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Northwest Pacific Action Plan

제주대학교
JEJU NATIONAL UNIVERSITY

Asia-Pacific Network (APN) Workshop on Key Indicator Species and Habitats for Marine Biodiversity Change in East Asia

28 – 30 November, 2022
Ara Convention Hall, Jeju National University, Korea

Program & Abstracts

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Asia-Pacific Network (APN) Workshop on Key Indicator Species and Habitats for Marine Biodiversity Change in East Asia

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Organized by

Asia-Pacific Network for Global Change Research
Northwest Pacific Action Plan (NOWPAP)
Jeju National University, Korea

Welcome Messages

Prof. Eel-Hwan Kim

President of Jeju National University

On behalf of the Jeju National University, I warmly welcome you to the Asia-Pacific Network (APN) workshop on Key Indicator Species and Habitats for Marine Biodiversity Change in East Asia hosted by Jeju National University. It is indeed a privilege and pleasure to deliver this message as a President of the Jeju National University on the occasion of the APN workshop scheduled to be held on 28th, 29th, and 30th November 2022. I appreciate the project team for choosing a timely topic that suits the current situation, where marine biodiversity is affected by intensive urbanization combined with climate change impacts resulting in substantial changes. Jeju Island is rich in marine biodiversity, including finfish, shellfish, seagrass, corals, and other marine creatures. However, recent climatic changes influence marine diversity all over the region, including Jeju Island. Therefore, understanding the key indicator species will play a vital role in characterizing ongoing marine and coastal biodiversity changes, including standardization and new approaches to studying and conserving marine biodiversity changes. Especially, Jeju National University immensely contributes to monitoring and studying marine organisms and plays an important role in preserving marine organisms around the region.

I found that the APN workshop includes a range of inspiring keynote addresses and invited talks from eminent scientists and scholars. Further, I believe the workshop aims to disseminate the research findings and exchange experiences with researchers, policymakers, economists, and with budding young scientists and provides new insights for new approaches to studying marine biodiversity. I congratulate the project collaborators, all the scientists, and the organizing committee of the APN workshop for organizing this landmark workshop and wish the workshop and its participants all success.

Prof. Eel-Hwan Kim

President of Jeju National University

Welcome Messages

Prof. Kwang-Sik Choi

Chair of Organizing Committee

Dear Colleagues,

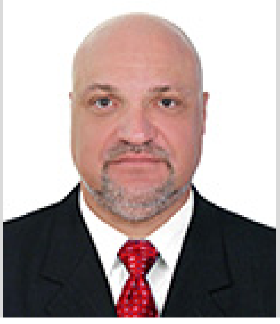
On behalf of the organizing committee, I welcome you to the Asia-Pacific Network (APN) Workshop on Key Indicator Species and Habitats for Marine Biodiversity Change in East Asia in Jeju, Korea from 28 to 30 November 2022. The purpose of this workshop is to enhance capabilities to participate in research on global change and sustainability and to support science-based decision-making in the region and beyond to understand what are key indicator species, ecosystem types and major pathways resulting in marine biodiversity changes in the Northwest Pacific.

I hope you enjoy the scientific and social programs that we have prepared for you and have a great time in Jeju Island.

Prof. Kwang-Sik Choi

Jeju National University

Welcome Messages



Dr. Yegor Volovik

NOWPAP Coordinator

Dear Ladies and Gentlemen, Dear Colleagues,

It is a great pity that I cannot participate in this event in person. It would have been a unique opportunity to discuss in more detail the very important aspects of conserving biodiversity in the Northwest Pacific region and ensuring the development and sustainable likelihoods of local communities and countries' economies as a whole

I do believe the audience of this workshop can speak for the present and future of our environmental science and action. Inevitably, the involvement of young scientists and professionals in advancing the current global environmental agenda is vital for overall success.

Most of us live in the Northwest Pacific region. We know that our region is one of the most densely populated areas of the world, with significant anthropogenic pressure on the regional marine ecosystems. More and more, this pressure is intensified by the negative impacts of climate change. Coastal and marine ecosystems of the Northwest Pacific continue to suffer and are further threatened by unsustainable aquaculture practices, as well as over-fishing and destructive harvesting habits.

I want to inform you that in 2014, NOWPAP Member States agreed to adopt a suite of five Ecological Quality Objectives (EcoQOs) for the region, two of which are directly relevant to marine biodiversity:

- EcoQo1: Biological and habitat diversity are not changed significantly due to anthropogenic pressure;
- EcoQO2: alien species are at levels that do not adversely alter the ecosystems.

In 2019, NOWPAP, in cooperation with the Jeju National University, submitted a joint project proposal to the APN Secretariat and received a grant to implement the current project.

The project aims to enhance the region's capabilities to participate in research and specific studies on global change versus sustainability and to support science-based decision-making in the region and beyond. These capacities are critical for developing a good knowledge base of what key indicator species are for typical natural ecosystem types and major pathways resulting in the current changes in marine biodiversity in the Northwest Pacific.

Recommendations of this international workshop, entitled "Key Indicator Species and Habitats for Marine Biodiversity Change in East Asia", are expected to strengthen the evidence-based science-policy dialogue and capacitate the process of supporting decision-makers and enhancing public awareness in the region about marine biodiversity loss and recent negative changes.

Furthermore, the outcomes of the workshop would provide information and the required inputs into the development of the NOWPAP Regional Action Plan on Marine and Coastal Biodiversity and contribute to the achievement of SDG 14 – Life below Water.

In conclusion, I want to assure you that NOWPAP is committed and looks forward to working closely with scientists and practitioners in the Northwest Pacific region and APN Secretariat to advance our joint action to strengthen the efforts on marine biodiversity conservation and management.
With this, I want to wish the workshop participants very fruitful discussions, which would lead to looking-ahead outcomes and for the workshop - to be a success.

Yegor Volovik, MCE, PhD

NOWPAP Coordinator

Organizing Committee

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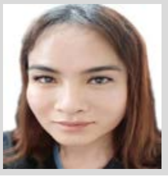
Project Leader **Dr. Kwang-Sik Choi**		Jeju National University, Republic of Korea *skchoi@jejunu.ac.kr*
Collaborator **Dr. Sukgeun Jung**		Jeju National University, Republic of Korea *sukgeun@jejunu.ac.kr*
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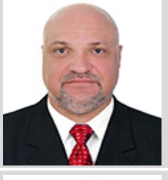
Collaborator **Dr. Yegor Volvik**		NOWPAP/UNEP *yegor.volovik@un.org*
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Collaborator **Dr. Satoshi Nagai**		Japan Fisheries Research and Education Agency, Japan *snagai@affrc.go.jp*

Keynote Speakers

Name	Organization
Dr. Kwang-Sik Choi	Jeju National University, Republic of Korea *skchoi@jejunu.ac.kr*
Dr. Sukgeun Jung	Jeju National University, Republic of Korea *sukgeun@jejunu.ac.kr*
Dr. Xiaoxia Sun	Institute of Oceanology, Chinese Academy of Science, China *xsun@qdio.ac.cn*
Dr. Tatsuya Kawakami	Hokkaido University, Japan *kawakami@fish.hokudai.ac.jp*
Dr. Benjamin Jr. Vallejo	University of the Philippines, Philippines *bmvallejo1@up.edu.ph*
Dr. Tatyana Orlova	National Scientific Center of Marine Biology, Russia *torlova06@mail.ru*
Dr. Ning Liu	NOWPAP/UNEP *ning.liu@un.org*

Invited Speakers

Name	Organization
Dr. Jinho Chae	Marine Environmental Research and Information Laboratory, Republic of Korea *jinhochae@gmail.com*
Dr. Hye-Won Moon	National Marine Biodiversity Institute of Korea, Republic of Korea *hwmoon@mabik.re.kr*
Dr. Donggu Jeon	Chung-Ang University, Republic of Korea *donggu84@gmail.com*
Dr. Christophe Vieira	Jeju National University, Republic of Korea *cvcarp@gmail.com*
Dr. Hongjun Li	National Marine Environmental Monitoring Center, China *hjli@nmemc.org.cn*
Dr. Shingo Udagawa	University of the Ryukyus, Japan *shingouda0117@gmail.com*
Dr. Hyun-Sung Yang	Jeju Research Institute, Korea Institute of Ocean Science and Technology, Republic of Korea *hsyang@kiost.ac.kr*
Dr. Hee Yoon Kang	Chonnam National University, Korea *heeyoun0809@naver.com*
Mr. Ronald G Noseworthy	Jeju National University, Republic of Korea *rgnshells@yahoo.ca*

Workshop Schedule

28 November 2022 (Monday)

09:00 – 09:30 **Workshop Registration**

09:30 – 10:00 **Opening Address**
Prof. Kwang-Sik Choi (Chair of the Organizing Committee)

Welcome Address
Prof. Eel-Hwan Kim, President of Jeju National University
Dr. Do-Hyung Kang, Director of KIOST Jeju Center
Dr. Yegor Volovik, NOWPAP Coordinator

Group Photo

10:00 – 10:30 **Conserve Marine Biodiversity in the Northwest Pacific Region**
Dr. Ning Liu
NOWPAP/UNEP

Session 1-1 : Marine Biodiversity Indicators I

Chair : Dr. Ning Liu

10:30 – 11:00 **[Keynote Speaker]**
Biodiversity and Ecology of High Latitude Scleractinian Corals in Jeju Island
Dr. Kwang-Sik Choi
Jeju National University, Republic of Korea

11:00 – 11:30 **[Invited Speaker]**
Biogeography of Marine Mollusks on Jeju Island
Mr. Ronald G Noseworthy
Jeju National University, Republic of Korea

11:30 – 12:00 **[Invited Speaker]**
Distribution and Diversity of Corals in Korea
Dr. Hye-Won Moon
National Marine Biodiversity Institute of Korea, Republic of Korea

12:00 – 13:30 **Lunch & Break**

Session 1-2 : Marine Biodiversity Indicators II

Chair : Dr. Tatsuya Kawakami

13:30 – 14:00 **[Keynote Speaker]**
Climate-Change Driven Range Shifts of Exploitable Chub Mackerel (*Scomber japonicus*) Projected by Bio-physical Coupling Individual-based Model in the Western North Pacific
Dr. Sukgeun Jung
Jeju National University, Republic of Korea

14:00 – 14:30 **[Invited Speaker]**
An Integrated Phylogenomic Approach for Potential Host-Associated Evolution of Monstrilloid Copepods
Dr. Donggu Jeon
Chung-Ang University, Republic of Korea

14:30 – 15:00 **[Invited Speaker]**
Seaweeds Biodiversity and Role in Globally Changing Environment
Dr. Christophe Vieira
Jeju National University, Republic of Korea

15:00 – 15:10 **Coffee Break**

Session 2 : Marine Biodiversity Changes

Chair : Dr. Benjamin Jr. Vallejo

15:10 – 15:40 **[Keynote Speaker]**
Changes on the Plankton Functional Groups in Jiaozhou Bay, the Yellow Sea
Dr. Xiaoxia Sun
Chinese Academy of Sciences, China

15:40 – 16:10 **[Invited Speaker]**
Overview of Marine Environment and Ecology Monitoring and Assessment in China
Dr. Hongjun Li
National Marine Environmental Monitoring Center, China

16:10 – 16:40 **[Invited Speaker]**
Relationship Between Moonlight and Coral Reef Organisms in Okinawa
Dr. Shingo Udagawa
University of the Ryukyus, Japan

16:40 – 16:50 **Coffee Break**

16:50 – 17:30 **Discussion**

17:30 **Session Closing**

18:00 **Networking Dinner**

29 November 2022 (Tuesday)

Session 3-1 : Marine Biodiversity Monitoring I

Chair : Dr. Kwang-Sik Choi

10:00 – 10:30

[Keynote Speaker]
Environmental DNA as a Powerful Tool to Detect Fish Biodiversity in the Open Ocean
Dr. Tatsuya Kawakami
Hokkaido University, Japan

10:30 – 11:00

[Invited Speaker]
How to Monitor Changes in the Marine Biodiversity in Jeju, Korea
Dr. Hyun-Sung Yang
Korea Institute of Ocean Science and Technology (KIOST), Republic of Korea

11:00 – 11:30

[Invited Speaker]
Identifying Patterns in the Multitrophic Community and Food-Web Structure of a Low-Turbidity Temperate Estuarine Bay
Dr. Hee Yoon Kang
Chonnam National University, Republic of Korea

11:30 – 13:30 **Lunch & Break**

Session 3-2 : Marine Biodiversity Monitoring II

Chair : Dr. Christophe Vieira

13:30 – 14:00 **[Keynote Speaker]**
Using eDNA to Detect the Presence of Marine Invasive Species in Ports and Harbors
Dr. Benjamin Jr. Vallejo
University of the Philippines, Philippines

14:00 – 14:30 **[Invited Speaker]**
Artificial Drivers of Jellyfish Blooms and Transport of Non-Native Species
Dr. Jinho Chae
Marine Environmental Research and Information Laboratory, Republic of Korea

14:30 – 15:00 **[Keynote Speaker]**
TBD
Dr. Tatyana Orlova
National Scientific Center of Marine Biology, Russia

15:00 – 15:10 **Coffee Break**

15:10 – 16:00 **Discussion**

16:00 **Session Closing**

18:00 **Networking Dinner**

30 November 2022 (Wednesday)

10:00 – 12:00 **Field Trip**
Sungsan Fork Village
Intertidal Area

Conserve Marine Biodiversity in the Northwest Pacific Region

Ning Liu

NOWPAP/UNEP

The Northwest Pacific is home to tens of thousands of marine life species and, at the global scale, is one of the most biologically diverse regions. Yet, habitat destruction, pollution, non-indigenous invasive species, over-fishing, and climate change have been threatening the wealth of fauna and flora inhabiting Northwest Pacific seas and coasts.

The Northwest Pacific Action Plan (NOWPAP) was adopted by China, Japan, the Republic of Korea, and Russia in 1994 as part of the United Nations Environment Programme's Regional Seas Programme. The overall goal of NOWPAP is "the wise use, development and management of the coastal and marine environment so as to obtain the utmost long-term benefits for the human populations of the region, while protecting human health, ecological integrity and the region's sustainability for future generations".

For nearly three decades, the NOWPAP Member States have invested resources in biodiversity conservation, including assessing major pressures on marine biodiversity in the region, maintaining a database on IUCN red list species in the region, assessing the state of marine protected areas, setting Ecological Quality Objectives, assessing the regional distribution of 'blue carbon' sinks – seagrass beds, developing "State of the Marine Environment Report for the NOWPAP region" reports, assessing marine invasive species, as well as a series of other efforts.

The assessments and tools developed have supported the national governments' response to environmental threats from eutrophication and hypoxia, harmful algal blooms (HABs), marine litter, and intensified pressures on seagrass habitats. A Regional Action Plan on Marine and Coastal Biodiversity Conservation (RAP BIO) was prepared in 2022 to facilitate regional cooperation in biodiversity conservation.

Currently, NOWPAP continues assessing pressures caused by harmful algal blooms, invasive species, eutrophication, habitat modifications, and other adverse factors impacting the Northwest Pacific's marine and coastal biodiversity. The major projects on biodiversity conservation implemented by NOWPAP include an assessment of tidal flats and salt marshes distribution, several case studies on estimating seagrass blue carbon, advancing the development of the NOWPAP Eutrophication Assessment Tool (NEAT) for the assessment and monitoring of eutrophication using satellite chlorophyll-a, and, finally, the compilation of species of the IUCN Red List.

Furthermore, NOWPAP strengthens the collaboration with the North Pacific Marine Science Organization (PICES) in developing and applying effective area-based conservation measures and identifying non-ingenious species, penetrating the region with the use of the modern Environmental-DNA method. NOWPAP will also continue cooperating with the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) in Integrated Coastal and River Basin Management and other fields to enhance regional ocean governance.

Biodiversity and Ecology of High Latitude Scleractinian Corals in Jeju Island

Kwang-Sik Choi

Department of Marine Life Science, Jeju National University, Republic of Korea

Coastal benthic communities in temperate regions have been influenced by climate change, including increasing sea-surface temperature. Nevertheless, scleractinian coral *Alveopora japonica* Eguchi, 1968, is thriving in shallow subtidal hard bottoms around Jeju Island, off the southern coast of Korea. The presence of this corals has negatively impacted subtidal kelp populations in Jeju Island. However, there is no study to document how the presence or absence of this coral relates to other benthic communities. This study investigated the benthos in three shallow subtidal sites (Shinheung (SH), Bukchon (BC), and Seongsan (SS)) in northern Jeju using underwater photography. Macro-benthic organisms appearing on a 1 × 20 m line transect installed at depths of 5, 10, and 15 m at each site were analyzed. Results showed that of the three sites investigated, *A*. *japonica* colonies were most abundant at BC, accounting for 45.9% and 72.8% of the total transect area at 10 m and 15 m, respectively. At SS, *A*. *japonica* occupied 15.3% of the total area at 15 m and less than 1% at 5 m and 10 m. The same at SH accounted for 10% of the total area at 5 m, and less than 1% at 10 m and 15 m. Dead and bleached colonies accounted for 1.2–11.5% and 1.8–5.7%, respectively, at 5, 10, and 15 m at three sites. At SS, canopy-forming brown algae *Ecklonia cava* and *Sargassum* spp. accounted for 20.2 and 24.3% of the total transect area, respectively, at 5 m depth. In contrast, the percent cover of *E*. *cava* and *Sargassum* spp. at SH and BC ranged from 0.1 to 1.8%, respectively. Moreover, non-geniculate coralline algae dominated the subtidal substrate at SH, ranging between 60.2 and 69% at 15 and 10 m. The low cover of *A*. *japonica* in SS (at 5 m) coincided with a high percent cover of canopy-forming brown algae. However, canopy-forming brown algae were rare at all depths at SH and BC and were dominated instead by coralline algae and the scleractinian corals. This study, by utilizing a non-destructive method, provides a baseline qualitative and quantitative information for understanding the site and depth-dependent distribution of *A*. *japonica* and algal populations, which is important to understand climate change related changes in benthic communities in Jeju and elsewhere

Biogeography of Marine Mollusks on Jeju Island

Ronald G. Noseworthy and **Kwang-Sik Choi**

Jeju National University, Republic of Korea

Jeju Island is Korea's largest island with an area of about 1800 km². It is located about 80 km south of the Korean Peninsula. The island has a subtropical climate with mild winters and hot, humid summers, and an average yearly temperature of 16°C. The warm Tsushima Current branches from the northeastward flowing Kuroshio Current and flows past Jeju Island through the Korea Strait. Although cooler water currents exert some influence, particularly to the north of Jeju Island, the warm Tsushima Current predominates; the southern coastal area of the island having somewhat warmer sea temperatures The blending of warm and cool currents has given Jeju Island a rich mollusk fauna, with over 1000 species presently recorded.

A survey of mollusk distribution along the Jeju coastline reveals that most species occur on the south and east coasts, where the Tsushima Current exercises a stronger influence as it flows northeastward into the East Sea, and this influences the coastal distribution of mollusks. Gastropods, such as Cypraeidae, Conidae, and Ovulidae, which are mostly tropical in distribution occur mainly on the south coast, and most others are also found along the south and east coasts. Although many common bivalves are found on all coasts of the island, the largest number of species, including those with tropical distribution such as the Pteriidae, occurs on the south coast only, with a slightly smaller number found on both south and east coasts. The Polyplacophora and Cephalopoda (mainly cuttlefish and argonautids), also have a mostly southerly island distribution. The Scaphopoda are divided evenly between the south and east coasts.

Zonal-geographical groupings more clearly show the biogeographical affinities of mollusk species. The Jeju fauna is mainly a combination of subtropical (Korea and Japan to Taiwan) and tropical/subtropical species (southward to southeast Asia). There has been a large number of new species reported for the Jeju fauna. Since the first catalogue of Jeju Island mollusks was published in 2007, which indicated that a subtropical influence predominated, almost three dozen new species have been added, almost all with a tropical/subtropical affinity, giving the island a fauna which is increasingly influenced by the warming ocean currents. The exception is the Polyplacophora, which is subtropical/low boreal in distribution, preferring cooler water.

Most Jeju mollusk species are associated with rocky and sandy coastlines; mudflats are virtually nonexistent, and mudflat-associated mollusks, such as Rapana venosa and Meretrix spp. do not occur on Jeju Island. Most of its 92 species of hard and soft corals are found mainly on the south coast, and many species of nudibranchs, cypraeids, ovulids, and chamids inhabit the corals.

Climate change caused by global warming has caused many marine organisms to expand the geographical range of their habitats and is a strong possibility for the addition of new mollusk species to Jeju Island's fauna. The region around Jeju Island has been reported as one of the fastest warming regions in the world, and the sea surface temperature has risen significantly over the last century.

Coastal development, especially port development, has caused a loss of habitat along some parts of Jeju Island's coastline. Overcollecting of edible species is becoming a problem in certain areas; intensive collecting also disturbs the habitats of other species, resulting in a loss of biodiversity. Tourist pressure has also had a detrimental effect, which can be seen in the "hotspots" of mollusk diversity where, a decade ago, large numbers of species could be obtained, but now yield far fewer.

Distribution and Diversity of Corals in Korea

Hye-Won Moon

National Marine Biodiversity Institute of Korea, Republic of Korea

The class Anthozoa comprises approximately 7,500 species in the world. Among them 170 species, including soft corals (80 species of the order Alcyonacea), hard corals (35 species of the order Scleractinia), sea anemones (30 species of the order Actiniaria), and black corals (12 species of the order Antipatharia) have been reported from Korean waters by examining the specimens collected in the coastal areas of Korea from 1965 to 2021. This study aims to clarify the distribution of coral species along the coastal waters of Korea and to identify indicator species for the long-term monitoring of the changes in the distribution of coral species in response to climate change. Geographical analyses were performed to determine the distribution of coral species and to compare the species composition between regions in Korean waters. The 170 recorded coral species have been distributed in the following four regions, Korea: East Sea (28 species), Yellow Sea (21 species), South Sea (68 species), and Jejudo Island (124 species). As a results, it is shown that Jejudo Island has the highest diversity of coral species (73%) while the Yellow Sea has the lowest diversity of coral species (12%). The results reflect that most coral species in Korea are limitedly distributed along the Kuroshio warm Current.

In particular, given that scleractinian corals are significantly influenced by climate change in various ways, including because of their symbiotic relationship with zooxanthellae, the species composition and distribution of scleractinian corals as a key species provide critical baseline information to predict future environmental change in Korean waters. Most scleractinian corals in the tropical oceans are zooxanthellate. Six species of 35 scleractinian corals recorded in temperate Korean waters are zooxanthellate. As sea temperatures increase, the distribution of tropical zooxanthellate scleractinians expands northward. For example, we have found that one of the zooxanthellate scleractinian *Montipora efflorescens* Bernard, 1897 (빛단풍돌산호) is dominantly expanding from the southern part to the northern part in Jejudo Island. In this respect, it is considered that this species would be important as an indicator species for monitoring environmental consequences induced by climate change.

Climate-Change Driven Range Shifts of Exploitable Chub Mackerel (*Scomber japonicus*) Projected by Bio-Physical Coupling Individual-Based Model in the Western North Pacific

Sukgeun Jung and Seonggil Go

[1]Department of Marine Life Science, Jeju National University, Republic of Korea

We projected the effects of warming ocean on the range shift of biomass of chub mackerel (*Scomber japonicas*) covering from the larval to the adult stages up to age 3 yr by developing and applying individual-based models (IBM) based on a regional ocean circulation model for the western North Pacific and two climate change scenarios. From laboratory experiments, we observed a diurnal cycle in the buoyancy of larval mackerel. Our IBMs tentatively suggested that the larval and juvenile mackerel in the Korea Strait, the Japanese coastal areas and the Kuroshio extension areas are mostly transported from the East China Sea where they were hatched. Despite the greater uncertainty, the preliminary results of our IBMs projected that, by the 2050s, the strengthened Tsushima warm current in the Korea Strait and the East Sea, driven by global warming, will shift the young-of-the-year mackerel biomass distribution north to the East Sea, and adult mackerel biomass north, especially in the Yellow Sea. To improve the model performance, international cooperative research among the regional countries is required, especially for extensive ichthyoplankton surveys in the East China Sea.

An Integrated Phylogenomic Approach for Potential Host-Associated Evolution of Monstrilloid Copepods

Donggu Jeon[1], Chi-une Song[1], Hyeon Gyeong Jeong[2], Susumu Ohtsuka[3], Wonchoel Lee[4], Ho Young Soh[5], and Seong-il Eyun[1]

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[5]Faculty of Marine Technology, Chonnam National University, Republic of Korea

The order Monstrilloida Sars, 1901 is one of the most mysterious groups of Copepods with an unusually atrophied morphology and a complex semi-parasitic lifestyle. The lack of common diagnostic features from their morphological peculiarity and little information about the endoparasitic juveniles have caused many uncertainties and ambiguities in their taxonomy and phylogeny. To elucidate phylogenetic relationships and evolutionary significance of these organisms, we first generated two genomes and three transcriptomes from four monstrilloid species and analyzed the 25 nuclear protein-coding genes from 40 arthropod species. The molecular phylogenomic results supported the monophyly of Monstrilloida within Podoplea. Our analysis revealed that Monstrilloida was more closely related to Harpacticoida (Oligoarthra) than Siphonostomatoida which has been regarded as a sister group of Monstrilloida. These phylogenomic relationships for Copepoda were confirmed by statistical tree topology tests and the previously known phylogenies were rejected. Our arthropod phylogeny identified a long branch leading to Monstrilloida. Given the new phylogeny, we investigated hypotheses about monstrilloid evolution by integrating the known morphological and ecological traits of four monstrilloid genera.

Seaweeds Biodiversity and Role in Globally Changing Environment

Christophe Vieira

Department of Biology, Jeju National University, Republic of Korea

The world is confronted with major environmental challenges, in a large part due to anthropogenic stressors, which are critically affecting natural ecosystems. Among others, the impact that pollution and climate change pose on terrestrial and marine ecosystems is particularly alarming. In order to detect the effects of human activities on the quality of the environment and natural ecosystems, humans have used biological systems, species, and communities – i.e., biological indicators or bioindicators. Because of their moderate tolerance to environmental variability, bioindicators can effectively indicate the condition of their environment and ecosystem and therefore be used to obtain integrated qualitative data, which cannot necessarily be derived from technical measurement alone. Specific bioindicators need to be identified for particular ecosystems and should be easy to measure and allow to detect environmental and ecosystem changes. Seaweeds or macroalgae have emerged as valuable indicators in marine environments. While seaweeds contain a considerably much lower species diversity than their terrestrial counterparts, their ecological importance in global oceans' rocky coastal systems remains no less fundamental as primary producers and ecological engineers. Environmental changes have already considerably affected seaweeds globally, leading in worst cases to ecosystem phase shifts. Seaweed species are responding differently to environmental changes, thus leading to algal species composition shifts with some seaweeds becoming rare or disappearing, and others to bloom. Their critical ecological roles in combination with their sensitivity to environmental changes make some seaweed species potentially valuable bioindicators. Past efforts have mainly been oriented toward evaluating seaweed value as biological indicators of trace elements and contaminants presence in waters. Nevertheless, seaweeds function as bioindicators need to extend beyond mere measures of water quality; seaweeds may detect impacts from other anthropogenic stressors including climate change (e.g., changes in temperature and pH), habitat destruction, exploitation, and invasive species. Future research efforts on seaweed potential functions as bioindicators need to be directed in those directions.

Changes on the Plankton Functional Groups in Jiaozhou Bay, the Yellow Sea

<u>Xiaoxia Sun</u>, Shujin Guo, Shan Zheng

Jiaozhou Bay Marine Ecosystem Research Station, Institute of Oceanology, Chinese Academy of Sciences, China

Understanding the long-term change of marine ecosystem is one of the most important issues for the health and sustainable development of marine ecosystems. Here, we takes Jiaozhou Bay, the Yellow Sea as an example to study the variation trends of plankton functional groups in temperate coastal seas in the past 10 years, and the combined effects of climate change, human activities, and environmental protection on plankton was analyzed and discussed.

Chlorophyll *a* (Chl *a*) concentration showed a decreasing trend after 2006 in Jiaozhou Bay, which was quite different from that before 2006. The abundance of diatoms has declined, leading to the increased dominance of dinoflagellates. In all four seasons of the year, the proportion of dinoflagellate in total phytoplankton community has increased significantly since 2006. Therefore, the phytoplankton community has shifted from a diatom-dominated community to diatom and dinoflagellate co-dominated community in Jiaozhou Bay in recent decades.

The abundance of copepods has decreased gradually in the Jiaozhou Bay, especially in May, August and November when compared with the same period in early years. At the same time, the proportion of large-sized copepods has decreased, and the proportion of small-sized copepods has increased. The abundance of a microzooplankton species *Noctiluca* also increased significantly. Therefore, there is a decreasing trend for copepods abundance and a miniaturization trend of the zooplankton community in Jiaozhou Bay in recent years, which is most probably caused by seawater temperature rising.

From the perspective of ecosystem health, good water exchange and the existence of sufficient filter-feeding shellfish are important and beneficial for maintaining the health condition of the Jiaozhou Bay ecosystem. Although water quality has improved due to the decrease in nutrient concentrations in recent decades, it is still necessary to keep an eye on the effects of climate change and human activities. Under the background of global change, the health assessment, scenario prediction and ecosystem-based management of the marine ecosystem are important measures to maintain the sustainable development of the ocean.

Overview of Marine Environment and Ecology Monitoring and Assessment in China

Hongjun Li

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The coastal zone of China comprises an area of more than three million square kilometers, and possesses an 18000 km coastline stretching across tropical, subtropical and temperate zones. The Ministry of Ecology and Environment is responsible for supervising human activities in marine environment, and organizing the investigation, monitoring, surveillance and evaluation of the coastal environment. The Bulletin of Marine Ecology and Environment Status of China has been published annually for more than twenty years, and is responsible for directing, coordinating and supervising marine environmental protection work throughout the nation. In 2021, we monitored seawater quality in 1,350 national monitoring sites, 193 riverine sections flowing into the sea, 442 sewage outlets with daily discharge volume exceeding 100 tons, and 31 bathing beaches. We also monitored the marine sediment quality of 540 national monitoring sites and the ecological status of 24 typical marine ecosystems. The monitoring results showed that China's marine ecology and environment status remained stable in 2020. The overall quality of marine water was getting better, with 96.8% of the marine water under jurisdiction of China according with the Seawater Quality Standard Grade Ⅰ. In the coastal area, 77.4% of these areas had Excellent or Good water quality, up by 0.8% compared with the previous year. The polluted areas were mainly located at Liaodong Bay, Yellow River Estuary, Jiangsu Coast, Yangtze River Estuary, Hangzhou Bay, Zhejiang Coast, and Pearl River Estuary. The dominant indicators failing the Seawater Quality Standard were inorganic nitrogen and active phosphate. The health status of typical marine ecosystems remained stable overall. The water quality of all the monitored sea-entering rivers is Slightly Polluted on the whole, with no significant change compared with the previous year. The marine environment quality in the ocean dumping zones and oil/gas exploration zones basically met the environmental protection requirements for marine functional zones. The environmental quality of marine fishery areas was generally in good status. Both the frequency and the cumulative area of recorded red tides have slightly decreased from the previous year.

Relationship Between Moonlight and Coral Reef Organisms in Okinawa

Shingo Udagawa

University of the Ryukyus, Japan

Most of the organisms inhabiting a variety of environments on Earth synchronize their own ecological and physiological activities to their habitats. Periodic changes in the environment (e.g., circadian, circatidal, circalunar, and circannual) have a variety of effects on marine organisms. These are caused by the environment with cyclic changes in light and darkness (approximately 24 hours), tidal change (approximately 12.4 hours), moon phase (approximately one month), seasonal change (approximately one year), and so on. Most organisms have developed an endogenous clock that allows them to anticipate daily and seasonal changes and adapt their physiological, behavioral, and biochemical activity accordingly. Endogenous clocks are entrained to their local conditions by environmental cycles through input cues such as light or nutrition. In fish, entrainment of biological activity to habitat environmental factors is an important adaptive strategy and is essential for improving reproductive success and reducing predation risk. It is generally accepted that cyclic changes in the photoperiod and water temperature are potent environmental factors, and that daily and yearly periodicity in these factors is closely related to the initiation or termination and acceleration or deceleration of synchronous reproductive activity in fishes that inhabit temperate and higher latitudes. In the fishes inhibiting coral reefs, various reproductive events are known to be often synchronized with periodic changes associated with the Moon. This presentation will be introduced their moon-synchronized reproductive events, physiological changes, and the effects of moonlight on them, with a focus on the groupers (*Epinephelus*) and *Siganus,* which have been studied in my laboratory. Additionally, the impact of artificial light from our living environment (ELP: ecological light pollution) on marine organisms, for which light is an important factor in their ecological and physiological activities will also be introduced.

Environmental DNA as a Powerful Tool to Detect Fish Biodiversity in the Open Ocean

Tatsuya Kawakami

Hokkaido University, Japan

Monitoring marine biodiversity on a global scale, particularly the distribution of indicator species, will provide essential baseline data for uncovering changes in marine ecosystems. Recent advancements in the analysis of environmental DNA (eDNA), which is extra-organism DNA extracted from various environmental samples, have made it possible to obtain information about fish diversity in aquatic ecosystems in a less laborious, non-invasive, and cost-effective way. However, the majority of eDNA research has been conducted in freshwater or coastal environments, and applications in the open ocean are still uncommon. For the successful use of the eDNA survey to improve our understanding of marine ecosystems, it is recommended to conduct a pilot study.

This study aimed to evaluate the ability of eDNA to characterize the distribution of pelagic fish and detect a transition in fish species composition in the open ocean, covering multiple biogeographic zones. First, the fish community structure in pelagic water was analyzed using eDNA metabarcoding, which can comprehensively identify eDNA in a sample. During the Arctic cruise of the R/V Mirai (JAMSTEC) held in 2020, eDNA samples were collected latitudinally from the coast of Japan to the Arctic Chukchi Sea (45 sites in total). The result indicated a clear latitudinal cline in taxonomic richness (2–48 taxa per site), with a notable boundary in the Kuroshio-Oyashio transition zone. Successive clustering and ordination analysis revealed that the fish community composition derived from eDNA metabarcoding closely matched the conventional biogeographic classification of pelagic waters. Second, species-specific eDNA detection was performed on these samples to provide an overview of the distribution of polar cod, *Boreogadus saida*, throughout the Pacific Arctic region. The polar cod is closely associated with sea ice and is considered a key species in the Arctic ecosystem. Polar cod eDNA was detected primarily in the central part of the Chukchi Sea shelf and the vicinity of the sea-ice-covered region, indicating that polar fish prefer cold and low-salinity water.

These findings indicated that eDNA is a powerful tool for detecting fish biodiversity in the open ocean and describing the geographical distribution of target species across a wide range of oceans. Although several technical difficulties (such as reducing contamination risk, preventing false negatives, and ensuring the accuracy of taxonomic assignment) need to be overcome, eDNA can be a reliable tool for replacing or supplementing conventional approaches. In conjunction with oceanographic research, continuous eDNA surveys will enhance our understanding of the marine ecosystem.

How to Monitor Changes in the Marine Biodiversity in Jeju, Korea

Hyun-Sung Yang

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Increasing seawater temperatures driven by climate change have negative impacts on marine biodiversity. Jeju Island has been suggested as an area capable of supporting high biodiversity, due to its geographical position and the different water masses influencing the marine environment around the island. Jeju is located within temperate latitudes, but borders to environmental changes, providing an ideal testbed for assessments on life under rapid climate change. However, a major limitation of monitoring programs is the difficulty to compare and quantify results generated by different methods. The MarineGEO program from the Smithsonian Institution's Tennenbaum Marine Observatories Network (TMON) developed a quantitative, standardized method of sampling monitoring data, called Autonomous Reef Monitoring Structures (ARMS) to overcome these problems. This is the first report to provide an inventory of marine biodiversity from Jeju waters in Korea using ARMS. We deployed ARMS units in Jeju (Kangjung, Bomok, and Seongsan) in 2018. After 12 months, the ARMS units were retrieved and a taxonomic analysis determining the marine biodiversity conducted. A total of 191 marine species were identified from ARMS; 109 species from Gangjung, 106 species from Bomok, and 91 species from Seongsan. The most abundant phylum was arthropods, followed by mollusks, annelids, and echinoderms. So far, we found two new species of Osctracoda and one unrecorded species of gastropod from the ARMS units. We expect this baseline data will provide further information to detect “climate refugees”, i.e. newly extended species due to climate change, as well as species new to science of understudied taxa. These “climate refugees“ would disturb marine ecosystems as they compete with indigenous marine organisms. Besides investigating changes in marine ecosystems caused by climate change, and detecting invasive marine species, this standardized monitoring method (ARMS) is applied to understand the role of biodiversity in sustaining resilient coastal marine ecosystems under climate threat.

Identifying Patterns in the Multitrophic Community and Food-Web Structure of a Low-Turbidity Temperate Estuarine Bay

Hee Yoon Kang

Chonnam National University, Republic of Korea

Food web dynamics outline the ecosystem processes that regulate community structure. Challenges in the approaches used to capture topological descriptions of food webs arise due to the difficulties in collecting extensive empirical data with temporal and spatial variations in community structure and predator-prey interactions. We use a Kohonen self-organizing map algorithm (as a measure of community pattern) and stable isotope-mixing models (as a measure of trophic interaction) to identify food web patterns across a low-turbidity water channel of a temperate estuarine-coastal continuum. We find a spatial difference in the patterns of community compositions between the estuarine and deep-bay channels and a seasonal difference in the plankton pattern but less in the macrobenthos and nekton communities. Dietary mixing models of co-occurring dominant taxa reveal site-specific but unchanging food web topologies and the prominent role of phytoplankton in the trophic base of pelagic and prevalent-detrital benthic pathways. Our approach provides realistic frameworks for linking key nodes from producers to predators in trophic networks.

Using eDNA to Detect the Presence of Marine Invasive Species in Ports and Harbors

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Institute of Environmental Science and Meteorology, College of Science, University of the Philippines, Philippines

With the global extent of maritime trade, the risks for introducing marine invasive species in ports and harbors worldwide is great. A majority of member states of the International Maritime Organization (IMO) have acceded to the Ballast Water Management Convention of 2004 (BWMC) and the Antifouling Systems Convention of 2001 (AFS) which aim to reduce the risks of introducing non-indigenous and invasive species in ports. The IMO has set certain standards of ballast water release compliance, the D1 and D2 standards. The installation of ballast water treatment systems on ships have reduced the risk but not eliminated risks of marine invasive introductions. The current ecological count methods of assessing compliance are time consuming and tedious that only 1% of global shipping is regularly scientifically assessed. Environmental DNA (eDNA) metabarcoding presents a promising approach for rapid assessment of marine biological invasion risks in ports but presents certain methodological difficulties especially in the lack of environmental baseline and genomic databases. I present initial results of our research on tropical ports on eDNA and in ballast water that show the practicalities and promising directions of using eDNA in ballast water compliance assessment and in port ecological baselines.

Artificial Drivers of Jellyfish Blooms and Transport of Non-Native Species

Jinho Chae

Marine Environmental Research and Information Laboratory, Republic of Korea

Recent studies have perceived that the jellyfish increase is a global trend, portrayed as a symptom of ocean degradation. Changes in marine environments due to human activities could enormously contribute to the jellyfish abundance; overfishing, marine construction, eutrophication, global warming, etc., may benefit jellyfish populations over fish. However, others suggested that this perception is based primarily on a few case studies and anecdotal evidence. Thus, the perception of a worldwide trend toward increased jellyfish abundance may still be unsupported because of many exaggerated and sometimes even distorted information by citation mistakes and lack of confidence in existing evidence. We have examined the causation of jellyfish blooms, the impacts of newly found non-indigenous species on the endemic communities, artificial effects on jellyfish feeding and distribution for *Aurelia coerulea*, *Blackfordia* spp., and *Carybdea brevipedalia*, the ecologically interesting but often problematic jellyfish species.

Because the population size of polyps may be a crucial factor in determining the intensity of medusa blooms in the next seasons, we have located polyp populations of *Aurelia coerulea* and determined their total amount around the Korean coast using underwater photographs collected by SCUBA diving. Diving observation has been made approximately in ca 2,600 sites, finding substantial (significantly large) polyp populations from more than 800 sites. Downward-facing surfaces of various underwater artificial structures were the most frequently observed habitats of the jellyfish polyps. We found polyp populations in only one natural habitat. These results provide compelling evidence that the increase in coastal development and construction is the primary cause of the rise of *Aurelia coerulea*, the most frequent and large-scale blooming species.

Medusa individuals of *Blackfordia virginica*, non-indigenous hydromedusae, were first found at Shihwa Lake in 2013, while the polyps were photographed formerly in 2004 which were identified recently. *Blackfordia virginica* and *B. polytentaculata* were simultaneously found for the first time at Seomjin estuary in 2021. We first recorded these two congeneric species in Korean waters and examined their distribution in various estuaries, long-term population dynamics, and trophic relationships. *Blackfordia virginica* blooms (the highest mean density of 679.3 ind m^{-3}) almost every years in 2013-2020 in Shihwa Lake. Copepods and barnacle larvae were the primary food sources of the jellyfish, according to a stable isotope-ratio analysis. Copepods, the dominant prey, were exhausted soon after the hydrozoan blooms, and then bell shrinkage of the jellyfish occurred consecutively. *Blackfordia polytentaculata* in the Seomjin estuary was recorded only from its type location, Jiulong River, Fujian province in China before this study.

A very venomous box jellyfishes, *Carybdea brevipedalia* is a small to medium sized cubozoan only distributed in Japan and southern coast of Korea. We examined swimming and feeding behavior to understand the mechanisms employed by this species to capture its prey. Larger zooplankters such as decapod and fish larvae, mysids, and swimming polychaetes (> 0.2 Cmg^{-1} ind^{-1}) were the major prey items, while copepods (< 0.05 Cmg^{-1} ind^{-1}), the most predominant in the study area were little found in the gut. Feeding was minimal during the day. More than 80 % of individuals observed at 20:30-03:00 involved 1–6 prey in their digestion pouch. It was a strong vertical migrator, conspicuously ascending right before sunset. They distinctly elongated their tentacles under dark conditions. PIV analysis shows that it swims a long distance at night, the feeding time. Even though the species is a fast swimmer and voracious predator, having a complex visual structure including lens eyes, it is a passive hunter, fishing rather than hunting. Tentacle elongation and agile swimming are the most important means to succeed in feeding on the faster swimming prey. Ascending to the surface water at sunset may lead its position to more frequently encounter nocturnal prey species. We assumed the impacts of artificial light on their feeding rate because of the solid positive phototaxis to the collimated light, both predators and prey; however, the light pollution affecting their productivity has not been elucidated. The possible northward shift onto the eastern coast of Korea was found recently.

Workshop Location

Ara Convention Hall, Jeju National University

Address: 102, Jejudaehak-ro, Jeju-si, Jeju Special Self-Governing Province, 63243, Republic of Korea

From the Jeju Airport
Bus : No.500(Towards Jeju National University) Travel time: about 35 min.
Taxi : Travel time: about 20 min.

From City
Bus : (Towards Jeju National University) Travel time: about 20 min.
Taxi : Travel time: about 15 min.

A bus will be provided to the hotel-convention room and banquet hall.

Note-Taking

Note-Taking

Note-Taking

ASIA-PACIFIC NETWORK FOR
GLOBAL CHANGE RESEARCH

Key Indicator Species and Habitats for Marine Biodiversity Change in East Asia

NOWPAP
Northwest Pacific Action Plan

제주대학교
JEJU NATIONAL UNIVERSITY

中国科学院大学
University of Chinese Academy of Sciences

전남대학교
CHONNAM NATIONAL UNIVERSITY

国家海洋环境监测中心
NATIONAL MARINE ENVIRONMENTAL MONITORING CENTER

KIOST

CAU 중앙대학교
CHUNG-ANG UNIVERSITY

국립해양생물자원관
NATIONAL MARINE BIODIVERSITY INSTITUTE OF KOREA

HOKKAIDO
UNIVERSITY

UNIVERSITY OF THE PHILIPPINES 1908

UNIVERSITY OF THE RYUKYUS 1950

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