-Skoko**: What are the synergistic effects of interannual environmental changes and habitat modifications on juvenile fish communities?

18:20 – 18:35 **Domen Trkov**: Feeding ecology of Mediterranean cryptobenthic fish fauna: lessons learnt from clingfishes (Gobiesocidae)

18:35 – 18:50 **Zoran Marčić**: Age and growth comparison of surface and subterranean individuals of karstic dace (*Telestes karsticus*)

18:50 – 19:00 Time for discussion

19:00 – 19:40 **Poster session – Biology and Ecology**

14 October 2022

9:00 – 9:50 Plenary lecture
José Carlos Hernández: Nature protection and ecosystem resilience: what have we learn from a catastrophic underwater volcanic eruption?

10:00 – 13:00 Study visit to the fish-processing factory Sardina d.o.o. in Postira

13:00 – 14:30 Lunch break

Session: Fisheries and Aquaculture; Taxonomy and Phylogeny

Chairman: Ana Pešić, Barbara Zorica

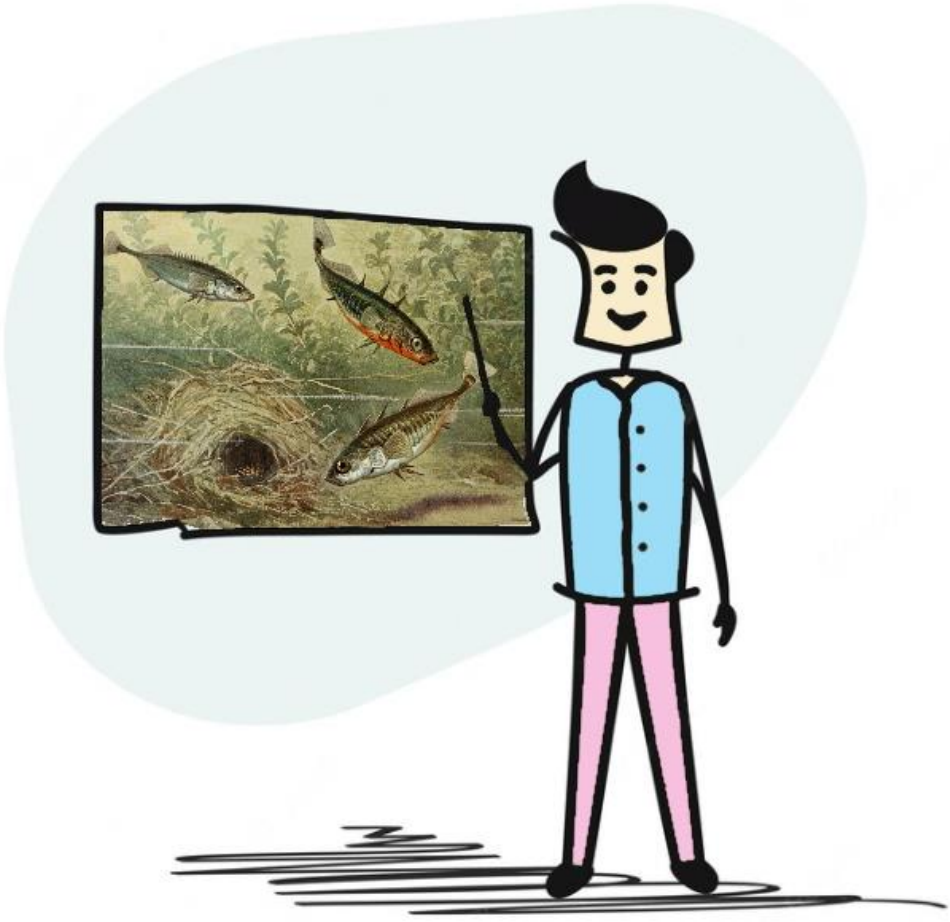
14:30 – 14:45	**Evangelos Koufalis**: Risk assessment of Golani's round herring, *Etrumeus golanii* (DiBattista, Randall & Bowen, 2012) in Greece
14:45 – 15:00	**Tanja Šegvić – Bubić**: Interaction of semi-offshore tuna farms with marine biodiversity
15:00 – 15:15	**Iva Žužul Vrgoč**: Genetic structure of greater amberjack *Seriola dumerilli* (RISSO, 1810) populations in the Mediterranean Sea
15:15 – 15:30	**Belma Kalamujić Stroil**: Importance of genetic monitoring in aquaculture – two decades of experience in Bosnia and Herzegovina
15:30 – 15:45	**Sara Pleše**: Tackling the phylogeny of lampreys – insight in Croatia's Danube basin
15:45 – 15:55	Time for discussion
15:55 – 16:30	Coffee break
16:30 – 17:15	**Poster session – Fisheries and Aquaculture**
20:00	Conference gala dinner

15 October 2022

Excursion trip

INVITED SPEAKERS' PRESENTATION TITLES

Main plenary session will involve eminent invited speakers to talk about recent ecological trends through the prism of lessons learned, opportunities and treaths for the future southeastern Europe marine and freshwater biodiversity.



PL1

Croatian marine ichthyologists: a 440-years long journey

Jakov Dulčić

Head of Laboratory of Ichthyology and Coastal Fisheries, Scientific Advisor with tenure at Institute of Oceanography and Fisheries, Split, Full professor at University of Zagreb. His research interest includes taxonomy, biology and ecology of coastal fish, fish population dynamics, coastal fish assemblage ecology, marine biodiversity of marine coastal areas, the processes of tropicalisation and bioinvasion in the Adriatic Sea, bioinvasion, zoogeography, history of marine research.

Abstract

In his presentation he presents a historical overview of the development of marine ichthyology in Croatia from the 16th century and the work/correspodence of Jakov Sorkočević Lovrov until the present day (a 440 – years journey). The presentation also gives data concerning the most important marine ichthyologists (Sorkočević, Bučić, Kolombatović, Brusina, Kosić, Lorini, Šoljan, Gamulin, among others) whose work marked certain periods of history in a particular way. Some of their works (such as „Fishes of the Adriatic“) that contributed to the development of marine ichthyology in Croatia and wider area are discussed as well.

PL2

From evolutionary ‘highways’ to diversification ‘blind-ends’ – the origin and perspective of exceptionally rich ichthyodiversity harbored inside Dinaric karstic watersheds

Ivana Buj

Employed as an assistant professor at the Zoological Department of the Faculty of Science, University of Zagreb. The main focus of her work includes taxonomical, population genetic and evolutionary investigations of freshwater fish species, particularly endemic species in karstic watersheds. Moreover, she is dedicated to conservation of exceptional ichthyodiversity present in Croatian watersheds by combining all available approaches, including conservation genetics principles and integrative approaches.

Abstract

The diversity and richness of the freshwater biota in Croatia is usually explained by division of Croatian waters into two watersheds (Adriatic and Black Sea watersheds) that express different geological, hydromorphological and ecological conditions. Nevertheless, in order to better comprehend origin, but also future of the exceptionally rich fish communities in karstic watersheds, we need to dive deep into the past and search for evolutionary pathways and phenomena that were provoked by complex geologic history of this area and shaped the ichthyodiversity that we can admire today. Fortunately, by recently conducted molecular genetic investigations, we were able to shed at least some light on the evolution of the freshwater fishes in Dinaric water systems. From almost 30 million years ago, the period when the whole southern Europe was an archipelago, through Dinarids upwelling, freshwater systems appearance and evolution, fluctuations in the Adriatic Sea water level, up to the Pleistocene interchange of glacial and interglacial periods and current days Earth landscapes, severely influenced by anthropogenic activities, we were able to trace evolutionary histories of several freshwater fish species and genera, whose developments were inseparably connected with Dinaric karstic watersheds. From Aulopyge huegli, whose evolutionary history comprised more than 20 million ‘years of silence’ to genus Squalius that colonized this area on three distinct occasions; from genera Telestes and Delminichthys, that originated in this region to the genus Salmo, that colonized Dinaric watersheds from other sources, but became the most extraordinary here (for example, S. obtusirostris or S. farioides); from exceptionally high genetic diversities comprised inside Cobitis dalmatina or Telestes turskyi to populations that comprise genetic material of more than a single species - all ‘shapes and colours’ of evolutionary trajectories and phenomena, diversification events and speciation modes and phases left their trace in the recent diversity of freshwater fish in this ichtyological ‘hot spot’. Although we have methods and capabilities to discover their pasts, the question on their future perspectives, even though highly depending on our activities, remains unrevealed.

PL3

The state of art of elasmobranch research in the Adriatic Sea: experiences from the Gulf of Trieste

Lovrenc Lipej

Scientific Counsellor at Marine Biology Station Piran, National Institute of Biology, Slovenia. Full professor at University of Ljubljana. His research interest includes coastal fish assemblage ecology, shark ecology, marine biodiversity of marine coastal areas, with special regard to protected areas, the processes of tropicalisation and bioinvasion in the Adriatic Sea, special interest in endangered species and habitat types of the Mediterranean, raptor ecology in the Mediterranean type ecosystem.

Abstract

The fate of elasmobranchs in the Adriatic Sea and the whole Mediterranean basin is unclear. Due to their vulnerability to fishing pressure they are facing an unprecedented and dramatic decimation in their numbers. Since sharks and rays As apex predators can regulate prey species densities and their distribution, they are considered as suitable indicators of environmental health, however, they are still poorly investigated. To this end, it is important to achieve knowledge from all possible and available sources such as the specimens entangled in fishermen nets as bycatch and sighthings and to include modern options such as citizen science by applying LEK (local ecological knowledge). Author wish to present the state of art of elasmobranch research in the Adriatic Sea with experiences gained through research performed in its northernmost part and try to propose some options to improve the elasmobranch research and possible conservation measures.

PL4

We watched them spread, invade and become part of us - overview of alien fish in Turkey

Murat Bilecenoglu

Employed as a full professor at the Biology Department of Aydın Adnan Menderes University, Turkey. He has focused on several fields of marine research including fish taxonomy, alien species introductions, conservation biology, marine biodiversity studies (with an emphasize to marine protected areas) and fish population dynamics.

Abstract

Approximately 16% of the Turkish marine ichthyofauna is composed of alien species originating mostly from the Indo-Pacific Ocean and the Red Sea - a ratio doubled within the last two decades, as a pure indication of the unprecedented increase of introductions. Ongoing research is skewed towards recording new species introductions and range expansions, which provides a close and timely monitoring of their dispersal capabilities, while costly and laborious bio-ecological research is extremely limited to a few examples. Therefore, a good understanding of the magnitude of the multifaceted impact of alien fish has not yet been achieved, which is required for the efficient prioritization of actions for developing mitigation measures. This presentation will focus on the ecological, socioeconomics and human health impacts of notable alien fish based on experience gained from the Turkish coastline. The varying invasive species perception among different segments of the society will also be discussed.

PL5

From eggs to adults: dynamic trends in fish and fisheries at the Israeli Mediterranean coast, Levant Basin

Nir Stern

Head of fish and fisheries lab at the Israeli Oceanographic and Limnological Research Institute (IOLR). His studies focus mainly on the marine fish fauna of the eastern Mediterranean Sea, integrating traditional taxonomy with DNA-based methods to explore local biodiversity, from eggs to adults. Moreover, he is responsible for national monitoring projects both in marine and freshwater environments, and serves as an active member in national conservation efforts such as designing marine protected areas and implementing sustainable fisheries protocols.

Abstract

The ichthyofauna at the Israeli Mediterranean coast will be reviewed during this talk throughout its life cycle, pursuing a general attempt to describe the diversity and distribution of fish in a highly invaded and oligotrophic sea. First, Ichthyoplankton surveys that were conducted above the continental shelf and beyond will be discussed, including the advantageous use of DNA-based methods in processing the planktonic samples. Next, juvenile recruitment trends and adult benthic fish distribution will be presented based on seven years of monitoring experience, emphasizing the dynamic changes in fish communities of continental sandy habitats, a mixed outcome of intense biological invasion and global warming.

PL6

Nature protection and ecosystem resilience: what have we learn from a catastrophic underwater volcanic eruption?

José Carlos Hernández

Professor at the Universidad de La Laguna (Tenerife, Canary Islands, Spain) and head researcher of the *Marine Community Ecology and Conservation* research group. He is also an experience diver in love of every marine creature, specially fish. His motivation in life is to understand and to explain the secrets of the underwater life to his students; and doing so, he seeks to make them to care our connection to nature. He has extensively investigated the establishment and stability of alternative ecosystem states in subtropical rocky systems, such as sea urchin barrens and macroalgae forest. In parallel with the degenerating trend of the natural world around us he has also cultivated an especial interest on the study of human-derived stressors, such as overfishing and climate change, that can act to erode the resilience of marine communities, thus exacerbating the risk, spatial extent and irreversibility of an unwanted regime shifts for marine ecosystems. For this research topic, he has worked at different Marine Protected Areas worldwide to understand how ecosystem resilience can be enhance.

Abstract

Natural hazards are not uncommon in marine ecosystems. Recently, we have observed intense volcanic activity in the western part of the Canary Islands (Spain). In October 2011, an underwater eruption occurred on the southern coast of El Hierro Island. The large amount of gases emitted during the eruption created a sulfurous volcanic plume that caused large invertebrate and fish mortalities. This catastrophe affected the Mar de Las Calmas area, which includes a well-established, 24-year, marine protected area. We used this catastrophic event and 25-year time series data from Punta de La Restinga-Mar de Las Calmas Marine Reserve (PRMC-MR) to test the resilience of the commercial fish species to the mass mortality caused by the volcanic eruption. We considered resilience as a sequential process and partitioned it into (1) resistance or the ability to absorb the impact, (2) course or trajectories of recovery, and (3) recovery as the ability to restore a similar fish community 8 years after the volcanic impact ceased. Here, we demonstrate that the no-take zone can boost the resilience of commercial fish communities. This result was mainly due to the total fish biomass in the no-take zone that was resistant, had a positive course and had recovered from the perturbation. The fish community had not recovered to the prevolcanic state 8 years after the eruption. This was probably due to the contrasting return times of fish with different life histories. While the parrotfish Sparisoma cretense recovered and even surpassed its prevolcanic biomass within the first year after the eruption, the dusky grouper Epinephelus marginatus still had not yet reached its pristine biomass. We provide the first empirical evidence to date of the usefulness of no-take zones in promoting ecological resilience against underwater volcanism.

SESSION I – HISTORY OF ICHTHYOLOGY

PL1

Croatian marine ichthyologists: a 440-years long journey

Jakov Dulčić[1]

[1] Institute of Oceanography and Fisheries, Šetalište Ivana Meštrovića 63, 21000 Split, Croatia

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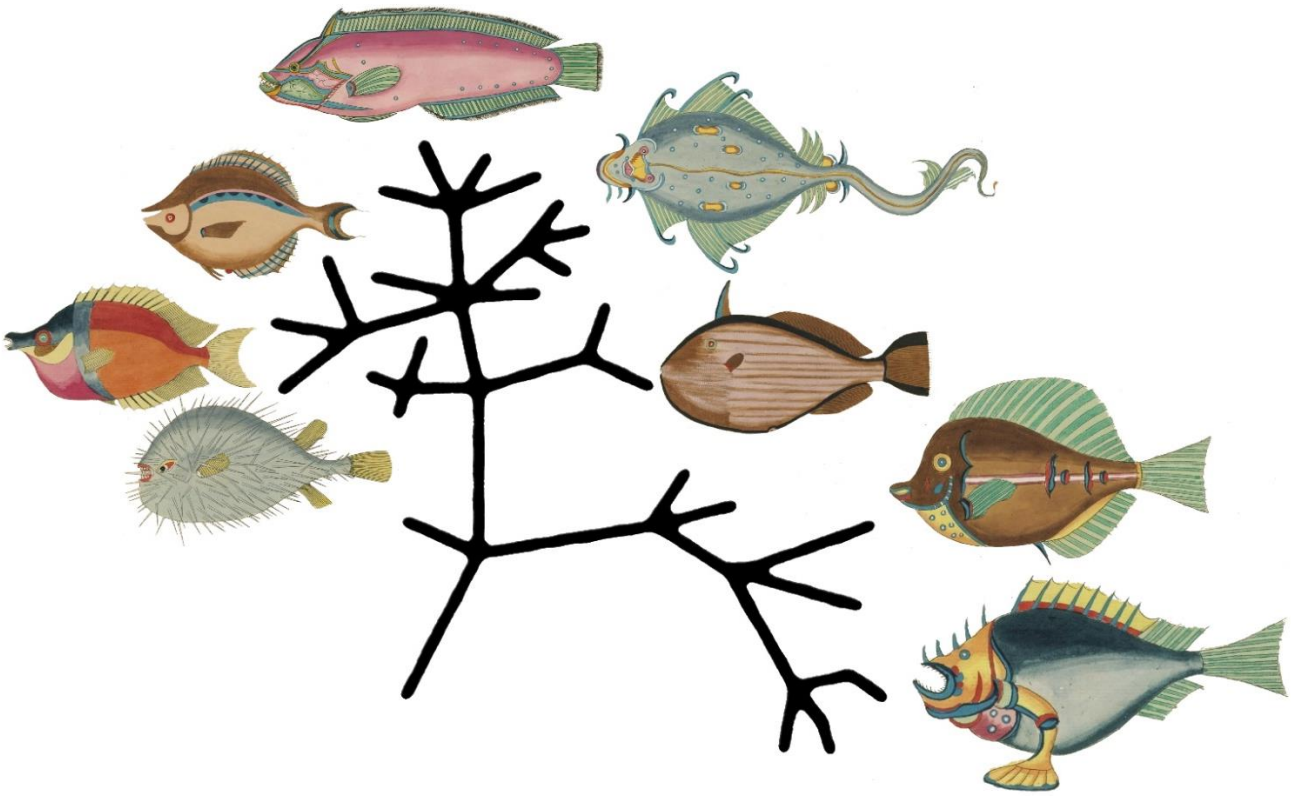
Abstract:

This presentation is giving a historical overview of the development of marine ichthyology in Croatia from the 16th century and the work/correspodence of Jakov Sorkočević Lovrov until the present day (a 440 – years journey). The presentation also gives data concerning the most important marine ichthyologists (Sorkočević, Bučić, Kolombatović, Brusina, Kosić, Lorini, Šoljan, Gamulin, among others) whose work marked certain periods of history in a particular way. Some of their works (such as „Fishes of the Adriatic“) that contributed to the development of marine ichthyology in Croatia and wider area are discussed as well.

Keywords: Key words: marine ichthyology, history, 440 years, Jakov Sorkočević Lovrov, Tonko Šoljan.

Type of presentation: Oral

SESSION II – TAXONOMY AND PHYLOGENY



TP-P1

Population genetic structure of the European squid *Loligo vulgaris* (Cephalopoda: Loliginidae) in the Eastern Adriatic Sea

Mirela Petrić[1], Željka Trumbić[1], Biljana Apostolska[2], Antonela Paladin[2], Mate Šantić[2]

[1] University of Split, Department of Marine Studies, Ruđera Boškovića 37, Split, Croatia
[2] University of Split, Faculty of Science, Ruđera Boškovića 33, Split, Croatia

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Abstract:

Knowledge of genetic diversity and population structure is the foundation of responsible and sustainable exploitation of every species, that ensures the sustainability of wildlife populations. In order to gain insight into the recent state of genetic diversity of *Loligo vulgaris* populations in the north, central and south part of the Eastern Adriatic, a part of the nucleotide sequence of the mitochondrial gene of the cytochrome c oxidase subunit I, known as COI, was analyzed. This genetic marker today represents the basis for the identification of all Metazoa, the study of their phylogenetic relationships as well as population structures. During the autumn-winter period of 2019, a total of 30 squids were collected. Sequencing of mitochondrial DNA fragments produced good quality results. The length of the sequenced region in most samples was about 630 base pairs (bp). A total of 9 polymorphic sites and 10 haplotypes were identified in the total sample of *L. vulgaris*. Of the 9 polymorphic sites, 5 were singletons with two possible variants. Of the 4 phylogenetically informative sites, all had two variants. Of the 10 haplotypes defined, 5 are represented by a single individual. Haplotype 1 (H1) showed the highest total frequency in the total sample. According to genetic diversity indices, high total haplotype diversity (Hd = 0.8005) and low nucleotide diversity (Pi = 0.00199) were found. The total mean difference between sequence pairs (k) was 1.26108. Obtained results indicate that there is a unique homogeneous stock of *L. vulgaris* in the Adriatic Sea.

Keywords: *Loligo vulgaris*, DNA, COI, diversity, Adriatic.

Type of presentation: Poster

TP-O1

Tackling the phylogeny of lampreys – insight in Croatia's Danube basin

Sara Pleše[1], Ivana Buj[1], Lucija Ivić[1], Lucija Onorato[1], Sven Horvatić[1], Zoran Marčić[1], Davor Zanella[1], Perica Mustafić[1], Marko Ćaleta[2]

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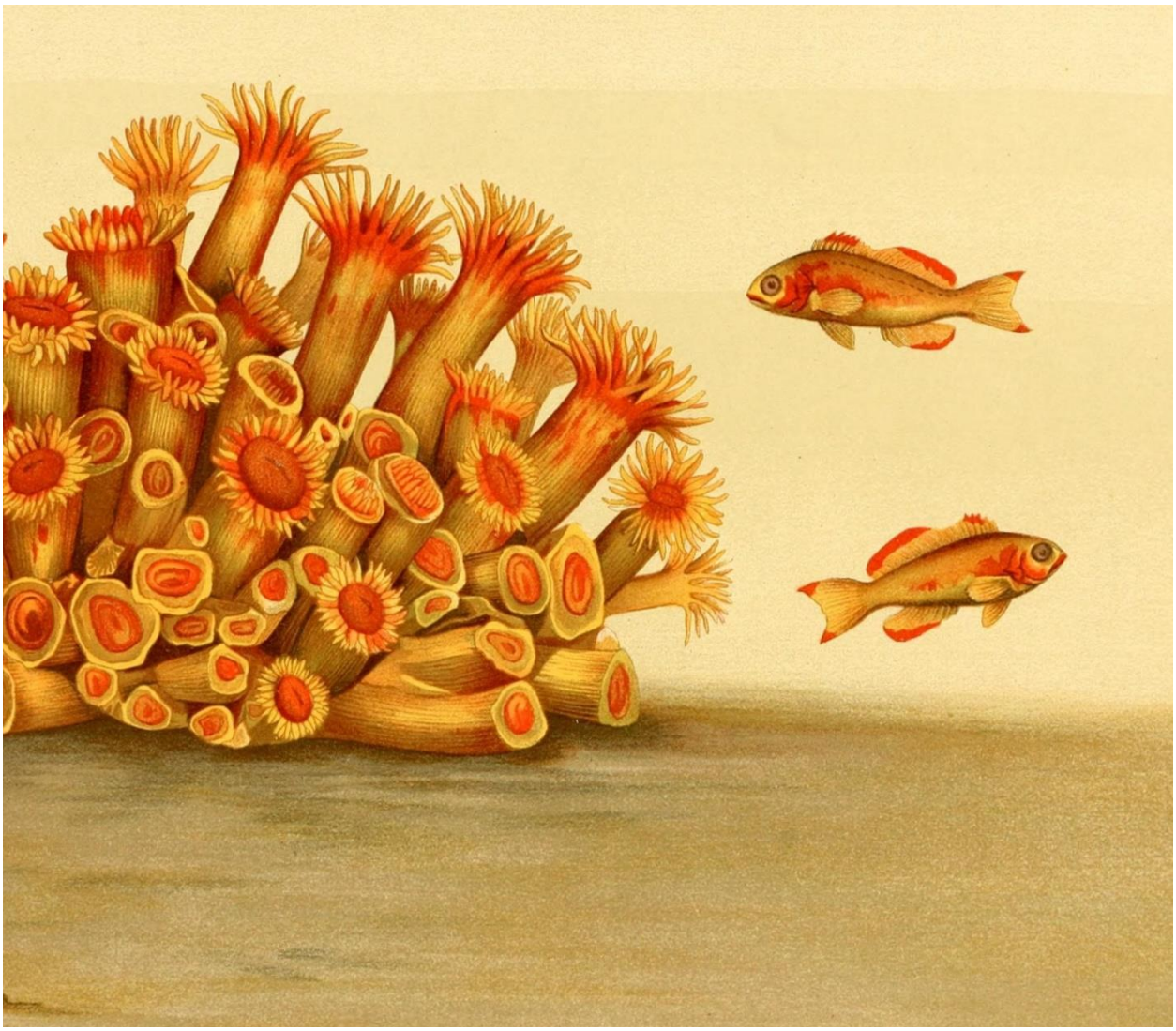
Abstract:

Lampreys (family Petromyzontidae), which according to many publications are still classified as fish, are a group of Vertebrates that 500 million years ago separated from fish and other classes of Vertebrates based on the absence of jaws. Together with the hagfish (family Mixynidae) they form an informal group called the cyclostomes (Cyclostomata). The taxonomy of lampreys has not been completely resolved at the global level, including in Croatia. With insufficiently studied taxonomy, it is not known the exact distribution of the species or whether they are endangered and in what way. In Croatia we find them in the Danube basin, Adriatic basin and in the Adriatic Sea, depending on whether they are freshwater or marine species, but the exact number of species for lampreys in Croatia has not been confirmed due to lack of modern molecular methods and analyzes. Without the above basic information, it is not possible to protect species that are part of the rich biodiversity of Croatian fauna. The aim of this research was to determine the phylogenetic relationships of the studied family, determine the exact taxonomic position of species within the family, make phylogenetic reconstruction of the group in the study area and assess the genetic diversity and structure of individual identified species and lines. To determine the taxonomic position of the species present in the Danube basin of Croatia, phylogenetic reconstruction was performed based on cytochrome *b* gene sequences using the maximum parsimony method, the maximum likelihood method and the median joining method. The obtained phylogenetic trees and phylogenetic network confirmed the existence of 4 separate lines within the species *Eudontomyzon vladykovi* Oliva and Zanandrea, 1959 and the presence of the species *Eudontomyzon danfordi* Regan, 1911 in Croatia. Using tests of genetic diversity and genetic differentiation in addition to molecular diagnostic analyzes, moderate to high levels of genetic diversity within and between identified species and lineages and deep structuring within the species *Eudontomyzon vladykovi* were determined. Greater details of the results along with the main conclusions will be discussed.

Keywords: lampreys, taxonomy, phylogeny, cytochrome *b*, lineages.

Type of presentation: Oral

SESSION III – BIOLOGY AND ECOLOGY



BE-P1

Bottom up control of fish populations across contrasting rocky macroalgae habitats

Beatriz Alfonso[1], Giulio Barone[2], Ana Alfaro[3], José Carlos Hernández[3]

[1] Departament d'Ecologia, Facultat de Biologia, Universitat de Barcelona, Spain
[2] Italian National Research Council, Italy
[3] Departamento de Biología Animal, Edafología y Ecología, Universidad de La Laguna, Canary Islands, Spain

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Abstract:

The present study aims to explore the structure and biomass of fish communities in different habitats of the Canary Islands, as well as todetermine the influence of nutrients and primary production (plancktonic-benthic). To conduct this study, abundance and length of fishes were collected in three periods at the four most common phytocenosis of the rocky bottoms of the Archipelago. The environmental variables studied were: temperature, salinity, nutrients (nitrites, nitrates, phosphates and silicates), planktonic and benthonic production, chlorophyll a and phaeophytin. Fish species were classified in six trophic groups. The results show that habitat has a significant influence on the biomass of the different trophic groups. The group "plancktivorous" showed the highest biomass in habitats dominated by *L. variegata* and Crustose corallines, the group "omnivorous" in the habitat Gelidilaes/Corallines and the group "microinvertebrate predators" in the habitat dominated by *C. abies-marina*. The environmental variables that explain best the distribution of fish's biomass were: (1) nitrate concentration, (2) chlorophyll a and (3) phaeophytin. Based on these variables, the group "herbivorous" had more biomass in sites with high nutrients concentration and the groups "plancktivorous and macroinvertebrate predatos" had more biomass in sites with high chlorophyll a concentration. The rest of groups did not show any correlation with these variables. The lowest trophic level fish groups are influenced by nutrients availability and phytoplankton presence.

Keywords: fish assemblages, Canary Islands, macro algae beds, primary production, nutrients.

Type of presentation: Poster

BE-O1

Does the competition cause oxidative stress? – Influence of biotic factor on antioxidant system of invasive round goby

Dagmara Błońska[1], Ali Serhan Tarkan[1,3], Bartosz Janic[1], Mariusz Tszydel[1], Bożena Bukowska[2]

[1] University of Łódź, Faculty of Biology and Environmental Protection, Department of Ecology and Vertebrate Zoology, 12/16 Banacha Str., Łódź 90-237, Poland
[2] University of Łódź, Faculty of Biology and Environmental Protection, Department of Biophysics of Environmental Pollution, Pomorska 141/143 St. Łódź 90-001, Poland
[3] Muğla Sıtkı Koçman University, Faculty of Fisheries, 48000, Menteşe, Muğla, Turkey

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Abstract:

Organisms are vulnerable to external stimuli and among various reactions they display are changes in oxidative status. There is quite grounded knowledge on the influence of abiotic factors such as temperature, salinity, heavy metals, or xenobiotic on the antioxidant system of different organisms, however, the impact of biotic factors (intra- and interspecific interactions) is still barely explored. Thus, the aim of the present study was to fill this gap and evaluate the effect of acute competitive interactions. Round goby *Neogobius melanostomus* individuals (resident and intruder) were subjected to competition for limited shelter resource in three treatments (1 h, 6 h and 12 h long), and oxidative stress parameters (total antioxidant capacity TAC, catalase activity CAT, reduced glutathione GSH, lipid peroxidation LPO), as well as behaviour (time spent in the shelter, guarding the shelter and aggression), were measured. All tested parameters showed higher values in the liver than in muscle tissue. Fish behaviour and antioxidant defence did not show any potential connections reflecting changes in antioxidant status and aggression, especially that there was no difference between resident and intruder fish in oxidative stress parameters. However, regarding oxidative damage there were noticeable similar trends in the level of oxidative damage and aggression acts, particularly in resident goby, with the highest aggression and highest oxidative damage within 1 h with a decrease in following treatments. Obtained results were compared with the outcomes of our previous studies, where we used similar experimental protocol and species, but used acute heat shock as a stressor. The higher temperature turned out to be a stronger stressor than the competition, which was most pronounced in oxidative damage (x12 greater in the liver and x30 in muscle). Intraspecific interactions evaluated in the present study might be more intense regarding competition between usually more aggressive invasive goby and native species, which are often outcompeted.

Keywords: invasive species, intraspecific interactions, antioxidant defence, oxidative damage.

Type of presentation: Oral

BE-P2

Reproductive biology of red mullet, *Mullus barbatus* (Linnaeus, 1758) from the eastern Adriatic Sea

Petar Ćurlin[1], Antonela Paladin[1], Mate Šantić[1], Biljana Apostolska[1]

[1] Faculty of Science, University of Split, 21 000 Split, Croatia

apaladin@pmfst.hr

Abstract:

The macroscopic and histological techniques were used to determine the changes occurring in gonads development of the red mullet, *Mullus barbatus*, from the eastern Adriatic Sea. In total 404 individuals were collected from March to October, from which 304 were females (75,25%), 92 males (22,72%) and 8 individuals of undetermined sex (1,98%). The total body length was ranged from 11.5 to 22,5 cm (18,72 ± 1,11 cm). The gonadosomatic index (GSI) of females ranged from 0,12 to 9,93 (2,85 ± 2,53) with the highest value in April (6,79 ± 1,53). Based on macroscopic and histological examination of the ovaries of *Mullus barbatus* five different developmental stages were identified. Based on monthly values of gonadosomatic index and histological analysis it was determined that the red mullet, *Mullus barbatus*, is spawning from April to June.

Keywords: *Mullus barbatus*, gonads, histological analysis spawning.

Type of presentation: Poster

BE-P3

Microchemistry fingerprint of three clupeid fish species from South Adriatic Sea (Montenegro)

Alija Kalač[1], Miljan Bigović[1], Ana Pešić[2], Danilo Mrdak[1], **Dragana Milošević[1]**

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Abstract:

Trace elements composition of otoliths can be used as biological tracers to identify fish populations, their migratory environmental histories, and fish stock identifications, also. In this regard, the most marine fish species, economically important species, particularly, have not been sufficiently researched. In order to verify the precise microchemistry fingerprint of two marine, *Sardina pilchardus* and *Engraulis encrasicolus*, and one migratory, *Alosa fallax*, fish species (Clupeiformes, Clupeidae) from Montenegrin waters (South Adriatic Sea), 15 elements in otoliths of 79 individuals were examined. Differences in otolith elemental composition among two marine and one estuarine clupeid fish species, and two marine species, separately, were examined, also. ANOVA indicates the Sr:Ca and K:Ca concentration was significantly different between the three examined fish species ($p < 0.01$). Principal component analysis revealed the Co:Ca and K:Ca ratio significantly differed *A.fallax* from *S. pilchardus* and *E.encrasicolus*. The comparison of otolith microchemistry composition of two marine clupeid fish species showed similar microchemistry fingerprint and significant differences only in Sr : Ca ratio which can be conditioned with different spawning ground areas. According to the results of this study clupeid fish species have the homogenous microchemistry fingerprint except for the elements which are the environmental condition markers. The present data show a typically anadromous profile for *A. fallax* regarding the Sr : Ca concentrations which fluctuate from 0 to 0.25 mg/L, also.

Keywords: Twait shad, European pilchard, European anchovy, trace element, sagittal otolith.

Type of presentation: Poster

BE-O2

Age and growth comparison of surface and subterranean individuals of karstic dace (*Telestes karsticus*)

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Abstract:

Karstic dace (*Telestes karsticus* Marčić and Mrakovčić, 2011) is a stenoendemic freshwater fish that inhabits only a few localities in the area of Velika and Mala Kapela Mountains. It is known that individuals of this species were found in underground watercourses where they were recorded in both low and high water level periods. However, it is unknown whether a two-way migration exists, i.e. whether individuals that reached subterranean watercourse can return back to the surface. This study is a part of a larger investigation whose goal is to determine whether karstic dace forms a permanent cave population. In this study we compared the age and growth of the individuals of karstic dace sampled on the surface and underground watercourses of Sušik stream and sinkhole. Age and growth were determined by analysis of standard body lengths and direct reading of scale rings. The largest number of individuals, both surface and subterranean, belonged to the age class 3+. The average standard body length of the surface individuals was 96.57 mm, and of the underground individuals 106.07 mm. The growth coefficient determined from the von Bertalanffy curve for individuals of the surface population was 0.907, and for individuals of the underground population 0.848. The asymptotic length determined from the von Bertalanffy curve for individuals sampled on the surface was 123.51 mm and for individuals sampled underground was 144.12 mm. Our results show that cave individuals grow to larger sizes although they grow at a slower rate.

Keywords: caves, intermittent stream, sinkhole, Leuciscidae.

Type of presentation: Oral

BE-P4

Transplant caging of seabream (*Sparus aurata*) as a monitoring tool for marine pollution assessment in the Montenegrin Adriatic coast

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Abstract:

More frequent application of biological parameters beside the conventional chemical parameters in national monitoring for marine ecosystem assessment is supported by UNEP/MAP. Accordingly, to evaluate the possible effects of pollution by determination of trace element content and genotoxicity assessment in marine organisms within the Boka Kotorska Bay, Montenegro (southern Adriatic), we carried a field study which included transplantation of the seabream (*Sparus aurata*) from aquaculture farm (Orahovac) to more impacted sites (Dobrota and port of Tivat), situated in vicinity of the main ports. On the sampling site Orahovac, the group of seabream specimens were placed in closed fish trap on 5 m depth (O1), another fish trap was placed in Dobrota, while the third fish trap with seabreams was placed at the site port of Tivat. The additional group was sampled from standard aquaculture cage on sampling site (O2) to reduce possible bias in genotoxicity data due to confined space within the fish trap. After two weeks of exposure, blood from fish heart was taken, afterwards muscle tissues were prepared for trace element determination. Genotoxicity was measured by DNA damage induction based on comet (single cell gel electrophoresis) assay parameter – Tail intensity (TI%), while trace element (As, Cd, Pb, Hg, Cr, Cu, Fe, Mn, Ni, Zn and V) content was determined by ICP. Mean values of TI% obtained from seabream specimens at the sampling site Orahovac were: 4.26 ± 0.17 – O1 and 2.56 ± 0.11 – O2, while TI% values for transplanted specimens on the sites Dobrota and port of Tivat were 6.38 ± 0.17 and 11.06 ± 0.23, respectively. Statistically significant differences ($p<0,05$) of TI% were observed between all specimens groups. The group of seabream from port of Tivat showed the highest TI% (higher level of DNA damage), most probably caused by marine pollution. Obtained trace element concentrations in seabream tissues were significantly lower in comparison to values recommended by FAO, EC and national legislatives of Croatia, Spain and Turkey. Since transplanted fish showed a significant response in a relatively short exposure period, our results support the introduction of seabream caging as monitoring tool to reveal marine pollution by multiple biomarker approach. Considering the significant share of aquacultured seabream in human consumption, higher availability for sampling and convenience in application for molecular biomarker analyses in the same samples, such an integrated monitoring approach would contribute to more credible data.

Keywords: seabream, *Sparus aurata*, caging, transplanted fish.

Type of presentation: Poster

BE-O3

What are the synergistic effects of interannual environmental changes and habitat modifications on juvenile fish communities?

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Abstract:

Continuous embankment has been reported in recent decades along the Adriatic coast. In the same time, environmental changes associated with warming and climate change are evident throughout Mediterranean. Further on, a signs of high fishing pressure are recognized and highlighted on the European level. The eastern Adriatic coast characterised by numerous bays, coves and lagoons represent at the same time a mosaic of different nurseries for a great number of fish species. In the present study, the multivariate analysis was conducted to elucidate the interannual changes of new settlers' occurrence and abundance in different nurseries in relation to interannual environmental differences and habitat degradation due continuous embankment. With that aim, fishing, trophic and taxonomic composition and structure of the community data were analysed. Sampling included sites from estuaries to marine coves and statistically significant interannual differences in temperature were found but not in salinity. However, defined groups expressed significant difference in fish abundance and species richness related to the significant difference in salinity and temperature for the same consecutive years. Settler's delay or retention due negative temperature deviation in spawning period is primarily linked to the northern estuarine nurseries that are under greater coastal influence. Pure marine nurseries at south were less sensitive to interannual temperature fluctuations and mostly defined by salinity influence. The observed community changes in species composition were probably governed by the same pattern since they are reported for specific nursery type. Moreover, the species that mostly contributed to the observed changes were non-commercial, small, benthic resident fishes or those associated with canopy alga for shelter and feeding. The results suggested that major sifting in juvenile fish communities can be expected if the spring is cold and rainy (like in 2019) when late settlement and longer retention of specific fish species were determined due to negative temperature deviation in the spawning period, particularly at the nurseries located in the northern transitional waters that are under a stronger coastal influence and characterised by constant embankment process and marine infrastructure construction. These shifts can have ecological consequences on the population dynamics and inter- and intraspecific relationships within specific nursery 'communities and for sure can influence recruit year-class strength and therefore have a serious impact on fisheries.

Keywords: environmental changes, habitat modifications, fish juveniles, nurseries.

Type of presentation: Oral

BE-P5

Population structure, gonadosomatic index, growth rate, condition index and diet items of grayling, *Thymallus thymallus* (Linnaeus, 1758) from the river Ćehotina, Montenegro

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Abstract:

Grayling is a poorly researched species from the Montenegrin rivers, and the data obtained in this research gives better insight into the biology and ecology of this species which will improve its management. For that purpose, samples were collected from the Ćehotina river at five localities during one year cycle, including all seasons. The following data were collected: total length (TL), body weight (W), gonad weight (GW), sex, and stomach contents. The aim of this study was to examine the variation of condition factor (CF) and diet items by the seasons, length-weight relationship as well as the sex ratio, and gonadosomatic index.

Keywords: Montenegro, Salmonidae, *Thymallus thymallus*, biology, morphometry, ecology, ecological indexes.

Type of presentation: Poster

BE-P6

Diets and Trophic Structure of Fish Assemblages in a Semi-Arid Region of Central Turkey

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Abstract:

Climate change and the introduction of invasive species have drastic impacts on biodiversity and its functioning. They generate ecological impacts that propagate along the food web, particularly in semi-arid regions. Fish assemblages were surveyed in eight lakes in central Turkey with the aim of identifying the trophic roles of fishes and describing the trophic structure of these assemblages. Fourteen species (337 gut content) were analyzed. The trophic structure varied along the different lakes with the relative species richness of fish consuming aquatic insect remains, ostracods, fish remains, vegetal remains, and gastropods. This is based on the Prey-Specific Index of Relative Importance (PSIRI). The omnivory index indicates that most of the species are specialists. Horn's niche overlap index (H) indicated a high overlap between the exotic and native species (H >0.66) in the different lakes. This study describes the feeding habits of fish along the lakes in central Turkey, the first dietary descriptions for 14 species. This knowledge is critical for management and conservation, serving as a baseline in the context of future environmental changes and producing novel evidence on the functioning of ecosystems in this understudied climatic region.

Keywords: Fish feeding ecology, trophic structure, feeding habits.

Type of presentation: Poster

BE-O4

Geometric morphometrics reveals sexual shape dimorphism in bogue *Boops boops* (Linnaeus, 1758) along the eastern Adriatic Sea

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Abstract:

The bogue, *Boops boops*, is one of the most common bycatch species in the commercial purse seine fishery and one of the most important species used as baitfish feed for tuna farming. It also fulfills important ecological roles as it represents an intermediate link between large predators and components of the zooplankton in the marine food web, and mitigates the environmental impacts of fish farms by absorbing much of the particulate waste produced during farming. Although it is a commercially important species in the Adriatic Sea, many aspects of its biology are still unknown. The aim of the present research was to investigate morphological traits of species from natural habitats (WO) and from aquaculture pressured environments (FA), i.e. tuna farms where large populations reside throughout the year. Tuna farms provide additional structural complexity in the water column due to sea cage infrastructure, availability of food through tuna feeding losses, and high hydrodynamic complexity, making them attractive to wild fish. Landmark-based geometric morphometrics were used to analyze body shape and examine allometric patterns of shape change with increases in total length. Although populations differed in size composition, the test for homogeneity of slopes revealed nonsignificant group allometry, suggesting that bogues change shape similarly as they increase in length at WO and FA environments. Phenotypic trajectory analysis revealed the presence of sexual shape dimorphism in bogue along the eastern Adriatic, with males having a deeper body and slightly larger head profile compared to females. Females from FA environments were bulkier compared to females from the wild, while WO and FA males had similar body shape characteristics. Variation patterns in sexual shape dimorphism between and within populations were recorded both in the wild and farm-associated environments. Despite the complex interplay of local biotic and abiotic interactions affecting phenotypic traits of bogue populations in the coastal areas of the eastern Adriatic, shape differences between males and females persist. However, further studies are needed to determine the temporal stability of the observed sex differences in response to climate change and aquaculture-pressured environments.

Keywords: geometric morphometrics, bogue, sexual shape dimorphism, morphology.

Type of presentation: Oral

BE-O5

Feeding ecology of Mediterranean cryptobenthic fish fauna: lessons learnt from clingfishes (Gobiesocidae)

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Abstract:

Cryptobenthic fishes are an important part of the fish community whose role has often been overlooked in the past, but which have the potential to impact the ecosystem due to their high abundance. Recently, many authors have reported on the importance (energy transfer) of cryptobenthic fish species in tropical seas. Despite their importance, the cryptobenthic fish fauna of the Adriatic Sea, as well as the Mediterranean Sea, is generally poorly understood, especially with respect to their feeding ecology. This is especially true for the family Gobiesocidae, which is one of the least known fish families of the Mediterranean. Knowledge of feeding habits gives us insight into ecological processes at the level of individuals, populations, and communities. Understanding such feeding relationships is very important as it could reveal different strategies to reduce competition. The aim of this study is to increase knowledge about the feeding ecology of three cryptobenthic clingfish species (*Lepadogaster lepadogaster*, *L. candolii* and *Apletodon incognitus*) occurring in the Gulf of Trieste (northern Adriatic Sea). A method based on faecal pellet analysis was developed to study the diet of clingfish, which does not require sacrificing the fish. Freshly caught specimens were placed immediately after sampling in a specially designed box for collecting faecal pellets, which was supplied by an aerator. Fish were left in the chambers for 24 hours to defecate. The faecal pellets were carefully removed and fixed in 70% alcohol. The contents of the pellets were then analysed under a stereomicroscope. Faecal pellets were obtained from 96.9% of all studied specimens. Examination of the diet showed that all three species were opportunists whose main prey were crustaceans. Among them, benthic copepods, amphipods and decapods were the main prey groups. The Bray-Curtis dissimilarity index showed that the greatest overlap in diet was between *L. candolii* and *L. lepadogaster* and the least between *A. incognitus* and *L. lepadogaster*. In terms of diet composition, *L. lepadogaster* had the highest TROPHs index, followed by *L. candolii* and *A. incognitus*. The method of collecting faecal pellets immediately after defecation has proven to be a useful and effective non-lethal method for studying the diet of clingfish.

Keywords: clingfish, feeding ecology, faecal pellet, Gulf of Trieste.

Type of presentation: Oral

BE-P7

Ichthyofauna of the salt marsh Palud – Palù (Istria, Croatia) - summer aspect

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Abstract:

Special ornithological reserve Palud – Palù is a saltmarsh wetland of antropogenic origin located on the west coast of Istria near the sea, about 8 km southeast of Rovinj. This important part of protected areas in Istria covers about 18 ha and is one of the few remaining coastal wetlands on the eastern Adriatic coast. This natural depression has turned into a wetland due to the rainwater inflow from the surrounding area and springs in the northern part. It is connected to the sea by the Austro-Hungarian army in 1906 by digging a 200-m canal in order to prevent the development of mosquito larvae that were carriers of malaria by increasing the salinity of the water. As result the wetland has become more brackish, and over time increasingly saline to its current hypersaline state (> 45 ppt). Wetland is a very valuable habitat primarily for wading birds as a nesting, resting and feeding area during migrations. The analysis of the available data shows no systematic and comprehensive research of ichthyofaunistic values. During the project "CREW – Coordinated Wetland Management in Italy – Croatia Cross Border Region" (Project ID: 10044942) a preliminary inventory of fish fauna was made. Sampling of fish was performed during July and August 2021. In the study of the composition, biomass and structure of fish communities, experimental fishing was performed using small coastal seine nets, hand nets and fish traps. The presence of 6 species has been recorded; 3 from the family Mugilidae – *Mugil cephalus*, *Chelon saliens* and *Chelon auratus*, as well as *Sparus aurata*, *Gambusia sp*. and *Anguilla anguilla*. Gambusia was the most numerous with 67% in the total number of catches, followed by *Ch. saliens* (18.77%), *M. cephalus* (9.83%), *Ch. auratus* (4.34%), while *A. anguilla* and *S. aurata* were presented with 0.12%. Juvenile stages predominated in the fish communities of mullets indicating wetland as important feeding and nursery habitat. Record of *A. anguilla* is rare finding of this species in such saline habitat conditions on the eastern Adriatic coast. Although there are few species, the wetland ichthyofauna is of dynamic composition since the mullet populations show periodic day – night migrations to the sea, while gambusia is a permanent resident. In a broader ecological sense, although the composition of fish communities in the wetland is not natural, it is of special importance for the ichthyophage bird fauna and as such is necessary to maintain their nesting and migrating populations.

Keywords: hypersaline conditions, fish communities, changing environmental conditions, Mugilidae.

Type of presentation: Poster

BE-P8

Fish assembleges associated with floating marine litter along eastern Adriatic Sea coast, Croatia

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Abstract:

The abundance and diversity of mostly juvenile fishes associated with plastic macro-litter floating by wind and surface currents were observed during last two decades by using visual census as an experimental tool in the nearshore and open waters of the eastern Adriatic Sea, Croatia. Ten fish species belonging to six families were identified associated with floating litter. Most of the specimens observed were juveniles suggesting the importance of floating objects as a nurseries, and thus in the recruitment and redistribution of young fishes. Marine litter represent a matter of growing concern for the Mediterranean Sea due deeply altering the structure of native communities. However, the role of floating marine litter as habitat/shelter or as a dispersal agent for fishes have received relatively little attention. Results from the present study suggest that fishes opportunistically use whatever habitats as shelters are available in pelagic environments where substrates are scarce. The Mediterranean Sea is one of the most polluted seas worldwide, especially with regard to plastics. The vast quantities of floating anthropogenic debris, comprised primarily of non-biodegradable plastic polymers, probably will augment natural floating substrates in marine environment and include large effects and interactions with species exposed to massive litter quantities. Local Ecological Knowledge (LEK) of traditional fishermen and people who are often on the sea are very valuable source of information regarding the fishes associated with floating marine litter.

Keywords: floating marine litter, plastic pollution, fish aggregation, Adriatic Sea.

Type of presentation: Poster

BE-O6

Tracking northward expansion of groupers (genus *Epinephelus*) in the eastern Adriatic (Croatian coast) using the Local Ecological Knowledge (LEK) of recreational and sport fishermen

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Abstract:

Groupers are considered important top predators that are threatened by the impacts of extensive fishing. They are also important commercial fishes and valuable trophies in recreational and sport fishery. The most widespread species in the Adriatic, the dusky grouper (*Epinephelus marginatus*), is known to inhabit rocky reefs in the waters of the southern and central Adriatic, while other species have historically been mostly restricted to its southern part. More recently, probably due to the effects of climate change, some grouper species have expanded their range and are now found throughout the eastern Adriatic. This expansion has not been adequately documented because conventional research methods have rarely addressed rocky coastal habitats, which are rarely used by commercial fisheries and therefore are not the focus of frequent fisheries monitoring programmes. Instead, such areas are frequently fished by recreational and sport fishermen, and the hypothesis of recent grouper expansion has been perceived primarily through anecdotal and unsystematically collected evidence. Using citizen science, news portals and social media we attempted to trace the process of expansion of groupers in Croatian coast of the eastern Adriatic. The LEK study was undertaken using semi-structured interviews to record fishers' knowledge about the perception of changes which occurred in relation to their catches and personal observations. The data included in this study shed light on the fishers' perception of the spatial and temporal expansion of groupers over the last 60 years in the eastern Adriatic area.

Keywords: northward expansion, recreative fishery, thermophilic native species.

Type of presentation: Oral

BE-P9

Reproductive biology of four-spot megrim *Lepidorhombus boscii* (Risso, 1810) from the eastern Adriatic Sea

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Abstract:

The reproductive parameters of the four-spot mergim *Lepidorhombus boscii*, collected by bottom trawls along the eastern Adriatic Sea were analysed by studying the seasonal macroscopic and histological changes of the gonads, fecundity and other various features related to reproduction. In total 1070 individuals were collected, from which 507 were females (47.38%), 455 males (42.52%) and 108 individuals of undetermined sex (10.09%). The total body length was ranged from 12.5 to 34.4 cm (20.02 ± 3.21 cm). Based on monthly values of gonadosomatic index and histological analysis it was determined that the four-spot mergim is spawning in November and March. Spawning period in females was characterized by the increased number of oocytes in migratory nucleus or hydrated stage with the oocyte diameter ranging from 0.003 to 0.101 mm (0.012 ± 0.021 mm) and in males with the abundance of spermatozoa. This study presents first information on the reproductive cycle of *Lepidorhombus boscii* in the eastern Adriatic Sea and contributes to understanding of the biology of this species necessary for its future stock management.

Keywords: *Lepidorhombus boscii*, gonadal development, maturity, gonadosomatic index, Adriatic sea.

Type of presentation: Poster

BE-P10

Feeding habits of four-spotted megrim, *Lepidorhombus boscii* (Risso, 1810) from the eastern Adriatic Sea

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Abstract:

The feeding habits of the four-spotted megrim, *Lepidorhombus boscii* from the eastern Adriatic Sea were analysed. Stomach contents of 1070 specimens, 507 females and 455 males from 12.5 to 34.0 cm of total length (Lt), were studied. The samples were collected by the bottom-trawl net from July 2020 to June 2021. Percentage of empty stomachs was 63.27%. The analysis showed that four-spotted megrim is a carnivore. Moreover, it was found that there is no statistically significant difference in the food composition between seasons and sex. Three groups of prey were found in the analysed stomachs: Pisces, Crustacea and Mollusca. According to the number of prey, Crustacea and Mollusca were dominant, while Pisces was the least represented group. The essential foods were Crustacea (IRI = 5338.98; MFI = 2336.27; Q = 2496.33), Mollusca (IRI = 979.72; MFI = 570.36; Q = 551.17) and Pisces (IRI = 397.78; MFI = 193.21; Q = 188.91). Among Crustacea, the most important food were species *Parapeneus longirostris* (IRI = 1028.66; MFI = 491.03; Q = 482.71), *Goneplax rhomboides* (IRI = 530.60; MFI = 205.18; Q = 204.84) and *Anuropodione amphiandra* (IRI = 119.752); Q = 68.87), and *Alloteuthis media* (IRI = 333.42; MFI = 203.52; Q = 198.88) within the group of Mollusca. All other prey species found in stomachs were secondary food. Crustacea was the most important prey group for both sexes in all seasons. Pisces and Mollusca are most important for both sexes in autumn and winter, while in spring and summer they are secondary food.

Keywords: diet analysis, seasonal variation, *Lepidorhombus boscii*, Adriatic sea.

Type of presentation: Poster

BE-P11

Fecundity estimation of two Lessepsian migrants, *Pterois miles* and *Etrumeus golanii*, from the Eastern Mediterranean Sea (Aegean Sea, Greece)

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Abstract:

Biological invasions are considered as a global-scale threat, which can lead, among others, to the disruption of food webs, habitat alternation, and are able to negatively impact ecosystem services with a resulting economic loss. Apart from the cornerstone role of climate change to aquatic invasions, a key component that enables the rapid progress of non-indigenous species (NIS) are anthropogenic pressures (e.g., corridors, ballast water, fouling). Since the opening of the Suez Canal, the Mediterranean Sea has received more than 140 fish species of Indo-Pacific origin (i.e., Lessepsian migrants). In order to understand the invasive potential of NIS, their impacts on biodiversity and ecosystem services, as well as the exploration of mitigation measures, knowledge of their biology is a perquisite. Fecundity, though an important life-history trait in all aspects of fisheries biology and management, has been found as a largely understudied. Towards filling in information gaps, we present results on the fecundity of two wide-spread Lessepsian fish species, the devil firefish, or lionfish, *Pterois miles*, and Golani's round herring *Etrumeus golanii*, from the Eastern Mediterranean (Aegean Sea) in order to explore their reproductive potential effort. For the purposes of estimating fecundity, 14 and 23 individuals of *P. miles* and *E. golanii*, respectively, were examined, using the gravimetric method. Thus, three gonadal subsamples (i.e., anterior, core, posterior) from mature female individuals of each species were used. In specific, our analyses showed that there was not any statistically significant difference between the observed number of oocytes in the three extracted subsamples (ANOVA: $p>>0.05$; Tukey's HSD: $p>>0.05$). The average and standard error (±) of the absolute fecundity (F_{abs}) of *P. miles* and *E. golanii* was estimated at 93623 ± 41222 and 13801 ± 5595, respectively. The allometric relationship between the F_{abs} and the gonadal weight (GW) was positive and statistically significant for both species (*P. miles*: $F_{abs}=6836*GW^{1.083}$, $R^2=0.5$, $p<<0.05$; *E. golanii*: $F_{abs}=2845*GW^{0.95}$; $R^2=0.81$, $p<<0.05$). Moreover, the F_{abs} and total length relationship exhibited an increasing trend until a certain maximum threshold (*P. miles*: 26.4 cm; *E. golanii*: 23.4cm). The aforementioned results can be used for the investigation of the invasive species reproductive dynamics as an intermediary tool for the effective monitoring and successful management of the understudied Lessepsian fish species. This study was undertaken in the frame of the project 4ALIEN: *Biology and the potential economic exploitation of four alien species in the Hellenic Seas*, funded by the NRSF 2017-2020 (MIS (ΟΠΣ): 5049511).

Keywords: Lessepsian species, reproduction, fecundity estimation, Mediterranean fishes.

Type of presentation: Poster

BE-O7

Temperature unravels the variability in life-history traits observed between non-indigenous and native fish species in the Mediterranean Sea

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Abstract:

Marine non-indigenous species (NIS) represent a serious ecological threat that may cause significant habitat alterations, distributional shifts of native aquatic species, along with quantitative and qualitative losses in the ecosystem services. The introduction, and the subsequent establishment of NIS to new areas have been attributed to various factors, such as climate change and anthropogenic maritime activities (e.g., shipping and aquaculture). In the present study, we investigated the variability patterns of life-history traits between NIS and native fish species (MED) of the Mediterranean. We gathered data from FishBase on 13 life-history traits of 343 MED and 107 NIS fishes, which cover all the aspects of a fish species' biology: 1) Maximum length, 2) k coefficient, 3) Life span, 4) Age at maturity, 5) Length at maturity, 6) parameters a and b (7) of the length at weight relationship, 8) Generation time, 9) Trophic level, 10) Asymptotic length and 11-13) Minimum, mean and maximum temperature of preference. Species with a full dataset of the 13 traits were included in subsequent analyses. We standardized (i.e., zero mean value; standard deviation equals one) the aforementioned trait data and we estimated the variance (σ^2) of each trait at the family level, to explore the range of preference per family for both groups of species (i.e., MED/NIS). We explored whether there was difference in trait variability between groups: i) in the whole dataset and ii) in the dataset containing only common families (i.e., occurrence in both groups) via non-parametric statistical procedures. Following the (i) and (ii) approach, mean and maximum temperature were the only statistically significant variables when comparing the two groups. NIS species exhibited higher values of mean and maximum temperature, but with narrower variance range, compared to MED species. Subsequently, NIS may be considered as more competitively advantageous due to their preference in higher temperatures, also showing narrower temperature range in comparison to their native counterparts under a changing climate scenario. Surprisingly, the other traits examined did not show any difference between groups, thus highlighting the importance of temperature as a crucial parameter shaping the distribution of species under shifted environmental regimes; a finding in line with the ongoing temperature increase in the Mediterranean and its subsequent tropicalization. This study was undertaken in the frame of the project 4ALIEN: Biology and the potential economic exploitation of four alien species in the Hellenic Seas, funded by the NRSF 2017-2020 (MIS (ΟΠΣ): 5049511).

Keywords: Non-indigenous species, fishbase traits, variance analysis, Mediterranean fishes.

Type of presentation: Oral

BE-P12

Can spatial differences in geochemical composition of water and fish otoliths indicate different juvenile growth during settlement period?

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Abstract:

The gilthead seabream, *Sparus aurata* is one of the most studied and commercially important fish species in the Mediterranean Sea, both for the aquaculture and fisheries purposes. In the Mediterranean, it is known that *S. aurata* performs ontogenetic and trophic migrations between coastal habitats, mostly between lagoons and the open sea. This migration is associated with spawning, settlement and recruitment. Juveniles colonize sheltered coastal areas in early spring to feed and grow during their critical first summer of life before migrating out to open sea in the autumn. In this study, newly settled juveniles of *S. aurata* were collected by beach seine net on two locations (estuary of river Pantan and river Jadro) in the eastern Adriatic. These sites are located in Kastela bay with the distance of 16 km between sites. They hydrologically represent similar water types in the Adriatic Sea, exhibiting variable salinity gradients during the year with a muddy-sandy bottom partially overgrown with *Zostera marina*. Sampling was carried out each week from beginning of May to end of June during 2021 following settlement process. Upon collection fish were kept frozen and transported to the lab were the length and weight of each specimen were measured, the otoliths have been extracted, cleaned and prepared for transverse sections through the otolith core with a low-speed saw. On the predetermined sections of otoliths, laser ablation inductively coupledplasma mass spectrometry (LA-ICP-MS) with mass spectrometry were used toquantify concentrations of chemical elements along maximum growth rates andisotope concentrations. Among them, concentrations of Zn, Na,Mg, Sr, Ba, Mn, Li showed differences between the individuals and sites. The concentration of Ba was greater on Pantan site while significant concentrations of Sr were observed on both sides. Concentrations of Sr were higher on Pantan and during the sampling period, at Jadro gradually rise to meet Pantan levels of Sr. On Pantan site, two clear age classes are defined and growth of the smaller individuals were clear within sampling period. In terms of weight, the two age classes seem to differ evenmore, with greater growth slope recorded for the younger class. These could indicate a difference in the ability of the fish to take advantage of the specific habitat possibilities during intensive growth period. The results also represent the geochemical differences between juveniles from different sites. Theycan show how seemingly small differences in habitats that are spatially close can have a completely different outcome on the growth of the juvenile fish and indicate relative importance and contribution of estuarine nurseries to the local fish stocks along the eastern Adriatic coast.

Keywords: otolith chemistry, estuarine nurseries, *Sparus aurata*, Adriatic Sea.

Type of presentation: Poster

BE-P13

The three-spined stickleback populations of Southeast Europe: variations and stability

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Abstract:

The Mediterranean basin, and particular the Southeast Europe region, is known to harbour ancient purely freshwater populations of the three-spined stickleback (*Gasterosteus aculeatus*). The colonization of freshwater habitats in the Adriatic, Ionian and Aegean basins by this species occurred before the loss of the common marine ancestor in these seas, thus ending gene flow between them and effectively isolating these populations, often to a single river catchment. These isolated freshwater populations exhibit a high degree of morphometric diversity, despite the general similarity of habitats, while other traits remain stable across the Mediterranean distribution range. Numerous hypotheses have been posed to explain this diversity, from geographic position to environmental factors to genetic diversity, however, the origin of this diversity and the evolutionary ecology of these populations remains unclear. We examined the morphological traits of 26 freshwater populations of three-spined stickleback in the Adriatic, Ionian and Aegean Basins, and an outlier population in the Tyrrhenian Basin and examine the similarity and diversity of phenotypes in these similar habitats across this region and discuss the findings in the context of standing genetic variation.

Keywords: *Gasterosteus*, Mediterranean, phenotype diversity, morphology.

Type of presentation: Poster

SESSION IV – BIODIVERSITY AND CONSERVATION

BC-O1

Dubrovnik aquarium as conservation center for Adriatic biodiversity

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Abstract:

Dubrovnik aquarium was founded in 1953 as part of the Institute. In 2020 Institute for Marine and Coastal Research as Lead partner started the reconstruction of Dubrovnik aquarium as part of the EU project. The aquarium is designed as public aquarium and conservation center. Its mission is to promote global sustainability through the promotion and practice of effective conservation of the wildlife of the Adriatic Sea. Aquariums Dubrovnik provides fun-filled leisure and entertainment activities that double-up as centers for animal rescue, care and rehabilitation, scientific research, education and conservation. Aquariums contribute to ocean conservation in a variety of ways including but not limited to marine animal rescue and rehabilitation, coral reef rebuilding, wetland restoration, sustainable seafood programs, beach clean-up events, and sea turtle monitoring. Aquarium Dubrovnik became a sanctuary for sea turtle rescue, rehabilitation, and release more than 20 years ago, and has been telling their stories ever since. The turtle program is our cornerstone conservation program, calling attention to critical issues impacting wildlife and people, including climate change and plastic pollution.

Keywords: sustainability, rehabilitation, climate change, plastic pollution.

Type of presentation: Oral

PL4

We watched them spread, invade and become part of us - overview of alien fish in Turkey

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Abstract:

Approximately 16% of the Turkish marine ichthyofauna is composed of alien species originating mostly from the Indo-Pacific Ocean and the Red Sea - a ratio doubled within the last two decades, as a pure indication of the unprecedented increase of introductions. Ongoing research is skewed towards recording new species introductions and range expansions, which provides a close and timely monitoring of their dispersal capabilities, while costly and laborious bio-ecological research is extremely limited to a few examples. Therefore, a good understanding of the magnitude of the multifaceted impact of alien fish has not yet been achieved, which is required for the efficient prioritization of actions for developing mitigation measures. This presentation will focus on the ecological, socioeconomics and human health impacts of notable alien fish based on experience gained from the Turkish coastline. The varying invasive species perception among different segments of the society will also be discussed.

Keywords: Alien fish species, eastern Mediterranean Sea, established taxa, invasion impacts.

Type of presentation: Oral

BC-P1

Distribution and community structure of juvenile fish populations in the inner shallow areas of Medulin Bay

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Abstract:

In the southernmost part of Istria, next to Rt Kamenjak, there is a protected area of Medulin Bay that belongs to the Natura 2000 network (HR3000173). The inner part of bay is a shallow coastal area with several closed bays rich in fresh water sources. In the most indented part, Pomer Bay (HR3000174) stands out as a highly productive area where any form of fishing is prohibited by a special regulation. In order to obtain data on the composition, abundance, biomass and structure of fish communities, sampling of juvenile fish was carried out at four locations (Šćuza, Bijeca, Vižula, Tašalera) in September 2021 using the small coastal trawl net (length 50 cm, height 30-250 cm, mesh size in the central part 4 mm). In order to make the sampling as representative as possible, 3 replicas were carried out at each location. 30 species from 15 families were recorded, and a total of 2,223 individuals, with a total weight of 5,266.81 g, were caught. As expected, Šćuza Bay stands out for the largest number of individuals (1,222 individuals) and the highest biomass (2,973.08 g). In relation to the biodiversity, the Vižula site stood out with the highest number of species (20 species from 12 families). This site is characterized by more diverse habitat features which supports a greater abundance and variety of species. The structure of fish communities was characterized by the predominance of a small number of species in total number and biomass. The most numerous species at all locations was big-scale sand smelt (*Atherina boyeri*) (55.33%), which shows that its occurrence is not conditioned by the type and peculiarities of the habitat. The obtained results undoubtedly indicate the exceptional importance of the studied bays as nursery areas of juvenile fish before moving to deeper waters and joining adult populations.

Keywords: Natura 2000, Pomer Bay, nursery areas, habitat differences.

Type of presentation: Poster

BC-P2

Shell length comparison of two samples of rare deep-sea bivalve mollusc *Idas simpsoni* (Marshall, 1900) from middle and south Adriatic Sea

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Abstract:

A small population of the whale bone-associated, deep sea bivalve *Idas simpsoni* was recovered on the maxillar bone of a fin whale *Balaenoptera physalus*, trawled up near the island of Vis in the middle Adriatic Sea from the depth of 120 m. In this paper basic biometric and population structure of forementioned species is presented. The data acquired from this population is compared to set of data from previous finding of *Idas simpsoni* trawled in 2003 off the island of Mljet, south Adriatic Sea, from the depth of 430 m. The comparison showed that there is strong positive statistical relationship between the size of the shell and the depth (F=48,017).

Keywords: whale bone, Mytilidae, chemoautotrophy, island of Vis.

Type of presentation: Poster

PL2

From evolutionary 'highways' to diversification 'blind-ends' – the origin and perspective of exceptionally rich ichthyodiversity harboured inside Dinaric karstic watersheds

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Abstract:

Despite its relatively small area, habitats, ecosystems and species found in Croatia express exceptionally high levels of diversity. This biodiversity reaches its peaks particularly in freshwater systems. Namely, with around 140 presently recognized freshwater fish species, Croatia harbours one of the richest ichthyofauna in Europe and not many places in the world are inhabited by as much fish species as are karstic watersheds in southeast Europe. The paradox on the greatest richness of the fish species living in one the harshest freshwater environments is still not fully understood. The diversity and richness of the freshwater biota in Croatia is usually explained by division of Croatian waters into two watersheds (Adriatic and Black Sea watersheds) that express different geological, hydromorphological and ecological conditions. Nevertheless, in order to better comprehend origin, but also future of the exceptionally rich fish communities in karstic watersheds, we need to dive deep into the past and search for evolutionary pathways and phenomena that were provoked by complex geologic history of this area and shaped the ichthyodiversity that we can admire today. Fortunately, by recently conducted molecular genetic investigations, we were able to shed at least some light on the evolution of the freshwater fishes in Dinaric water systems. From almost 30 million years ago, the period when the whole southern Europe was an archipelago, through Dinarids upwelling, freshwater systems appearance and evolution, fluctuations in the Adriatic Sea water level, up to the Pleistocene interchange of glacial and interglacial periods and current days Earth landscapes, severely influenced by anthropogenic activities, we were able to trace evolutionary histories of several freshwater fish species and genera, whose developments were inseparably connected with Dinaric karstic watersheds. From *Aulopyge huegli*, whose evolutionary history comprised more than 20 million 'years of silence' to genus *Squalius* that colonized this area on three distinct occasions; from genera *Telestes* and *Delminichthys* that originated in this region to the genus *Salmo*, that colonized Dinaric watersheds from other sources, but became the most extraordinary here (for example, *S. obtusirostris* or *S. farioides*); from exceptionally high genetic diversities comprised inside *Cobitis dalmatina* or *Telestes turskyi* to populations that comprise genetic material of more than a single species - all 'shapes and colours' of evolutionary trajectories and phenomena, diversification events and speciation modes and phases left their trace in the recent diversity of freshwater fish in this ichtyological 'hot spot'. Although we have methods and capabilities to discover their pasts, the question on their future perspectives, even though highly depending on our activities, remains unrevealed.

Keywords: Evolutionary history, Ichthyodiversity, karstic watersheds, speciation.

Type of presentation: Oral

BC-O2

First insight into the genetic diversity of Sterlet (Actinopterygii: *Acipenser ruthenus* Linnaeus, 1758) in Croatia with implications for its conservation

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Abstract:

Sterlet (*Acipenser ruthenus*) is a commercially important species of Euroasian rivers that is threatened by overfishing, habitat modifications, gene pollution and the loss of genetic diversity due to introduction of stocked individuals into natural watercourses. Due to poor regulation and slow implementation of conservation measures for this species throughout years and its range, Sterlet is now facing extinction as it was listed as a vulnerable species on the IUCN Red List of Threatened Species. In order to develop effective conservation measures for Sterlet populations in Croatia, we conducted this research to ascertain genetic diversity and population structure. By applying genetic analyses based on mitochondrial gene for cytochrome *b* (cyt *b*) of 27 individuals collected in Sava River and obtained from Fish farm Kupa, we defined phylogenetic status and described intraspecies diversity of wild Sava River populations and stocked population. Apart from investigating genetic diversity, we had also assessed the current distribution of Sterlet in rivers of the Danube basin in Croatia. In addition to sequences of individuals collected at the sampling sites and fish farm, analyzes included sequences from the Gen Bank repository. Phylogenetic reconstruction was performed using two methods, maximum parsimony (MP) and maximum likelihood (ML), along with median-joining (MJ) algorithm which resulted in phylogenetic network. Finally, intraspecific diversity was measured and approximated for both wild and stocked populations. Investigation of Sterlet distribution in Danube basin in Croatia confirmed the presence of Sterlet in Sava river, but we did not detect or confirm its presence in Mura and Drava Rivers. Given the plethora of threats in the entire range of this species, as well as the disappearance of other members of Acipenseridae family in Croatia, we identified Dubrovčak and Prevlaka localities as habitats of particular importance for Sterlet populations due to high population abundance. On the other hand, sequencing of cyt *b* gene revealed 12 different haplotypes, with great variation of haplotype frequency between wild and stocked populations. Also, intraspecific genetic diversity revealed unexpectedly high variety of this species in Sava, making this river a gene reservoir. This discovery can be useful for future conservation and management efforts which might entail stocking and augmentation with native haplotypes in order to achieve stable and viable populations throughout the Danube basin in Croatia, since the current gene diversity in stocked population is almost not existent.

Keywords: Sterlet, genetic diversity, mtDNA, conservation, Danube basin.

Type of presentation: Oral

BC-P3

The impacts of alien fish species on NATURA 2000 sites in Croatia

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Abstract:

Alien, exotic, introduced or non-native species impose strong negative impacts on biological diversity, causing declines in abundance and distribution, and ultimately the loss of native species. Fresh waters are particularly sensitive to the introduction of alien species due to their small surface area and strong anthropogenic influence, and the freshwater fish are among the most threatened groups. In Croatia to date, about 20 alien freshwater fish species are known to have successfully adapted to these habitats and established self-maintaining populations in the wild. Among the alien species, certain invasive alien species have been classified as species of Union concern (IAS). In addition to alien species, a growing problem for freshwater ichthyofauna is the translocation of native species between different rivers, biogeographic regions or river basins. One way to protect species and habitats is to declare an area as part of the NATURA 2000 ecological network, thus entering into the European network of protected areas. In Croatia, 69 protected areas of the ecological network have been declared in which freshwater fish are the target species. However, it remains unknown how many alien and translocated species inhabit a particular protected area of the ecological network and their impact on the target fish species, and on other protected fish species. The aim of this paper was to analyse the status of populations of alien and introduced fish species in NATURA 2000 areas where freshwater fish are the target species. Further, the impact of alien and introduced species on the target species was assessed, and future trends in their presence and spread predicted. An overview of the trends of impacts of alien and introduced species is given.

Keywords: exotic fish, species introduction, ecological network, protected areas.

Type of presentation: Poster

BC-P4

Online survey and citizen science provide insight into distribution of *Squatina squatina* in the eastern Adriatic Sea

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Abstract:

In recent years, efforts to conserve elasmobranch species have revived the interest in this diverse and important group of fishes. *Squatina squatina* is a critically endangered species with severely depleted population in the eastern Adriatic Sea. Historically, this species has been relatively abundant throughout the Adriatic Sea with Northern Adriatic being notable for the high amounts of landing of this species. Motivated by the scarcity of data on *S. squatina* and the need for urgent measures aimed at conservation of this endangered animal, we employed an online survey in order to investigate fishermen knowledge on the recent status and geographical distribution of *S. squatina* in the eastern Adriatic. A total of 367 fishermen participated in the survey and provided information on both recent and historical catches and sightings of the species. In addition, we present new records of this species brought to the attention of scientist by fishermen and citizens. Both data sources consistently indicate the hotspot of *Squatina squatina* in the relatively small area of the central Adriatic and the presence of female specimens bearing well-developed pups, as well as the presence of juveniles and newborn specimens, underline the importance of this area for this emblematic species.

Keywords: elasmobranchs, conservation, local ecological knowledge.

Type of presentation: Poster

BC-O3

Functional ecology of four invasive Ponto-Caspian goby species

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Abstract:

Among the most invasive freshwater fish species in Europe, there are Ponto-Caspian gobies, small freshwater and brackish water fish that have been rapidly spreading since the end of the previous century. They have already invaded main European river systems, i.e. the Danube, Rhine, Moselle, Meuse, Vistula, Elbe, Nemunas, Neva, Volga, and established in large and small rivers, streams, dam reservoirs, lakes, and artificial canals. While the round goby Neogobius melanostomus, the most wide-ranging and the largest in size among them received a lot of scientific interest, much less is known about the other gobies of the same origin that almost at the same time expanded in many European waters. These are Proterorhinus semilunaris, Ponticola kessleri, Babka gymnotrachelus and Neogobius fluviatilis. There are 17 countries where at least one of these four goby species has been recorded as alien species. The contribution of given goby species to local fish assemblages varies depending on the site, type of habitat, duration of established population, and presence of co-occurring fish species. Considering their wide invasive range distribution, variety of occupied aquatic environments, abundance, and frequency of occurrence based on our studies and revision of published papers we assessed the ecological impact of four P-C gobies: monkey, bighead, racer, western tubenose goby on co-occurring species both native or non-native. We summarised their role and place in the trophic web in invaded ecosystems: as predator, prey of piscivorous species, competitor, host or vector of parasites.

Keywords: biological invasions, Gobiidae, impact, alien species.

Type of presentation: Oral

PL6

Nature protection and ecosystem resilience: what have we learn from a catastrophic underwater volcanic eruption?

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Abstract:

Natural hazards are not uncommon in marine ecosystems. Recently, we have observed intense volcanic activity in the western part of the Canary Islands (Spain). In October 2011, an underwater eruption occurred on the southern coast of El Hierro Island. The large amount of gases emitted during the eruption created a sulfurous volcanic plume that caused large invertebrate and fish mortalities. This catastrophe affected the Mar de Las Calmas area, which includes a well-established, 24-year, marine protected area. We used this catastrophic event and 25-year time series data from Punta de La Restinga-Mar de Las Calmas Marine Reserve (PRMC-MR) to test the resilience of the commercial fish species to the mass mortality caused by the volcanic eruption. We considered resilience as a sequential process and partitioned it into (1) *resistance* or the ability to absorb the impact, (2) *course* or trajectories of recovery, and (3)*recovery* as the ability to restore a similar fish community 8 years after the volcanic impact ceased. Here, we demonstrate that the no-take zone can boost the resilience of commercial fish communities. This result was mainly due to the total fish biomass in the no-take zone that was resistant, had a positive course and had recovered from the perturbation. The fish community had not recovered to the prevolcanic state 8 years after the eruption. This was probably due to the contrasting return times of fish with different life histories. While the parrotfish *Sparisoma cretense* recovered and even surpassed its prevolcanic biomass within the first year after the eruption, the dusky grouper *Epinephelus marginatus* still had not yet reached its pristine biomass. We provide the first empirical evidence to date of the usefulness of no-take zones in promoting ecological resilience against underwater volcanism.

Keywords: Marine Protected Areas, Natural Hazards, underwater vulcanism, ecosystem resilience.

Type of presentation: Oral

BC-P6

G-BiKE: a network of researchers and practitioners harnessing genomic biodiversity knowledge for resilient ecosystems

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Abstract:

Life began in water, but the world's oceans and river systems are nowadays heavily impacted by the effects of climate change driven by century-long intense anthropogenic pressures. Due to the continuous degradation of ecosystems, the global biodiversity level plummeted, resulting in the history-worst biodiversity crisis. An overwhelming amount of scientific data points out that resilient ecosystems are vital for preserving ecosystem services needed to sustain all life on Earth. In a rapidly changing environment, ecosystems' resilience ultimately depends on species adaptability. Although many documents and indicators deal with halting the decline of species number, genetic diversity, one of the main pillars of biodiversity, is often overlooked and omitted from implementing conventions and directives for biodiversity conservation and climate change mitigation. Therefore, urgent, explicit, and committed consideration of genetic variation and functioning gene flow in species is needed in the post-2020 framework. Such actions should be built upon existing knowledge, data, resources, and technologies and by applying a multidisciplinary approach. This was the very rationale for establishing the G-BiKE (https://g-bikegenetics.eu/en), a scientific network funded by the EU H2020 Research Program through COST (European Cooperation in Science and Technology). G-BiKE (Genomic Biodiversity Knowledge for Resilient Ecosystems; CA18134) currently includes more than 120 researchers and practitioners from 42 countries. Its main scope is to create a large pan-European community of conservation practitioners and scientists to bring genetic diversity to the forefront of future biodiversity policies and practices. G-BiKE aims to assist scientists and practitioners across Europe and beyond in integrating genetic knowledge into conservation planning policies and promoting cross-border management to ensure the persistence of populations and species and, ultimately, the continued supply of nature-based ecosystem services. G-BiKE operates through five Working Groups: Implementing genetics into management, Monitoring of genetic diversity, Genomics and ecosystem services, Biotechnological assessment, and Knowledge sharing. Recognizing the need to raise awareness across different stakeholder groups, G-BiKE organizes specific Workshops, Training Schools, Short Term Scientific Missions and publishes scientific papers and Policy Briefs. G-BiKE community is committed to installing genetic diversity into policies, monitoring and management integrated into the EU Biodiversity Strategy, Habitats Directive, and CBD post-2020 strategy.

Keywords: COST action, genomic diversity, resilient ecosystems, researchers, practioners

Type of presentation: Poster

BC-O4

Insights into Climate Change Effects on Fish Biodiversity in the Semi-Arid Konya Closed Basin, Turkey

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Abstract:

Current and projected patterns of global climate change are one of the important concerns for freshwater fish biodiversity in Turkey. The magnitude of the impacts of climate change varies among species and ecoregions. The Konya Closed Basin is located on the central Anatolia plateau. The basin can be classified as a semi-arid region with a high risk of desertification. Although the freshwater potential of the basin is low, KCB has great fish endemicity compared to the other basins of Turkey and European countries, with 28 endemic species out of a total of 38 fish species. The average annual temperature increase in Turkey is predicted to range between 1 °C and 2.5 °C from 2016 to 2040, 3 °C and 5 °C from 2041 to 2070 and 3.5-4 °C and 6-7 °C in the years from 2071 to 2099 under the RCP4.5 and RCP8.5 scenario projections (Ministry of Agriculture and Forestry, 2016). For the interior regions of Turkey, like KCB, the increase would be greater in the winter. Climate change will affect water temperatures and alter stream flows and water levels, which then lead to water quality changes. These changes will have a significant impact on the distribution and survival of freshwater fishes in KCB, which are already stressed due to irrigation water abstractions and other ecological processes. In this context, we evaluated the possible effects of climate change on the sensitive KCB fish fauna. Most of the endemic freshwater fish species of KCB that are assessed as threatened have very small distribution ranges. Even relatively low environmental stress on these small populations will significantly impact negatively on the whole population and thus the likelihood of survival.

Keywords: climate change, fish biodiversity, semi-arid, Konya closed basin.

Type of presentation: Oral

BC-P7

Three invasive species of south Adriatic, dusky spinefoot (*Siganus luridus*), bluespotted cornetfish (*Fistularia commersonii*) and lionfish (*Pterois miles*)

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Abstract:

In the area of the East side of the southern Adriatic, in recent years we have noted numerous specimens of allochthonous organisms. There are different ways of arrival of these species, but most often it is active migration to the north. Some new species pose potential threat to native species and fisheries in general. These are the dusky spinefoot (*Siganus luridus*), the bluespotted cornetfish (*Fistularia commersonii*) and the lionfish (*Pterois miles*). Species were recorded in the southern Adriatic, as part of fishing or by notification of sport divers. The dusky spinefoot was recorded for the first time in the Adriatic in 2010 near island of Mljet. In the area of the southern Adriatic, where a significant numbers are present, it is hunted in Donji Molunat. In three samples taken with trawler net we noted 121 specimens during October 2016. It is an herbivorous species that drives domestic species such as salema (*Sarpa salpa*) into deeper waters. The bluespotted cornetfish was first recorded in 2006 near the island in front of Dubrovnik (Island of Sv. Andrija). It is a carnivorous species that feeds on small fish and juveniles. Till now we have recived six specimens from fishermen. The lionfish that was first observed in August 2021 near island of Vis (Middle Adriatic) and along the Konavle coast near Dubrovnik. It is a carnivorous species that does a great damage in the areas where it occurs by feeding on juveniles. Up to now, the number of finds is dominated by dusky spinefoot and trumpeters, while the lionfish has been recorded twice. With the change of conditions in the habitats caused of climate changes and possible establishment of their population, it is possible that the number of individuals of these species will increase. That is the reason why it is necessary to organize the informing of the public and the fishermen about those invasive species.

Keywords: Adriatic Sea, new species, *Pterois volitans*, *Fistularia commersonii*, *Siganus luridus*.

Type of presentation: Poster

PL3

The state of art of elasmobranch research in the Adriatic Sea: experiences from the Gulf of Trieste

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Abstract:

The fate of elasmobranchs in the Adriatic Sea and the whole Mediterranean basin is unclear. Due to their vulnerability to fishing pressure they are facing an unprecedented and dramatic decimation in their numbers. Since sharks and rays as apex predators can regulate prey species densities and their distribution, they are considered as suitable indicators of environmental health, however, they are still poorly investigated. The author wish to present the state of art of elasmobranch research in the Adriatic Sea with experiences gained through research performed in its northernmost part and try to propose some options to improve the elasmobranch research and possible conservation measures. During last decades certain elasmobranch species were regularly caught by fishermen as target species and many other as bycatch in local coastal fishery. Among them some rare and less known species were recorded, as well. To this end, it is important to achieve knowledge from all possible and available sources such as the specimens entangled in fishermen nets as bycatch, shark and ray sighthings and to include modern options such as citizen science by applying LEK (local ecological knowledge). During the last decades many interesting facts were discovered in the Slovenian coastal waters and in the northern Adriatic, as well. This shallow area, where the average depth is below 20 m, is characterized by limestone coast at the north and sandstone (flysch) coast at the south. Many neonate and juvenile specimens of sharks (*Mustelus mustelus*, *M. punctulatus*, *Alopias vulpinus*, *Prionace glauca*, *Carcharhinus plumbeus*) and batoids (*Myliobatis aquila*, *Aetomylaeus bovinus*, *Pteroplatytrigon violacea*, *Raja asterias*, *Raja clavata*, *Torpedo marmorata*) were recorded, which confirm the hypothesis that the study area may serve as a nursery for many elasmobranchs. Although the shallow waters of the Gulf of Trieste offer good opportunities for feeding, reproduction and development of young specimens, they also represent a threat for many species. During the last twenty years many cases of large sized shark entanglements in fishermen nets were recorded. Many rare shark species were captured such as *Hexanchus griseus*, *Heptranchias perlo*, *Cetorhinus maximus*, *Gaelorhinus galeus*, *Alopias vulpinus*, *Lamna nasus* and others. Investigations of feeding habits showed that the resident shark and batoid species have different diets, so the competition between them is low. Other discoveries, experienced in the studied area will be presented, as well.

Keywords: elasmobranchs, review, northern Adriatic, state of knowledge.

Type of presentation: Oral

BC-O5

Genetic structure and diversity of the endangered native and invasive alien trout species in the Plitvice Lakes area

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Abstract:

Two closely related species of trout, the Atlantic trout *Salmo trutta* Linnaeus, 1758 and the Danube trout *Salmo labrax* Pallas, 1814, inhabit the Plitvice Lakes area. Until recently, these two species were thought to belong only to two different lineages of the same species, but molecular research has confirmed they are actually two completely different species that evolved independently of each other. One of them, *Salmo trutta*, exhibits greater values of genetic diversity and effective population size, but it is considered an alien species, introduced to this area in the past. In contrast, *Salmo labrax* is native to the Plitvice lakes, and its pure populations, although rare throughout Europe, are still present there but only at few localities and represent the ancient diversity of this evolutionary unit. However, the effective populations of this species are small, with very low levels of diversity, and are threatened by anthropogenic impacts that have led to their genetic contamination. Some of the factors causing negative effects to *S. labrax* populations at Plitvice Lakes are the construction of dams and barriers in areas important for trout spawning (habitat fragmentation, isolation and gene flow restriction), anthropogenic eutrophication (habitat degradation) and the spread of invasive alien species. One such species is the Rainbow trout *Oncorhynchus mykiss* (Walbaum, 1792), which was introduced to and has established stable populations in the Plitvice Lakes area, thereby endangering the populations of other trout species. The cumulative effect of these factors will likely lead to the extinction of endangered populations of *S. labrax*. However, such an outcome can be prevented by applying necessary conservation measures and implementing an elaborate management plan for this area, for which a better knowledge of the genetic structure and diversity of the populations of mentioned three trout species is needed. Through this research I did a phylogenetic reconstruction with mitochondrial and nuclear gene markers for all three species using the methods of maximum parsimony, maximum likelihood and median joining. I also analysed the species' intraspecific structure and diversity by determining basic measures of genetic diversity (number of haplotypes, number of polymorphic sites, total number of mutations, haplotypes diversity and the average number of nucleotide differences) and by estimating the gene flow between individual populations of the same species. The initial results of the research will be discussed at the conference.

Keywords: Danube trout, Atlantic trout, Rainbow trout, population genetics, conservation.

Type of presentation: Oral

BC-P8

MaxEnt Modeling for predicting impacts of climate change on the potential distribution of seven range-restricted fish species in Greece (Trichonis Lake/ Acheloos River Basin-NW Greece)

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Abstract:

Freshwater fishes are predicted to be among the most vulnerable to climatic changes group of organisms. To this end, assessments of suitable environmental conditions have been applied to examine species' present and potential distribution shifts, especially in the case of range-restricted species of conservation interest. Moreover, to project species' distribution changes under climate change scenarios, niche modelling is applied to inform about the suitable distribution area. In the present case-study we propose the application of the modern methodological approach of Maximum Entropy (MaxEnt) bioclimatic models, to estimate the suitable environmental conditions for seven fish range-restricted in Trichonis lake and Acheloos river basin. These are the Trichonis spined loach (*Cobitis trichonica* Stephanidis 1974), Trichonis blenny (*Salaria economidisi* Kottelat 2004), Hellenic minnowroach (*Tropidophoxinellus hellenicus* (Stephanidis 1971)), Acheloos roach (*Leucos panosi* Bogutskaya & Iliadou 2006), Trichonis rudd (*Scardinius acarnanicus* Economidis 1991) and Trichonis dwarf goby (*Economidichthys trichonis* Economidis & Miller, 1990). Occurrence data were obtained from online biodiversity databases and were partitioned (k-fold cross-validation) towards the construction, calibration and evaluation of the produced bioclimatic models. Fifteen bioclimatic variables were downloaded from WorldClim v.2.1 database, with the selected optimal models showing the lowest Akaike Information Criterion (AIC). Species Distribution Models (SDMs) were evaluated by measuring their Area Under the Curve (AUC). Isothermality appeared to be important bioclimatic variable of the suitable conditions for all species except *T. hellenicus*. Mean Diurnal Range was found only important for *C. trichonica* and *S. economidisi*. Precipitation of Wettest Quarter was included in the models for the suitable conditions of *C. trichonica* and *L. panosi* whereas Precipitation of Wettest Month showed non-zero coefficient in the MaxEnt of *T. hellenicus*, *L. panosi* and *S. acarnanicus*. Annual Precipitation contributed most to the model only for *L. panosi* and *S. acarnanicus*. Finally, Temperature and Precipitation Seasonality were included in the MaxEnt model of *E. trichonis*. Given that the majority of species will face significant range reductions, due to the synergistic effects of habitat alterations and climate-change, thorough ecological studies on the species and proactive conservation practices are urgently needed. We expect that this approach could be promising in predicting the potential distribution of other range-restricted species. This research is co-financed by Greece and the European Union (European Social Fund- ESF) through the Operational Programme «Human Resources Development, Education and Lifelong Learning» in the context of the project "Reinforcement of Postdoctoral Researchers - 2nd Cycle" (MIS-5033021), implemented by the State Scholarships Foundation (IKY).

Keywords: niche modelling, freshwater fish, suitable conditions, climate projections.

Type of presentation: Poster

BC-O6

Prediction models in the assessment of genetic diversity of ichthyopopulations in certain temporal periods

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Abstract:

In understanding the genetic structure of ichthyopopulations, it is very important to know temporal changes in terms of the genetic structure of the population itself. Assuming that there are no samples from a certain historical period that would enable a comparison with a contemporary populations, it is very difficult to make a prediction of the fluctuation of the genetic diversity in regards to a certain population. For these purposes four main categories of simulation models can be used: *backward-in-time*, *forward-in-time*, resampling and artificial neural networks. *Backward-in-time* (coalescent approach) starts from the observed sample in the current generation and goes backwards, more precisely this approach correlates all alleles to one ancestor, designated as MRCA (Most Recent Common Ancestor). Unlike the coalescent model, the *forward-in-time* approach starts with an initial population and then follows individuals through numerous generations under different scenarios. Considering that it follows individuals, this method is significantly slower, but the modeling itself is much more complex. *Forward-in-time* is a model that can enable the projection of genetic diversity in a certain temporal period, while *backward-in-time* is primarily an evolutionary model. The third method is the resampling method, which directly generates genotypes by process of bootstrapping or jackknifing from existing data sets. Resampling is based on classic mathematical models, which is a process suitable for smaller data sets. Artificial neural networks can predict fluctuations in genetic diversity in a certain space and temporal periods. Algorithms of this technique use specific training data in order to discover certain patterns, build certain models, and make predictions based on the best possible outcome. In the case that we present, the model of artificial neural networks was used to assess the adequacy of the *forward-in-time* method thus testing neural networks as a prediction model. The data in this case were microsatellite loci of the *Salmo trutta* species from the Neretva River and its tributaries. The starting point is very important for adequate modelling. Genetic data can be obtained by proved autochthonous samples from museum collection (archive) or sampling specimens from remote isolate location with low probability of intrapecies hybridization. Therefore, artificial neural networks will become a significant method in predicting and simulating genetic data, especially in regards to assessing genetic diversity of rivers and their tributaries.

Keywords: ichthyopopulations, backward-in-time, forward-in-time, resampling, ANN.

Type of presentation: Oral

BC-O7

Removal of invasive fish species from the Plitvice Lakes water system helps in increasing viability of native fish species and restoring natural habitat conditions

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Abstract:

The Plitvice Lakes system is an important ichthyological area due to the fact that its not numerous fish species are unique and important for the conservation of the whole ecosystem while their genetic diversity represents the richness of Croatian biodiversity. Currently, ten species of fish inhabit the waters of the Plitvice Lakes National Park, of which only four are considered native. These are: Danube trout (*Salmo labrax*), Italian loach (*Sabanejewia larvata*), Italian spined loach (*Cobitis bilineata*) and Minnow (*Phoxinus* sp.) The remaining six species have been introduced into the lakes by human activities or their autochthony status has not yet been fully explored. Freshwater systems are often subject to a variety of human influences, with the spread and introduction of alien species having the greatest negative impact. A real example of such an impact on the Plitvice Lakes is the introduction of the Rudd (*Scardinius erythrophthalmus*). The Rudd is a cyprinid fish species which reason for intake in the Plitvice Lakes is not yet fully known, but it is assumed that it served as a living bait for trout fishing. The goal of this research is to determine how the Rudd population affects indigenous species, to assess the invasiveness and to study the population structure of the Rudd in the Prošćansko Lake by sorting the specimens into the age-size categories. It is important to note that the Rudd is not the only invasive species in the Plitvice Lakes (it is accompanied by Pike (*Esox lucius*) and Chub (*Squalius cephalus*)) but its impact on the surrounding ichthyofauna is the most significant. For the research on the Prošćansko Lake the Rudd was caught with multi-mesh gillnets from five localities of different biological, ecological and landscape characteristics, after which the standard, total length and mass of the sample was measured. Based on the obtained data, the statistical analyses were performed. The Rudd population, which has an exponential reproduction rate, constantly alters the habitat and successfully exerts competitive pressure on native species, most notably Danube trout populations that are sensitive to any changes within the ecosystem in which they live. Also, the Rudd from the Prošćansko Lake clearly show a preference for a certain type of microhabitat depending on the size and age category to which they belong. The Rudd of lower age-size categories prefer microhabitats that provide shelter and sufficient food sources, while individuals of higher age-size categories also live in unstructured microhabitats.

Keywords: endangerment, Plitvice Lakes, ichthyocenosis, anthropogenic impact, conservation.

Type of presentation: Oral

BC-P9

Composition and structure of coastal ichthyocommunites in marine Natura 2000 areas of the southern Istria, North Adriatic Sea

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Abstract:

The southern part of Istria peninsula comprises two Natura 2000 areas (Medulin Bay and Western Istria aquatorium), which are highly diverse and heterogenouus across small spatial scales. The current state of coastal fish communities within those areas was assessed in situ by means of underwater visual census. Analyses were performed on total fish abundance and biomass, species richness and multivariate composition and structure of observed fish assemblages. A total of 38 different fish species, belonging to 10 families, were recorded. Considering species occurrence frequency, fish communities were dominated by a small number of species, with two fish species, *Diplodus vulgaris* and *Coris julis*, observed in every single diving profile. Both surveyed Natura 2000 areas displayed similar overall species richness, abundance and biomass of ichthyocommunities, while their composition and structure differed, more so between the individual locations within the Natura 2000 areas, then the areas themselves, reflecting the natural variability conditioned primarily by habitat heterogeneity on a small spatial scale. Population analysis of economically important species could only be conducted for *D. vulgaris* which was the highly dominant species in number (43%) and biomass (63%) on the diving profiles. More *D. vulgaris* individuals were observed, overall and on average per single diving transect, in southern parts of western Istria aquatorium than in Medulin Bay, which were on average 8% larger differing also regarding the overall demographic structure. The differences in *D. vulgaris* populations of these two Natura 2000 areas are due to the significantly higher proportion of older juveniles (12-20 cm in length) observed in the southern parts of western Istria, while younger juveniles (6-8 cm in length) are more likely to be found in Medulin Bay. The observed distribution is consistent with the ontogenetic characteristics of the species. In the populations of *D. vulgaris*, regardless of the Natura 2000 area, small individuals (≤ 18 cm) dominate, while adult specimens are extremely rare. The largest individuals observed are 24 cm long, which is far below the length to which *Diplodus vulgaris* is known to grow (45-50 cm). Overall, the research data indicate the relatively low abundance and impoverished composition and structure of the ichthyocommunities, most likely as a result of high fishing pressure. Given that coastal ichthyocommunities in this area have generally been very sparsely and unsystematically researched, this research provides baseline data for future monitoring and can contribute to the organization of the protection and management of this area.

Keywords: coastal fish communities, underwater visual census, Natura 2000 area.

Type of presentation: Poster

PL5

From eggs to adults: dynamic trends in fish and fisheries at the Israeli Mediterranean coast, Levant Basin

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Abstract:

The ichthyofauna of the Israeli Mediterranean will be reviewed throughout its life cycle, describing the diversity and distribution of fish in a highly invaded and oligotrophic sea. First, Ichthyoplankton surveys that were conducted above the continental shelf and beyond will be discussed, including the advantageous use of DNA-based methods in processing the planktonic samples. Next, juvenile recruitment trends and adult benthic fish distribution will be presented based on seven years of monitoring experience, emphasizing the dynamic changes in fish communities of continental sandy habitats, a mixed outcome of intense biological invasion and global warming.

Keywords: ichthyoplankton diversity, marine monitoring, Lessepsian migration, molecular taxonomy.

Type of presentation: Oral

BC-P10

Modifications of the lowland streams alter natural fish assemblages

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Abstract:

Croatia has one of the richest ichthyofaunas in Europe, with many endemic fish species. Unfortunately, the native fish populations are negatively affected by habitat destruction and the introduction of alien fish species, especially in the lowland streams and rivers of the Danube River Basin. This area is characterized by intensive agriculture that negatively affects freshwater habitats by modifying watercourses for irrigation, and by water pollution. The aim of this research was to explore fish assemblage diversity within natural streams and artificial canals belonging to the lower part of the Sava River Basin. Field sampling was done in the spring of 2019 on 14 locations in the vicinity of the towns Okučani and Nova Gradiška, situated in eastern Croatia. Sampling sites were selected on four natural streams with varying degrees of bank and streambed alteration and on six artificial canals. Fish were sampled by backpack electrofishing. All fish abundance data was standardized as the number of fish per 100 meters of sampling. Analysis of fish assemblages was done by performing analysis of similarity (ANOSIM) and similarity percentage (SIMPER) tests, based on the Bray-Curtis similarity index. Sites were grouped together based on the species similarity by performing cluster analysis. The diversity of each site was estimated by calculating the Shannon-Wiener index. Mann-Whitney test was used to determine possible differences between diversity in streams and canals based on the Shannon-Wiener index and abundance of native and alien fish species. Overall, 20 fish species were found during the sampling, of which 16 were native and 4 were alien. ANOSIM showed a significant difference between fish assemblages in natural streams and artificial canals. SIMPER analysis attributed this difference mostly to the abundance of *Carassius gibelio* and *Cobitis elongatoides*, present in both types of water bodies, but more abundant in canals. Most of the rheophilic fish species were found only in natural streams and some of them (*Alburnoides bipunctatus*, *Barbus balcanicus*) were most abundant in the least modified site. There were no significant differences in overall diversity indices and abundance of species between natural and artificial habitats, as tested by the Mann-Whitney test. Results indicate that modification of natural streams and the introduction of alien fish species lead to the homogenization of fish assemblages in lowland freshwater habitats. On the other hand, undisturbed natural streams of this area still provide a suitable habitat for abundant populations of native fish species.

Keywords: freshwater habitats, stressors, alien species, diversity.

Type of presentation: Poster

BC-P11

Fish fauna of Zagreb's urban streams - hidden diversity in anthropogenic habitats?

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Abstract:

Urban waterways that originate as small brooks on the Medvednica Mountain, run through the city of Zagreb, Croatia, and ultimately flow into the Sava River, are altered in a way that favours the urbanisation process and needs of Zagreb's inhabitants. From a more natural meandering appearance, streams were transformed into linear canals with grass dominated riparian zones heavily exposed to sun, or got entirely enclosed and connected to city sewage systems. Such changed environment presents a challenge to survival of native fish and invertebrate communities, that evolved in more natural conditions. Considering all aforementioned, the goal of this research was to determine the diversity and distribution of ichthyofauna in such changed environments, and to explore urban streams suitability for native and alien fish species. A short-term research of the fish fauna diversity and abundance in Zagreb's urban streams was performed by the students and members of Biology Students Association – BIUS through April and June of 2021. Fishes were sampled on 20 locations, separated on six different streams (Dubravica/Orešje, Vrapčak, Kustošak, Črnomerec, Bliznec and Trnava/Sopnica) and their tributaries, while using the method of electrofishing (performed with Hans Grassl IG200/2 electrofishing device) along a 100 meter long transect. Fish specimens were determined on field, weighed, measured for standard and total length, and photographed. During this research, nine different fish species were found in the urban streams in Zagreb: *Alburnus alburnus*, *Barbus balcanicus*, *Cobitis elongatoides*, *Gobio obtusirostris*, *Lepomis gibbosus*, *Pseudorasbora parva*, *Rhodeus amarus*, *Rutilus rutilus* and *Squalius cephalus*, and they belong to six different families: Acheilognathidae, Centrarchidae, Cobitidae, Cyprinidae, Gobionidae and Leuciscidae. Chub (*S. cephalus*) is the most prevalent and abundant fish species in urban streams, with 138 specimens caught (46 % of all specimens sampled during this research), while Dubravica is the most diverse waterway in terms of the variety of species collected (seven species in total). Invasive species pumpkinseed (*L. gibbosus*) and stone moroko (*P. parva*) were also recorded, although only in three streams and in areas that were close to the Sava River confluence. This research showed that fish species are not equally distributed in different streams and are also not similarly abundant. Additionally, several streams revealed a variety of microhabitats that could affect the species diversity.

Keywords: ichthyofauna, urban environment, electrofishing, alien species, microhabitats.

Type of presentation: Poster

BC-O8

Population structure and connectivity of the triplefin blenny *Tripterygion tripteronotum* in the Adriatic Sea

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Abstract:

Population structure and connectivity of marine organisms are shaped by isolation by distance and/or isolation by resistance, the latter for instance determined by oceanographic barriers. In particular, ocean currents can have a large influence on planktonic larval dispersal, which is also the major form of dispersal for many large benthic animals. In the present study, we address the effects of the hydrodynamic properties of the Adriatic Sea on the population structure of a small, benthic fish, the triplefin blenny *Tripterygion tripteronotum*, a common inhabitant of the shallow rocky littoral. The Adriatic Sea is divided into three major sub-basins, the northern, central and southern Adriatic, which correspond to recognized biogeographic regions and are connected through a cyclonic basin-wide surface circulation. Seasonally changing re-circulation gyres are embedded within each of the three sub-basins and a fourth cyclonic gyre exists in the very northern part of the Adriatic between the Istrian peninsula and the Po river delta. In most previous studies, the sparse sampling of Adriatic populations did not allow to distinguish between effects of geographic distance and effects of dispersal barriers (gyre boundaries) on population structure. Here, we collected mtDNA sequences from *T. tripteronotum* populations sampled at intervals of <5 - 90 km along the Croatian coast and detected a significant correlation between population differentiation and the Adriatic gyres. The most pronounced differentiation occurred between the central and northern sub-basin, while weaker differentiation between the two northern gyres might be associated with shorter divergence times after post-glacial recolonization of the desiccated northern sub-basin. Lagrangian simulations of particle drift revealed that the observed structure cannot simply be explained by passive planktonic drift, but suggest additional roles for larval swimming behavior or differential settlement success. Within gyres, connectivity among populations was high and independent of geographic distance.

Keywords: cryptobenthic fish, Mediterranean Sea, Lagrangian simulation, seascape genetics, dloop, mtDNA.

Type of presentation: Oral

BC-P12

The ichthyoplankton assemblage along the eastern Adriatic Sea during two consecutive summers

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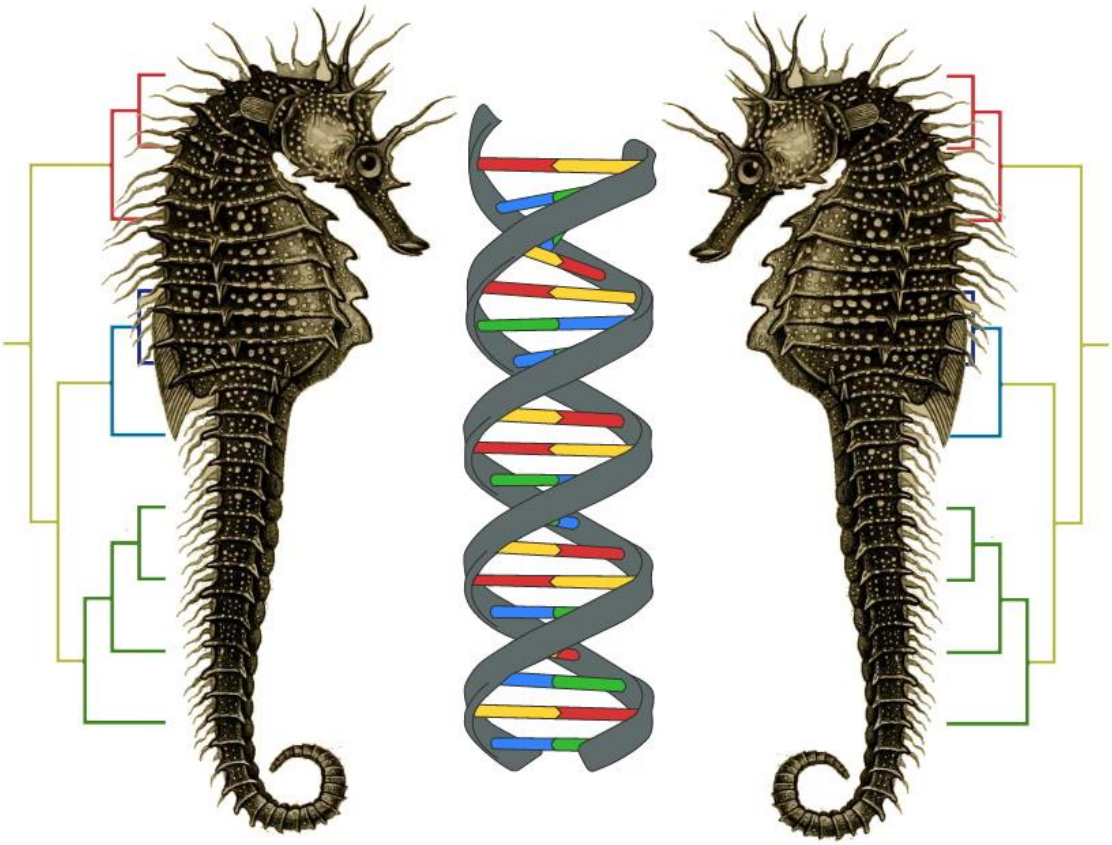
Abstract:

Two ichthyoplankton surveys (June – July 2019; 2020) were conducted along the eastern side of the Adriatic Sea (Croatian fishing ground). Ichthyoplankton samples were obtained by standard vertical plankton tows using a WP2 sampler (mouth opening, 0.255 m^2; mesh size, 0.200 mm) and preserved in 96% ethanol. In the laboratory, ichthyoplankton was isolated under the binocular and its taxonomy was determined using DNA barcoding with cytochrome c oxidase subunit I (COI). Overall, 1381 fish eggs and 407 larvae were collected and they belonged to 39 fish taxa. Quantitatively, the dominant taxa was *Engraulis encrasicolus* (L.). Biodiversity indices (Species richness (S), Simpson's Index of Diversity (D), Shannon-Wiener Index (H), Evenness (E), Jaccard Index (J)) pointed out that samples obtained within two summers were quite similar (J=81.8%).

Keywords: fish early life stages, biodiversity, Adriatic, Mediterranean.

Type of presentation: Poster

SESSION V – MOLECULAR BIOLOGY



MB-O1

Brown trout (*Salmo* cf. *trutta*) from the Danube Basin in Croatia – genetic structure of populations

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Abstract:

Research of the brown trout (*Salmo* cf. *trutta*) phylogeography using the Control Region of mitochondrial DNA revealed that it is genetically and geographically highly structured species. Previous studies showed the presence of two of the seven main lineages in rivers of the Danube basin in Croatia: Danubian and Atlantic. Only one haplotype is considered autochthonous in the analysed area, while majority of other haplotypes are most likely present as a consequence of stocking by non-native stocking material. Eight microsatellite loci of 141 individuals from 15 brown trout populations collected in 15 streams in the regions of Gorski Kotar, Žumberak and western Slavonia were analysed. The lowest values of expected and detected heterozygosity were recorded in brown trout from the River Orljava (western Slavonia), which also revealed the lowest average number of alleles per locus, i.e., a decrease in genetic variability. The highest values of expected and observed heterozygosity were recorder in the River Jasenak while the highest average number of alleles per locus was recorded in the population from the River Kupčina (Žumberak). Analysis of the population structure revealed the existence of twelve genetic clusters in the research area, indicating a potential contact and gene flow among populations within cluster. Individuals from Jankovački stream and Jankovačko lake (western Slavonia) were grouped into one cluster. The populations from the rivers Slapnica and Curak (Žumberak) stood out the most, which is concordant with mitochondrial data that showed lack of the Atlantic lineage haplotypes, indicating their purely indigenous character. In contrast, brown trout from the fish farm situated at the River Kupčina (Žumberak) also showed distinct features, probably due to presence of exclusively Atlantic mitochondrial haplotypes. These data suggest great pressure of stocking on the brown trout populations that urgently need to be protected, in order to maintain their still native character.

Keywords: microsatellites, genetic diversity, trout, mitochondrial haplotype.

Type of presentation: Oral

MB-O2

ddRADSeq of Salmo trutta Da, At and Ad lineage provide a huge number of SNPs

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Abstract:

Next-generation sequencing (NGS) enables deep sequencing coverage for an entire genome of only selected regions and provides the opportunity of getting massive DNA datasets only in one sequencing run. We used the ddRAD technique for sample library preparation with the aim to do a whole genome NGS scan of three lineages of *Salmo trutta*: Danube (Da1), Adriatic (Adcs11) and Atlantic (At1). In total, we scanned 24 individuals of Da1 lineage, 8 individuals of At1 lineage and 22 individuals of Adcs11 lineage. After sequencing we got a range of 830285 – 1771817 reads (mean value - 1355557 reads) with mean number of 203333609 bp (0,203 Gbp) sequenced per sample, which represent 8,58 % of whole *Salmo trutta* reference genome. Within those 0,203 Gbp, there were 1243585 polymorphic sites (SNP) on average for the whole *Salmo trutta* sample. Such a huge number of SNPs provides a great variability data set for different kinds of population and phylogenetic analysis as well as a possibility of designing PCR based detection protocols.

Keywords: NGS, ddRAD, *Salmo trutta*, number of reds, SNP.

Type of presentation: Oral

SESSION VI – FISHERIES AND AQUACULTURE

FA-P1

Morphometric and haematological parameters of *Aulopyge huegelli* from Lake Šator in spring

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Abstract:

Monitoring of morphometric and haematological parameters of fish is a very significant indicator of the general health status of fish, and these parameters are an indirect indicator of both the general state of the environment, while Fulton coefficient can be used to monitor the influence of environmental factors on the general condition of fish. Lake Šator, as a natural treasure of Bosnia and Herzegovina, has been insufficiently researched from a biological point of view. The aim of this research was to determine the morphometric and hematological parameters of individuals *Aulopyhe hugelli* from Lake Šator in the spring season. In the research carried out, a total of 122 individuals of *Aulopyhge hugelli* were caught, and the mentioned parameters were analyzed in 20 individuals of *Aulopyhge hugelli*. From the morphometric parameters, the following were analyzed: total length (TL_{mean}= 8.36 cm ± 1.35 cm) and standard length (SL_{mean}= 6.86 cm ± 1.16 cm), and at the same time the mass was determined (W_{mean}=5.10 g ± 3.28 g) and Fulton's coefficient (K_{mean}= 1.42 ± 0.18). The recorded values of the haematological parameters in individuals of *Aulopyhge hugelli* from Lake Šator were: RBC (0.98 ± 0.29 x 10^{12}/l), Hb (84.98 ± 20.27 g/l), HCT (0.45 ± 0.10 l/l), MCV (472.61 ± 133.23 fl), MCH (97.95 ± 36.71 pg), MCHC (184.11 ± 52.95 g/l). The mean value of the number of leukocytes for the *Aulopyhge hugelli* individuals from Lake Šator was 36.00 ± 18.49 x 10^{9}/l, and the largest proportion of lymphocytes was recorded (76.80%), followed by unsegemented neutrophils (12.05%), monocytes (6.90%), segmented neutrophils (3.45%), basophils (0.45%) and pseudoeozinophyls (0.20%). Considering the higher values of Fulton coefficient, as well as other analyzed parameters, it can be concluded that the *Aulopyhge hugelli* has adapted well to the effects of environmental factors characteristic of Lake Šator.

Keywords: *Aulopyge hugelli*, morphometric parameters, haematological parameters, Lake Šator.

Type of presentation: Poster

FA-P2

Preliminary data of biofouling impact in cage farming of seabass *Dicentrarchus labrax* (Linnaeus, 1758)

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Abstract:

Since the beginning of mariculture activity, biofouling has negatively affected the biological and physiological state of cultivated organisms. Biofouling succession on aquaculture cages decreases the size of the mesh openings, as well as slows down the exchange of the water mass through the net. Consequently, the concentration of oxygen in the cages is reduced. Furthermore, unwanted weight of the net caused by biofouling negatively affects profitability, and therefore the economy of cultivation. This research was carried out *in situ* with the help of an autonomous diving apparatus, using photographs and the square method. The dynamics of the occurrence of biofouling and its influence on the mesh openings of the nets on the cages for seabass farming *Dicentrarchus labrax* (Linnaeus, 1758) were monitored in relation to the control net. For sampling purposes, a square construction with a fixed extension was designed. Using ANOVA, a statistically significant difference was identified between the sides of the cages and the side of the control net ($p<0.001$).

Keywords: mariculture, biofouling, *Dicentrarchus labrax*, Adriatic.

Type of presentation: Poster

FA-O6

Significance and role of the Croatian Sport Fishing Association in the management and protection of freshwater ichthyofauna

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Abstract:

During the past several decades, the Croatian Sport Fishing Association (CSFA) has played a large and significant role in the organization of freshwater sport fishing. Moreover, in its many years of work through organized expert committees, the Association has made special efforts to protect ichthyofauna in the Republic of Croatia and to prevent water pollution. For this reason, until 2001, membership card of the Association was valid as a licence for sport fishing in fishing waters that were handed over by former municipalities of the Republic of Croatia to certain fishing clubs/associations management. The new Freshwater Fishing Act, which was adopted in 2001, gave Association public authority in recognition of its work performed up to that point, its expertise and its ability to structure and organize certain activities. Over the past 20 years, CSFA members have established economic foundations – plans for management of waters (floods, droughts, damage caused by fish-eating birds, emergence of new species in fishing waters, etc.). Fish warden activities have also been established.

We emphasize that fishermen take the fishing exam, which is a prerequisite for obtaining a fishing licence, only in freshwater fisheries. Through the above activities, the Association raises awareness among citizens engaged in sport fishing about the need for expertise and protection of fish. In particular, we note that there is a large number of fishermen interested in taking an exam for becoming a fish warden (about 4000 fishermen), which shows that there is a desire and need to ensure that only lawful sport fishing is conducted in fishing waters. In order to ensure the quality of the above examinations, the Association has published the Manual for Taking the Fishing Exam and the Fish Warden Exam. In addition, the Manual on Management of Fishing Waters has been published as a special edition. It represents the compulsory reading for the professional examination that a person must pass in order to become a manager, i.e. a person that performs fish stock management activities on behalf of a fishing right holder. All this indicates that sport fishing in the Republic of Croatia is well organised and the Croatian Sport Fishing Association played the largest part in achieving this.

Keywords: freshwater sport fishing, licences, fishing exam, fish warden exam

Type of presentation: Oral

FA-P3

Composition of the catches of purse seine "srdelara" in Croatian waters

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Abstract:

Purse seine net is surrounding fishing gear with a mesh size of min 14 mm that captures fish shoals of small pelagic fish species attracted by light. The main target fish species are anchovy, *Engraulis encraicolus,* sardine, *Sardina pilchardus,* and other small pelagic fish species of less economic importance- garfish *Belone belone gracilis*, sprat *Sprattus sprattus,* chub mackerel *Scomber colias,* Atlantic mackerel *Scomber scombrus,* round sardinella *Sardinella aurita,* Atlantic horse mackerel *Trachurus trachurus and* Mediterranean horse mackerel *Trachurus mediterraneus*. Purse seiners (168 active vessels in last years) are operating in the entire Croatian part of the Adriatic Sea, with exception of the channel area for larger fishing vessels, almost all year round (exception of fishing ban in December-January and May) and are part of the monitoring program EU-DCF from 2013. Average official catches of Croatian purse seiners in the period from 2016 to 2021, were around 61,140 tonnes. Percentage in total catches varied from 77.7 to 86.8% for sardine, from 12.3 to 22.2% for anchovy, and from 2.1 to 3.8% for bycatch and discard species. During monthly sampling on board and on the landing place in the most active fishing zones for purse seiners, in six subsequent years, analyses of the catches were recorded and analyzed. In general, the main species caught besides sardine (80.1%) and anchovy (17.2%) were *Scomber- S. colias* (1.4%), *S. scombrus* (0.001%), and *Trachurus -T. mediterraneus* (0.8%), *T.trachurus* (0.4%). Altogether 65 different species (besides target ones) were detected in on-board and landing sampling of this fishing gear in the selected time period. This bycatch and discard species composed 0.08% of the total catch. In total landed weight of sampled bycatch and discard, *Boops boops* made 84.6%, *Mola mola* 4.5%, while the rest of the species' individual percentage in weight were below 2%. Most of the species occurred in catches in all investigated years. Length distribution of the sampled target species varied from 7.5 cm to 18.0 cm for sardine, 9.5 to 17 cm for anchovy, while chub mackerel varied from 6.5 to 26.5 cm and Atlantic mackerel from 7.5 to 24 cm in total length. Bycatch species more significantly varied in length- between 2.0 - 3.5 cm (*Allotheutis media*) and 30.0-38.0 cm (*Belone belone gracilis*).

Keywords: purse seine, Croatia, catch composition.

Type of presentation: Poster

FA-O1

The historical trends and recent collapse of European eel fishery in the Neretva Estuary

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Abstract:

The European eel, *Anguilla anguilla* was the most important fish in the European estuaries for centuries. Due to different reasons, the populations along the European coasts are recently at their lowest historical levels. The situation in the most important Eastern Adriatic eel habitat, Neretva Estuary, is painted with a similar significant decrease and total capture in 2021 was estimated at two tons only. The official statistics before large human interventions, in the period from 1930 to 1940 according to available data, was about 75 tons per year. It was marked by the organized purchase of eels at the state station in the town of Opuzen, and its processing by drying or salting. In addition to the catch that was officially registered the recreational fishery for own consumption also existed. This period can be considered the natural state of the eel population in Neretva Estuary, and an estimated catch of 100 tons per year can be considered reliable. The period from 1960 to 1970 was marked by large land reclamations of the main eel fishery grounds, and after the decline in catches began, which is fully evident in the 1970s. During this period, the catch was mostly purchased from state cooperatives, and a smaller part was captured in recreational fishing and average yearly catch in this period varied from 68.5 tons in 1961 to 46.3 tons in 1969, showing a sharp decline. The later period from 1970 to 2015 and to the present days followed a similar trend of decreasing catches in commercial (autumn-winter) fishing. The increase in the price (today 200 kuna per kilo) also increased fishing effort, which made the further impact of recreational fishing on the eel population comprehensive and negative. Increased control by state institutions since 2020 has significantly reduced the number of recreational tools (especially traps), but due to high eel prices, the fishing effort remains high, although eel catches are declining and eel sizes are decreasing to 50-100 grams only. Additionally, due to the huge increase in the number of invasive species, such as the Largemouth bass, *Micropterus salmoides* in the freshwater areas, and the Blue crab, *Callinectes sapidus* in the brackish ecosystems, which either feed or compete for food with eel, a decrease of smaller eel below 30 grams is visible. The decline of eel catches in the last sixty years have an exponential trend, as a result of a series of anthropogenic activities, the most important of which are large reclamations in the Neretva delta that drastically reduced the area of suitable habitats. This was recently accompanied by the introduction of invasive predatory and competitive species. The increased demand for tourism and attractive price, ongoing fishery pressure, and described ecological changes in traditional habitats, drive the eel population in Neretva Estuary on the extinction pathway.

Keywords: European eel, historical trends, recent collapse, invasive species, overfishing.

Type of presentation: Oral

FA-P4

Establishment of Fisheries Restricted Area for protection of demersal resources in the central Adriatic Sea

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Abstract:

The Jabuka Pit, the deepest part of the central Adriatic, represents a key habitat and spawning ground in the Adriatic and as such can be classified in the category of Essential Fish Habitats. Not only do the main demersal species such as hake, Norway lobster, anglerfish and deep sea red shrimp spawn here, but also pelagic species such as sardines and anchovies. This area is an important fishing ground for the Croatian and Italian fishing fleet, and about 30% of the trawl fishing takes place in this area. The state of demersal fish stocks in the Adriatic Sea has recently become extremely negative, and according to STECF and SAC GFCM estimates, most stocks belong to the "overfished" or "overexploited" categories. With the aim of improving the situation, scientists have developed a proposal to establish a protected area in the central part of the Jabuka Pit to try to improve the recruitment of key resources by protecting this sensitive area. In 2015, Croatia and Italy bilaterally protected part of the Jabuka pit for one year. This protection was continuously extended until 2018, when the GFCM declared the Jabuka pit a Fisheries Restricted Area - FRA Jabuka. In 2021, a permanent fishing ban was adopted. The protected area covers an area of about 3500 km2 and consists of several zones. In the no-take zone (area about 1500 km2) trawling is completely prohibited, while in the two buffer zones (area 1400 km2 Zone B and 420 km2 Zone C) fishing is limited to 2 days per week. Immediately after the ban, monitoring of the state of the resources was established, carried out by the Laboratory of Marine Biology and Fisheries - LBMP from Fano, Italy and the Institute of Oceanography and Fisheries from Split - IOR, Croatia. The results of the monitoring show that the status of the resources has improved after the establishment of FRA Jabuka. This improvement is reflected in the increase of the biomass index and in the improvement of the demographic structure of the main species both in the protected area (No Take Zone) and in the buffer zones (Zone B and C), as well as in the surrounding sea. Of particular note is the increase in the biomass index of cartilaginous fishes in the area, especially sharks, which are one of the best biological indicators of improving resource status. In addition to the positive trends in cartilaginous fish biomass, an increase in catches of demersal species along the east and west coasts of the Adriatic Sea has also been noted. Moreover, new assessments of the status of the stocks show positive changes reflected in the reduction of fishing mortality, increase in spawning stock biomass (SSB), and increase in recruitment. The positive changes observed after the establishment of FRA Jabuka encouraged scientists to lay new foundations for the establishment of similar protected areas in the southern and northern Adriatic.

Keywords: Adriatic Sea, restricted area, Jabuka Pit, fisheries, demersal resources.

Type of presentation: Poster

FA-P5

New record of *Fistularia commersonii* from the coast of Montenegro (South-eastern Adriatic)

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Abstract:

This paper presents an additional record of bluespotted cornetfish (*Fistularia commersonii*) from coastal waters of Montenegro. *F. commersonii* is recorded in 2006 for the first time in the Adriatic Sea, while first record from Montenegrin waters dates from 2009. It is well known as the one of the most successful lessepsian migrants, with rapid population increase in colonized areas across the Mediterranean Sea. Its home region includes the Red Sea, from which it migrated into the Mediterranean through the Suez channel. Here described specimen was caught on 20.05.2022 near Budva by recreational fishers and represents the species most recent record in Montenegrin waters.

Keywords: Montenegrin waters, invasive species, climate change, additional record.

Type of presentation: Poster

FA-O2

Importance of genetic monitoring in aquaculture – two decades of experience in Bosnia and Herzegovina

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Abstract:

Decades-worth studies demonstrated that genetically heterogeneous individuals display higher resistance to environmental perturbations during development, better survival rates, and higher relative growth rates. Notwithstanding the significant benefits of the molecular approach to management and conservation strategies, the genomic methods have still not been effectively integrated into fisheries and aquaculture management in many countries worldwide. Current legislation on freshwater fisheries in all administrative parts of Bosnia and Herzegovina (the Federation of Bosnia and Herzegovina, the Republic of Srpska, and the Brčko District) requires stocking of wild waters with healthy fish, fingerlings, fry, and fertilized eggs, after health control and fish quality checkup. However, neither law specifically prescribes mandatory genetic testing of fish stocks before stocking. Many country's streams and rivers were subject to a "put-and-take" fisheries management, and the restocking is done occasionally, mostly without adequate supervision and transparency. The Laboratory for Molecular Genetics of Natural Resources (LMG) of the University of Sarajevo-Institute for Genetic Engineering and Biotechnology has been providing the expertise in molecular-genetic characterization of fish broodstocks and fry for the Bosnian-Herzegovinian fisheries and aquaculture sector for more than two decades. During this time, LMG has analyzed close to 2000 farmed fish, mostly *Salmo trutta*, *S. marmoratus*, and *S. obtusirostris*, from various fish farms within the country. The poorest state was recorded for farmed *trutta* populations, where allochthonous lineages were detected in most of the analyzed broodstocks and most of the years. The condition of farmed populations of soft-mouth trout and marble trout highly depended on the knowledge and awareness level of the farm manager. Also, the tendency to continually select broodstock from a small number of closely related individuals was observed, resulting in reduced genetic variability and increased inbreeding. Studies showed that *S. trutta* individuals of allochthonous origin had reached the wild waters in Bosnia and Herzegovina, indicating the incidences of escapes from the fish farms and/or uncontrolled stocking with such fish. Although fish farm managers perceive genetic control as a costly obligation conducted only when a higher authority requires it, the absence of such activities can be even more damaging in financial, socioeconomic, and environmental terms. Improving the legal framework should be considered a priority to account for regular mandatory genetic monitoring of fish intended for stocking wild waters. Consequently, the governments, academia/science sector, and private industry must see the benefits of genetic monitoring in regular management and commit to a strong partnership.

Keywords: aquaculture, genetic monitoring, brown trout, marble trout, softmouth trout

Type of presentation: Oral

FA-O3

Risk Assessment of Golani's round herring, *Etrumeus golanii* (DiBattista, Randall & Bowen, 2012) in Greece

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Abstract:

The waterway between the Indo-Pacific and the Mediterranean basins, through the Suez Canal, has altered the marine environment of the East Mediterranean. Climate change, coupled with the successive enlargement of the Suez Canal, has allowed the continuous invasion of non-indigenous species (NIS) in the Mediterranean Sea, resulting in its tropicalization. The invasion and establishment of NIS is impacting indigenous populations, habitats, and ecosystem services. In Greece, more than 270 aquatic NIS have been recorded, one of them being the Erythrean small pelagic fish Golani's round herring (*Etrumeus golanii*), first recorded in Greece in 2005. The species has already entered the Greek waters through natural dispersal from nearby countries and has been established in regions of central and southeast Greece e.g., the Cyclades, Crete, and the Dodecanese Islands. The limited knowledge of the species biology and its commercial importance for local fisheries were the trigger for its selection for a risk assessment (RA) and future management considerations. RAs are considered to provide useful information that indicate the potential inclusion of species in the list of Invasive Alien Species (IAS) of Union Concern, according to the Regulation (EU) 1143/2014 on the prevention and management of the introduction and spread of invasive alien species (the IAS Regulation). This work presents the results of the risk assessment of Golani's round herring and the possible commercial benefits that could occur under appropriate management schemes. For this purpose, the RA template previously used for the assessment of IAS was used. Based on the RA, although the species has not yet spread in the northern Aegean and the Ionian Seas, due to the region geomorphology and the winter isotherm, further spread in these areas related to the sea temperature increase can be expected in the near future. However, Golani's round herring is considered to have a moderate impact on the environment, raising minimum socio-economical concerns, and is not harmful to human health. The most effective way of controlling its population is the commercialization for human consumption, following the example of other countries in the Red Sea. This approach can turn bioinvasion into a good economic opportunity that would increase the income of local fishers.

This study was undertaken in the frame of the project 4ALIEN (Biology and the potential economic exploitation of four alien species in the Hellenic Seas) funded by the NRSF 2017-2020 (MIS: 5049511).

Keywords: *Etrumeus golanii*, risk assesment, alien species.

Type of presentation: Oral

FA-P11

Application of autonomous heterogenous robotic system in monitoring and control in fish mariculture

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Abstract:

Robotics has gained both high popularity and interest in solving multiple problems in recent years. Though single task robots have served humanity for some time, an idea of multiple heterogenous robots working together is only gaining momentum, and project Hektor is exploitinig such a possibility. Since the robotic system is intended to work on mariculture fish production cage, several tasks were devised to complement the system in real time operations. On underwater robot (ROV) a multi-parameter water quality logger probe will be mounted, which will be able to measure water parameters near-or within cage net, and thus determine throughput of water to and from the cage. We will be able to determine water exchange within the netted cage. Further, camera system will capture photo and video material of cage net and fish within the cage. That photo and video material shall be analysed with software (Lolitrack, Loligo systems, Denmark) and several parameters of net, such as the free area, biofouling intensity can be quantitized. Also, the free swimming fish can be analyzed in terms of population measure (the number of the fish, average size, possible skin colour change indicating health hazards) that can help us to determine the state of fish population in the cage.

Keywords: robotics, monitoring, fish aquaculture, net cages.

Type of presentation: Poster

FA-P7

Microplastics in cultured European flat oyster, *Ostrea edulis* (Linnaeus, 1758) in the Mali Ston Bay

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Abstract:

Samples of cultured (one year) European flat oysters, *Ostrea edulis* (Linnaeus, 1758) were collected in two locations in Mali Ston Bay. In both areas 30 of farmed oysters were collected, in the entrance of the bay and in the closed part of the bay. The results indicate the presence of microplastics in both sampling areas. The analysis showed multiple types of microplastic including fragments, fibers and other items, in four size groups. The most common form is fiber microplastics. The number of total microplastic particles varied from 9 to 73 items/individual. Regression analysis of particles per gram of shellfish tissue has shown a decrease of particle number with the increase of tissue mass (R^2 0,54 and 0,51). Statistically (ANOVA, $p < 0.05$) two samplings locations did not differ in microplastics count.

Keywords: shellfish, microplastic particles, mass, tissue.

Type of presentation: Poster

FA-P8

Catch composition of selected trammel nets and gillnets in the eastern Adriatic Sea

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Abstract:

Small-scale fisheries make up an important part of the Croatian fishing fleet. Characteristics of such fisheries are numerous multi-purpose boats with various fishing gears, multi-species catch composition and numerous landing sites. Through Data Collection Framework (DCF) data collection of small-scale fisheries is carried out in Croatian waters. In this study we present catch composition of major small-scale fishing gears (4 trammel nets: *poponica*, *listarica*, *salpara*, sipara; 3 gillnets: *prostica*, *psara*, *polandara*) in terms of species richness and biomass in the period from 2013 to 2021. The most diversified catches of trammel nets were from *poponica* (108 species) and of gillnets from *prostica* (95 species). The most represented species in catch biomass for trammel nets were: *poponica* - *Sepia officinalis* (20,78 %) and *Sparus aurata* (15,24 %); *listarica* - *Solea solea* (80, 55 %); *salpara* - *Sparus aurata* (41,63 %), *Euthynnus alletteratus* (13,65 %) and *Sarda sarda* (10,21 %); *sipara* - *Sepia officinalis* (69,95 %). The most represented species in catch biomass for gillnets were: *prostica* - *Merluccius merluccius* (62,86 %); *psara* - *Mustelus mustelus* (36,30 %) and *Mustelus punctulatus* (14,61 %); *polandara* - *Sparus aurata* (46,30 %) and *Sarda sarda* (13,20 %).

Keywords: fisheries, artisanal, trammel nets, gillnets.

Type of presentation: Poster

FA-P9

Landing and discard ratio analysis for some commercial species in Montenegrin trawling fisheries (Southeastern Adriatic Sea)

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Abstract:

General Fisheries Commission for the Mediterranean (GFCM) Discards monitoring programme has been carried out since 2018, covering all fleet segments operating with bottom trawl nets in Montenegro. Onboard samplings were performed continuously during 2018, 2019, 2020, 2021 and the beginning of 2022. Samplings were carried out in the following periods: August 2018 – December 2018; January 2019 – December 2019; April 2020 – November 2020 and April 2021 – February 2022. Number of samplings raised during the years, and samplings were performed on vessels belonging to T-10 (vessels between 6 and 12 meters in length overall) and T-11 fleet segments (vessels between 12 and 24 meters in length overall), according to GFCM's fleet segmentation. Catch from two of the more hauls was measured, and length and weight data were collected for every recorded species. A total of 203 samplings were analyzed. Percentage of total trawling discard has varied among the years, with its minimum of 15.82% (2019) and its maximum of 25.13% (2021-2022). Data presented here shows the ratio between discard and landing per each fleet segment and provides the ratio between discard and landing and length frequency distributions (LFDs) of both landed and discarded catch fractions for some most present commercial fish species exploited by Montenegrin trawlers. LFDs are given for hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), common pandora (*Pagellus erythrinus*), Atlantic horse mackerel (*Trachurus trachurus*) and bogue (*Boops boops*). LFDs are used to describe each species landing size at which more than 50% of individuals are landed and check how it corresponds with length at first maturity.

Keywords: trawl fishery, discard, landing, Montenegro, Adriatic Sea.

Type of presentation: Poster

FA-P6

Eating up the invaders: an example of processing the invasive alien *Etrumeus golanii*

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Abstract:

Non-indigenous species (NIS) are well acknowledged for their impacts on biodiversity and ecosystem services. According to EU regulation 1143/2014 "*the potential benefits of uses and the costs of mitigation to weigh them against the adverse impact*" are an essential component when risk assessing invasive alien species (IAS). Yet, information of potential use and its costs as mitigation measures are rarely available. *Etrumeus golanii*, is a small pelagic IAS, forming relatively large schools. It is widely distributed in the Eastern Mediterranean, and in Greece, it is found mainly in the Central and South Aegean Sea, the Dodecanese islands and Crete. The species has been introduced to the Hellenic market, and being sold fresh, in the past couple of years. Recent research has shown desired quality feature, namely, a very nice filet, with high protein and n3 and n6 fatty acids contents. This makes the fish an excellent candidate for human consumption. Based on the above, potential processing techniques were explored, either those traditionally used to similar species, such as anchovy and sardine (e.g. salting), those for bigger sized species (e.g. smoking), or innovative methods, such as the creation of fish jerkies. Towards that direction, filleting the fish, salting, and different types/times of smoking were applied. *Etrumeus golanii* was found easy to fillet and the backbone easily removed, resulting in a premium fillet. The fillets, were lightly salted with Greek herbs in a mixture of oils and natural antioxidants of *Rosmarinus*. With respect to smoking the light natural oak smoke was applied, a method used in other fish (e.g. seabass, salmonids). The result was an interesting delicacy that could easily commercially compete similar products, as that of natural smoked seabass. Finally, a unique product rich in proteins and n3 oils was the protein snack fish "*jerkies couer de fillet*". The above-mentioned processing, resulted from fish offal, that under the concept of "circular economy" could further be used to increase the percentage of n3 in nutritional emulsions for pet and human nutritional supplements. Such products are being explored using offal of seabass and gilthead seabream from Greek aquaculture, and will also be explored for *E. golanii* at a second stage. This study was undertaken in the frame of the project 4ALIEN: Biology and the potential economic exploitation of four alien species in the Hellenic Seas, funded by the NRSF 2017-2020 (MIS (ΟΠΣ): 5049511).

Keywords: processing, alien species, commercial exploitation, fish food.

Type of presentation: Poster

FA-O4

Interaction of semi-offshore tuna farms with marine biodiversity

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Abstract:

Tuna farms play an important role in wild fish populations in several ways. Fish cages, which present artificial elements in coastal ecosystems, are considered large fish aggregation devices (FADs) because numerous wild fish species are aggregated in large numbers throughout the year. The cages provide shelter, where the unused portion of the food that passes through the cages adds to the attraction. Tuna farms may also impact egg production and potential recruitment of Bluefin tuna in the Adriatic Sea because they are supplied with juvenile fish and practice prolonged farming period of 18 to 32 months, which overlaps with the period of fish first maturity. To assess the attraction of tuna farms to wild fish populations and the spawning activity of caged farmed fish, species richness and abundance of wild fish were estimated by visual census, while reproductive output and egg production of farmed tuna were estimated by gonadal histology and intensive ichthyoplankton collection with genetic identification of tuna eggs at a farm off the southwest coast of Brač Island, Croatia. On average, 1200 fishes from 12 taxa and 7 families were recorded per transect of 11 250 m3 in the immediate vicinity of the tuna farm during the three-year study period. Both species richness and total fish abundance were significantly higher near the fish farm than in the control areas in all study years. Gonadosomatic index values for farmed tuna indicate that the maturation period peaks in May, followed by the onset of spawning in June. Barcoding of tuna-like eggs collected near farms during the spawning season confirmed the presence of *Thunnus thynnus* individuals. In conclusion, tuna farms can serve as functional marine protected areas if no fishing conditions are practiced within the leasehold areas, while the phenomenon of eggs escape by tuna spawning in the cages could have positive effects on the recruitment of Bluefin tuna in the Adriatic Sea.

Keywords: capture-based aquaculture, wild fish, spawning, barcoding, diversity.

Type of presentation: Oral

FA-P10

Potential negative impacts of capture-based Atlantic bluefin tuna *Thunnus thynnus* (Linnaeus, 1758) farming on marine environment

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Abstract:

Mariculture has a long tradition in the Mediterranean Sea. Socio-economic importance of mariculture has grown since the end of the 20th century due to the high exploitation of wild stocks. Atlantic bluefin tuna *Thunnus thynnus* (Linnaeus, 1758) farming plays a vital role in Croatian aquaculture and economy in general. Tuna farming industry still relies on catch of young animals in their natural habitat and rearing them in cages. This paper aims to provide an overview of the potential impacts of capture-based bluefin tuna farming on marine habitats and organisms. In the Mediterranean and the Adriatic Sea, research studies have shown that negative impacts of tuna farming on marine environment include increased concentration of organic matter and nutrients in the water column and sediment, and increased pressure on tuna tuna populations, as well as on tuna prey (small pelagic fish). Potential negative impacts also include genetic changes, behavioral changes, changes in migratory patterns of wild tuna populations as well as changes in the predator-prey relationship. The environmental impact of tuna farming has to be strictly monitored. The ecosystem-based approach should be applied in the process of development of bluefin tuna rearing facilities, respecting all the principles of sustainable development.

Keywords: Atlantic bluefin tuna, mariculture, environmental impact, farming, sustainable development.

Type of presentation: Poster

FA-O5

Genetic structure of greater amberjack *Seriola dumerili* (RISSO, 1810) populations in the Mediterranean Sea

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Abstract:

Due to its high growth performance and market value, the greater amberjack (*Seriola dumerili*) is a promising species for aquaculture in the Mediterranean. Although captive breeding started in the 1980s, industrial production in closed rearing facilities is relatively new. Farmed fish are usually produced from relatively few broodstock individuals with limited genetic diversity so that the genetic composition of these populations differs significantly from the natural population. In addition, net-pen farming and escapes can lead to a range of socio-economic and ecological interactions in the coastal zone. In the present study, a total of 479 wild and farmed individuals of *Seriola dumerili* collected between 2013 and 2021 in the western and central Mediterranean Sea were genotyped with 15 microsatellite loci in two microsatellite multiplexes. Observed and expected heterozygosity varied among populations (0.65-0.76 for Ho; 0.65-0.73 for He), with farmed populations having significantly lower allelic richness (4.6 vs. 6.8) than wild populations. The farmed populations had significantly higher observed heterozygosity (0.70 vs. 0.66) and lower inbreeding coefficient (FIS) (-0.14 vs. -0.01), which was due to excessive heterozygosity at several loci. The high FST differentiation index of 0.114 was observed among farmed populations and differed significantly from the low index observed in the wild populations (0.008). Farmed populations were characterised by very low effective population sizes (Ne < 10 individuals), in contrast to the overall estimates of Ne > 1000 individuals for the wild populations. Initial Structure analysis of the dataset revealed K = 2. Examination of the additional structural signal at K = 5 revealed that all farmed populations were assigned to a separate cluster with some degree of admixture. These results are consistent with previous findings for species with a much longer history of farming. To maintain the genetic diversity of a wild population, it is important from an ecological point of view to obtain information on the origin of the farmed populations to avoid the introduction of foreign alleles that could alter the genetic structure of the wild populations. Escaped farmed fish pose a conservation problem because of the risk of erosion of genetic structure, loss of local adaptive genetic variation, or complete replacement of wild populations by farmed populations. It is recommended to use local hatchery stocks wherever possible to minimize the potential disturbance of locally adapted populations by escaped farmed fish.

Keywords: *Seriola dumerili*, aquaculture, escapes, Mediterranean Sea.

Type of presentation: Oral

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