

## Summary Report of the 4<sup>th</sup> Joint Kuroshio Symposium : Effects of Recent Societal Changes on the Natural Environment in the Kuroshio-Related S-Shaped Zone

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### 1. Selection of the Study Subjects

The Fourth Joint Kuroshio Symposium held in Kochi, Japan, in November 2010, aimed at summarizing the results of the studies on the impact of recent changes in nature and the community on the ecosystem of the ocean and land areas in the Kuroshio Region and at determining the direction of the investigations and studies to be jointly conducted in the future mainly by the universities and institutes located in the Kuroshio-Related S-shaped Zone. It was expected that scientific networks on the Kuroshio would be further expanded, giving an additional impetus to investigation and study activities.

With these new prospects in mind, we selected "Effects of Recent Social Changes and Modifications to the Natural Environment on the Marine and Land-based Ecosystem in the Kuroshio Region" as the subject of the fourth Symposium. Based on this subject, the symposium intended to generally examine the methods of changing socioeconomic activities and life patterns affecting the environment in each country and to identify the priority subjects for our future joint studies.

### 2. Programs of the Symposium

The programs of the Symposium were divided into two categories: Part 1 "Marine-based studies" and Part 2 "Land-based studies," and the first day (November 6) was assigned to Part 1 with half of the second day (November 7), to Part 2. As is generally known, joint studies have already been conducted in the Kuroshio Triangle composed of Japan, Taiwan and the Philippines, and these marine-based studies have produced accumulated results. But land-based studies were first made in the present Fourth Symposium and thus we planned to give priority to increasing our mutual understanding through discussion of problems typical of the countries

and region concerned as our main themes. From the point of view of research methods, land-based studies are quite similar to workshops, and our main purpose at the Symposium was to discover the seeds of joint land-based studies in the future.

In the "marine-based study" session on the first day, the results of 16 studies were presented, and the status of a study conducted using sea kayaks, which was started at the source of the Kuroshio and has been extended to northern areas, was reported. In the "land-based study" session, four study reports were presented, and as a separately organized program, an outline from Tanjungpura University was reported.

On the third day (November 8), two excursions were conducted: one a visit to the Bay of Tosa, and the other, a tour to the Muroto Marine Deep Seawater Facility. We would like to express our deep gratitude to Usa Marine Biological Institute and Kochi Prefectural Deep Seawater laboratory for their cooperation with us in the excursions.

### 3. Summary of the Study Reports

This section summarizes the reports presented at the two sessions of the Symposium. For more details, please refer to the Appendices at the end of this publication.

#### Part 1. Results of recent "marine-based studies"

##### 1) Investigations and studies in the socioeconomic field

The report of Nieves, *et al.* (1-1) is based on a socioeconomic survey conducted on San Miguel Island, Tabaco, Albay Province, Bicol Region, the Philippines, and analyzes the impact of the Reming Typhoon (locally known as the Durian Typhoon) which struck the area. This typhoon had surprising destructive power and was said to be the greatest in the past half century. It caused serious damage to the district. But while the area has

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Joint survey of damage on San Miguel Is. from the typhoon "Lemin" (Dec. 2006)

been exposed to natural disasters, including climate changes, farming is being carried out and this has been increasing demographic pressure on the land. The report examined the situation there finding that the ecosystem has been deteriorating more and more due to these anthropogenic effects as well as natural impacts. The report also remedial measures.

Taking the case of the Marine Protected Area (MPA) established in the Lagonoy Gulf, Bicol Region, the report of Bradecina, *et al.* (1-2) discusses the situation and problems of the management of the MPA by the local inhabitants. The discussion is based on the Post-Socioeconomic and Resource Assessment carried out in 2005. The authors classify the type of MPA management into three according to how inhabitants and local governments have been involved in the management work, and examine the efficiency of the three types. Using the theory of the commons, they conclude that the case where inhabitants and their local government join hands to manage the MPA is the most desirable management system. This report can be regarded as a descriptive paper.

The report of Shinbo, *et al.* (1-3) examines the costs and benefits of the MPA of San Miguel Island. What is especially noteworthy is that they discussed the external economy of the MPA and expanded the viewpoint of their evaluation to the spillover effect that the cultivation of juvenile and larval fish has on the growth of adult fish in other sea areas, the effect on leisure activities and the contribution to recreation including diving and other similar activities and effects of cultivation in promoting biodiversity of the ocean ecosystem. The report also included the results of a multi-faceted analysis of the

MPA, including the management of *Bantay-dagat* (sea guard) organized to guard the coastal areas and also dealt with the idea of applying cost concepts to the scientific support from Bicol University.

The research team at National Sun Yat-sen University in Taiwan, including Lin(1-4), compares the Kenting Marine Protected Area in Taiwan to the MPA of San Miguel Island in the Philippines. Using the mitigation-adaptation model, they examine the measures to not only protect an ocean ecosystem greatly damaged by climate changes, especially typhoons that have grown larger in scale, but also to provide the ecosystem with enough resilience to cope with the impact of such climate changes. The team here proposes three steps for the ocean ecosystem to deal with such impacts, including the establishment of revival sites for particular fish species in the MPA. Their report offers a number of suggestions as to an ideal way to manage the coastal ecosystem more carefully by adopting the scale and zoning of the MPA that would enable the ecosystem to cope with external pressures.

## 2) Seaweeds: biology and medical science

In general, macroalgae are anchored on rocks and grow under the given environment. They need to differentiate cells or tissues to hold the bodies in an early developmental stage. The study by P. Elvira *et al.* (2-1) revealed that young *Valonia* cells were artificially induced to produce rhizoids adhering to substrata and secreted specific polysaccharides from Golgi bodies over the outer surface of the cell wall. It was suggested that the accumulation of the polysaccharides between cells and substrata might induce rhizoid formation. Details are reported in this Journal in the form of a scientific paper.

Tominaga *et al.* (2-2) reported that sea algae polysaccharides can activate cells through the receptors for natural immunity on the cell surface of other organisms. They examined the anti-allergic activity against delayed-type hypersensitivity and anti-tumor activity of sea algae polysaccharides. In particular, *Petalonia binghamiae* polysaccharides suppressed the inflammation caused by delayed-type hypersensitivity by reducing the production of interleukin-17, one of the cytokines that mediate the communication between cells including leukocytes. They also inhibited the migration of eosinophils that deteriorate the inflammatory response to the site of inflammation. Thus, they showed us that sea algae polysaccharides are useful to regulate immune responses

which sense the molecules in nature.

### 3) Ocean biology and ecology

Tanaka, K. *et al.* (3-1) have continued the year-to-year survey into what effects the temperature of seawater, which has shown a rising trend since the mid-1990s, has had on the distribution of *Sargassum fulvellum* (Phaeophyta), which forms important seaweed beds in the sea off the coast of Kochi Prefecture. Their report confirmed, based on the result of the investigation of the specific composition of *Sargassum fulvellum* from 2006 to 2009, that of the 14 species of *Sargassum fulvellum*, *S. duplicatum*, a tropical species, has the highest distribution and *S. micracanthum*, *S. yamamotoi* and some other temperate species have a high distribution, too. By classifying these species into five categories and comparing their distribution with the situation from the 1970s to the 1990s, they found that the tropical *Sargassum fulvellum* has gradually taken the place of temperate seaweed and that seaweed beds have tended to decrease in the past three years.

The report of Shashank, *et al.* (3-2) is a follow-up to the study on the evaluation of the impact of global warming on the ocean ecosystem which their research team has continue to investigate. Their study has been broken down by day and hour, season and geographic condition and has examined the state of the damage caused to the growth of healthy coral by rising seawater temperatures. In addition, the series of studies have collected detailed data concerning the physical impact of such factors as contaminated seawater, typhoons, changes in light and oxidation as well as biological effects, including diseases and the competitive relations of coexisting seaweeds and seagrasses. Based on the observation of cases in the sea areas of Taiwan, the present report discussed the diverse effects of higher sea-

water temperatures and human activities on coral and on biodiversity.

Orui *et al.* (3-3) collected brackish copepods in the four sea areas, i.e., the Kuroshio area in the Philippines, the Nansei Shoto Islands, in Western Japan north of Kyushu, and in South Korea. As a result, they discovered that the fauna of copepods greatly differs among these four areas, and it was supposed that the Kuroshio and the Tsushima Warm Current serve as barriers to the dispersion of brackish copepods. When they analyzed the genes of the widely distributed species of the copepods collected, they found that genetic differentiation and geographical distribution coincide with each other for some of them but do not for the others and that the phytogeographic pattern differs from species to species.

To examine the relation between the seasonal and yearly changes in the copepod fauna and the environmental factors in the inner areas of bays in the Sea of Ariake, Kyushu, Japan, Beltrao, *et al.* (3-4) collected plankton and measured nutrient salts in the sea area on a monthly basis. For copepods (including larvae), *Oithona davisae*, *Microsetella norvegica*, *Paracalanus crassirostris* and *Acartis* sp. were the dominant species. While *Oithona davisae* was dominant for almost all of the samples collected, *Microsetella norvegica* and *A. omorii* were dominant in September 2005 and March 2006 respectively, indicating that there were yearly changes in the dominant species. In addition, cluster analysis indicated hourly fluctuation of copepods and showed the relationship between species and environmental factors leading to similarities within the same group and dissimilarities between different groups.

Chiu, *et al.* (3-5) reported the results of their recent study of the physiological mechanism and ecology of the hagfish. Hagfish is a primitive craniate and belongs to the group of vertebrates. It is considered that a total of about 60 species of hagfish live in the world either in shallow or deep seas, of which 11 species have been observed in Taiwan, and this fish displays a great biodiversity. The reporters analyzed the most primitive of the species and confirmed that these species have a photoreceptor in their tails, which strongly reacts to light. They also found that the content by percentage ratio of Cd, Hg or As differs according to species and body part that this difference is caused not only by the different environmental factors of the deep seas but also by differences in the mechanism of absorption and accumulation. Their report examined the situation of excessive fishing



Scene of a presentation at Kochi Univ. (Nov. 2010)

in Taiwan as well as these physiological aspects together with the trend of related studies in recent years.

#### 4) Ocean resources and socioeconomic conditions

Akmar, *et al.* (4-1) reported on the ecology of razor clams (*Solen* spp.) known as “ambal” in the State of Sarawak, Malaysia. Razor clams have a high market value and are favorite foods for the general public and are thus known as a bivalve favored by both producers and consumers. Because this clam is fished recklessly, it is important to protect the resource, and the researchers examined the present conditions looked at an ideal method for the sustainable use of razor clam resources in comparison with the research conducted in Ehime Prefecture, Japan. In particular, they analyzed changes in the number of razor clams in the clamming season continuously collected for many years and found that vicious practice of excessive fishing has made it very difficult to restore razor clam resources.

The report of Mok, *et al.* (4-2) was concerned with the results of the study on the sounds emitted by the marine life, especially fish, collected from the fishing ports on Peng-hu Island and the lagoons and mouths of the eight largest rivers in Taiwan. The locations where most of the sounds were recorded were the fishing ports where angling can be enjoyed, while eight types of sounds were observed in the lagoons and the shallow parts of the rivers. The reporters compared the sounds recorded with the sounds emitted by soniferous fishes (catfish, etc.) and other similar noises in an attempt to help identify sound-emitting fishes. The sounds recorded at the fishing ports were supposed to be those of carangid species, and the reporters also referred to the result of the comparison of these sounds with those of the same species living in the fishing ports in Kochi, Japan, and presented their findings as to how a bioacoustic study would contribute to the management and protection of fishes.

Paying attention to sipunculans living in coastal waters, Hsieh, *et al.* (4-3) reported the result of their examination of various environmental effects on this animal by analyzing the heavy metals accumulated in its body. While this animal is eaten or used as a supplementary food in some countries in the southwestern Pacific, it is an animal which accumulates pollutants in its body through the food chain. In this study, the researchers measured the heavy metals stored in the two Sipunculans species, one of them collected in a coastal marsh and the other, in a seagrass bed, in Taiwan. Heavy metals were detected in both of the samples and in order of the quan-

tity measured were Cu>Cd>Zn>As>Hg>Cr. It was supposed that these heavy metals which accumulated in the body of Sipunculans were taken from the deposits on the sea floor.

Ame, E., *et al.* (4-5) reported part of their research on coastal areas in the Province of Cagayan in the north of Luzon, which has the richest ecosystem with the highest biodiversity of the countries under the influence of the Kuroshio. The mangroves and seagrass and coral communities in Cagayan are known as the spawning sites of tuna, eels, lobsters and other expensive marine products. But population growth and disorderly fishing activities in recent years have resulted in the loss or scarcity of these marine resources. The reporters studied the socioeconomic conditions of fishers and the state of biophysical resources in the four communities in the coastal region and found that improvement in fishing implements, illegal fishing methods and unlawful conversion of mangrove areas into fishponds have robbed the coastal ecosystem of its restorative capacity, thereby resulting in the destruction of the ecosystem. They also discussed the awareness of the inhabitants in the coastal areas about how to cope with problems caused by these human activities.

The theme of the report of Ame, R., *et al.* (4-6) is Nypa palm which is used as the material for the roofs of houses in the Philippines. Nypa is a tree found in mangrove forests in brackish waters and is in wide use as a food, medicine and construction material. While this tree has such wide use, there has been an increasing trend in recent years toward rapid conversion of Nypa palm farms into aquaculture ponds, which has produced the problem of soil erosion and highlighted the importance of the pro-



Meeting with Dr. Khairuddin A.Hamid (President of Sarawak Univ., center) in Kyoto



Scene of a mountainous village in Ohtoyo, Kochi

tection of coastal areas. The reporters investigated the situation whereby mangrove forests containing *Nypa* palm have been turned into aquaculture ponds and they assessed the effect of such practices on the ecosystem in the area, referring to the fact that land use involving the participation of inhabitants has played an important role in the sustainable use of resources.

The report of Soliman, *et al.* (4-6) is noteworthy in that it reports the executive order issued by the city, a new step taken in the MPA in San Miguel Island mentioned earlier. In the Philippines, local governments play a major role in the management of the MPA. But recently, while the local governments are taking software measures, such as restoring coral, planting mangrove trees and establishing no-fishing zones, fishers are demanding hardware steps, including imposing the mesh size limit, allotting the catch quota and introducing technical measures. Because of this, in 2010, the city issued an executive order that outlining the rules about (1) the prohibition of fishing for rabbitfish (*Siganus fuscescens*) from February to April and (2) the conditional fishing of grown fishes. The researchers reported the results of their study into the kinds of specific effects the executive order achieved.

## Part 2. Ecology of forests and the protection of nature

The first report of Part 2 of the Symposium presented by Masaru Tanaka (5-1) dealt with the new concept of studies on the interaction among forests, rural areas and coastal waters, paying attention to their interrelations. The findings from the reporter's field studies in the Ariake Sea for many years, which are summarized

as "Forests rear fish," is now attracting much attention as a new viewpoint for examining environmental problems in Japan. An outline of the concept is separately cited in the following Section 4 of this report.

The next report, Iiguni (5-2) makes a comparative examination of various problems facing Kochi Prefecture, the area having the highest ratio of forests in Japan. While an excessive use of forests is the cause of forest problems in other countries, too little forest use poses a serious problem in Japan. After the war, tree planting was carried out on a large scale in Japan aided by great rises in lumber prices. But the subsequent liberalization of the domestic lumber market caused sharp declines in the price of wood and resulted in devastated forests where planned thinning had not been carried out. Thinning is essential in recovering the ecosystem and the water recharging capacity of forests, but most forest owners have moved to other districts and have been unable to carry out any economically viable forest management, which would require at least 200 ha of forests. Now is the time to totally change the mechanism of forest management, including reviewing the ownership of forests.

Wasli *et al.* (5-3) reported on the natural environment, tribes and agriculture of the State of Sarawak, Malaysia, and the changes therein, especially the case of the shifting cultivation of the Iban tribe. Iban originally lived by shifting cultivation of short cropping periods and long fallows. The researchers reported that Iban have recently come to use the land around their communities for shifting cultivation continuously, and described how such shifting cultivation land is now used almost as regular farmland and how land far from Iban communities has not been used and has been left unattended as secondary forests. The authors found, as a result of their field studies and soil analysis, that while the secondary forests should be highly rated from the standpoint of the restoration and conservation of forests, the species composing these forests and the volume of their vegetation are inferior to those of natural forests when the period of being left unattended is only 50 years or so.

The report of Kato (5-4) assessed the effects of discontinuous eutrophication on lakes using a mathematical model built on the basis of the findings of his past field studies. This is a study on the phenomenon of a sudden change from an oligotrophic state into a eutrophic state by an excessive load of phosphorous flowing into the lake from the river. As a result of the model

analysis, Kato found that the average water depth and water temperature of the lake have an important role in discontinuous eutrophication and in post-eutrophication improvement in water quality. It was in the case where the average water depth was on a medium level that discontinuous eutrophication was most likely to occur and that improvements after the deterioration of water quality were most difficult to effect in such situations. This suggests that while plants along the lake work to dilute phosphorus in a shallow lake and deep water layers work to do that in a deep lake, there exist specific water depths where neither of these two effects come into play.

Finally, Mr. Elvira of Tanjungpura University, who was invited to attend the Symposium for the first time, reported on the general situation of his university (Topic B).

#### **Topic A: Kayak investigation**

Yahata *et al.* reported on their experience in the investigation of sharing the sense of the "sea" with the inhabitants of the survey area. These sharing activities were conducted on a hand-rowed boat (a two-seater sea kayak) locally known as a "banca" in the Province of Catanduanes, Bicol Region, the Philippines which is located at the source of the Kuroshio. The reporters have many years of experience in sailing on the ocean by sea kayak and started this large-scale plan in 2010 together with Professor Kosaku Yamaoka, Kochi University. The main purposes of the activities are to allow people to experience the natural and social environment in a unified way and to observe people's lives not separately in each place but more broadly in many areas while building up a closer relationship with local people in anticipation of the possibility that environmental changes now occurring in the Kuroshio area in the Philippines will spread to Japan in the future.

#### **4. Newly Integrated "H<sub>2</sub>O" Studies**

Dr. Masaru Tanaka, the Guest Speaker at this Symposium, treated us to a special lecture relating to his basic concept that "The mountain/forest breeds marine fish juveniles" based on his field studies ranging over 30 years. The following is adapted from his abstract on "Newly integrated studies covering from the headwater to the ocean "H<sub>2</sub>O Studies": Basic concept for nature conservation and sustainable human society".

Terrestrial and marine ecosystems have been nec-

essarily linked to interact with each other to maintain biological diversity in both ecosystems. However tremendously expanding human living and industrial activities have seriously damaged this essential linkage during the last half century. When looking at the present coastal marine ecosystem, we easily find substantial loss and seriously deteriorated boundary areas resulting mainly from anthropogenic effects both terrestrial and marine systems such as tidal flats, seaweed and grass beds, sandy beach, mangrove estuaries and coral reefs. All of these are recognized as essentially important nursery grounds for marine fish and invertebrates, and human beings are faced with declining fishery resources.

The previously established idea is that both ecosystems are independent of each other, but the author and his group have verified an intimate linkage between marine and terrestrial ecosystems primarily based on more than 30 years of model estuarine ecosystem research conducted in the Ariake Sea located in the western part of Japan. The major result has been the conclusion that "The mountain/forest breeds marine fish juveniles." Combined with additional sources of indirect evidence the author proposed the more sophisticated idea, a newly integrated study on the intimate linkage of forest-sato (human habitation)-sea in 2003. The key substance intimately linking each element is water, which always circulates among sea, atmosphere and land (forest). Furthermore water is the most important substance for not only human beings but also for all living organisms on the earth.

The author recently proposed "H to O studies" in 2010 as a name for the newly integrated studies established in 2003 as a common set of global studies. H indicates headwater and O, ocean. When we convert "to" to "2" we come up with the name H<sub>2</sub>O Studies. Terrestrial and marine biodiversities provide us with many ecological benefits, but we should consider ecological benefits as being on the linkage of terrestrial and marine ecosystems.

#### **Topic B: Research and Education**

Dr. Elvira introduced an outline of the research and education at Tanjungpura University in Indonesia (p. 125).

#### **5. Conclusion**

The participants in the Fourth Joint Kuroshio Symposium included those from Sarawak University in Malaysia and Tanjungpura University in Indonesia, in



Dr. Chairil Effendy (Rektor/President of Tanjungpura Univ., front) at MOU Ceremony

addition to those from the cooperative universities and organizations in Japan, Taiwan and the Philippines. A total of 22 reports were presented at the two sessions, i.e., the marine-based study and land-based study sessions, and there were 90 participants at the Symposium.

These reports covered a wide range of study fields and may be summarized into the following three categories:

First of all, "marine-based studies" have made considerable progress. At the past three symposiums, a common understanding was developed among participants regarding the problems facing the countries in the Kuroshio Region, namely, the deterioration of ocean ecosystems in coastal waters and the measures to be taken to cope with this situation. The reports presented at the latest Symposium were roughly based on this common understanding and dealt with conditions whereby the balance of the ecosystem started to be destroyed rapidly not only in seaweed beds and mangrove forests but also in coral reefs and other areas. This phenomenon has strongly been affected by anthropogenic and natural factors in a multifaceted way. In addition, as shown in the report from Taiwan, a remarkable accumulation of heavy metals through the food chain has been observed in hagfish and Sipunculans. In Sarawak, Malaysia, too, fears about the biological reproduction of a bivalve (razor clam) have begun to grow due to the excessive fishing of the bivalve. Much attention was focused on the examination of the actual state and mechanism of the deterioration of the bivalve's resources.

Mention should also be made of the fact that the results of related fundamental studies were reported. These studies suggested that Kuroshio waters contain a vast unknown world and would provide us with many

study subjects, including the mechanism of matrices attaching to large seaweeds, the identification and phyto-geographic pattern of copepods, the dominance of water fleas and the analysis of sounds emitted by fish.

The second category concerns the evaluation of activities regarding MPAs aiming at protecting the coastal ecosystem and the environment. The reports were concentrated on the investigations in the Philippines where local inhabitants are working with the head of the municipalities to establish and reinforce the function of MPAs, and we can view the background of increasing interest in the MPAs in that country as pioneering work considering the fact that the Kuroshio has its origin off the Philippines and goes up north from there. Important findings were reported regarding the costs and benefits of MPAs, new steps to protect the MPAs from climate changes and anthropogenic impacts and the fostering of cooperation with administrative organs. Special attention should be paid to the activities aimed at more advanced environmental conservation observed in, among others, the physical measures like the establishment of the no-fishing period and control over the fishing of adult fish introduced in Tabaco City, the case cited as an example. The comparative study by the Taiwanese team on the situation on San Miguel Island and that in Taiwan seems to suggest that the research on the Kuroshio Triangle has reached a new stage.

Third, there were some attempts to examine new frameworks for unifying land-based studies with marine-based studies for the countries in the Kuroshio-Related S-Shaped Zone, which include Malaysia and Indonesia in addition to the nations in the Kuroshio Triangle. As we have already realized at the past symposiums on marine-based studies, the integration of the humanities and sciences and studies covering both marine and land studies is no easy task. At the present Symposium, we were able to get some helpful hints for our future joint studies, such as the approaches for examining the environment as a whole and the selection of priority subjects for such examinations, on the basis of the concept of "study on the interaction among forests, rural areas and coastal waters." A preparatory period of several years will be needed in order to discuss problems of forests in Kochi, Japan, and Malaysia and to describe these problems more specifically while increasing our understanding of the nature of the issues. We should study the problems with which the countries in the Kuroshio Region are commonly faced by building up scientific information slowly but steadily.

#### Summary Report of the 4th Joint Kuroshio Symposium

As for the papers presented at this Symposium, we will have to realize that the studies were concentrated on the cases in the Philippines . There were only four reports from Kochi. Moreover, more time was spent on presentations than expected, which made it impossible for us to have any time for general discussion.

Considering these problems, we will examine the overall organization of symposium programs more carefully for next year's event.

Thanks to the cooperation of National Sun Yat-sen University, the Fifth Joint Kuroshio Symposium will be held in Kaohsiung, Taiwan, in December 2011.



The University of Sarawak, Malaysia (from HP)



The University of Tanjungpura, Indonesia (from HP)