

Summary Report of the 5th Joint Kuroshio Symposium: Adaptation to Climate and Socio-economic Changes

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Tse-Min Lee and Jeng-Di Lee**

Session I - Global Change and Ocean

Organizer: Chin-Chang Hung

The purpose of the session Global Change and Ocean was to describe and review some oceanographic phenomena associated with the Kuroshio Current. A total of eight papers were included. The keynote speech of the symposium, delivered by Dr. Mitsuo Uematsu, and entitled "Linkages in the biogeochemical cycles between the surface ocean and lower atmosphere over the western Pacific Ocean", serves as an introduction to this session.

Dr. R.S. Tseng's talk on "Measurements of turbulent mixing in the surrounding waters of Taiwan" brought forward similarities and differences in the turbulence characteristics among Penghu channel in Taiwan Strait, the northern South China region close to the Luzon Strait, and the Kuroshio vicinity region in southeastern Taiwan. Island wakes with a strong dissipation rate can be observed on the east coast of Taiwan caused by the impingement of Kuroshio.

"The Kuroshio east of Taiwan: general properties and the importance of island effect" was presented by Dr. Ming-Huei Chang. The wake induced by current-island interaction on the east coast of Taiwan could significantly change the current's flow patterns and properties. Large differences in flow characteristics upstream and leeward of Green Island, located southwest of Taiwan in the main Kuroshio axis, were observed. The vertical shear was believed to drive the turbulent mixing and thus to produce the cold and salty dome in the wake.

Dr. Sen Jan talked about "Evolution of the Kuroshio water east of Taiwan". Factors affecting the variation of the Kuroshio (e.g., direction of the monsoons) were discussed. Upcoming projects "Observation of the Kuroshio Transports and their

current's flow patterns and properties. Large differences in flow characteristics upstream and leeward of Green Island, located southwest of Taiwan in the main Kuroshio axis, were observed. The vertical shear was believed to drive the turbulent mixing and thus to produce the cold and salty dome in the wake.

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Dr. Yuh-ling Lee Chen reported evidence in her talk, "Nitrogen fixation of *Trichodesmium* and its significance in the trophic system of the Kuroshio" that through the *Trichodesmium* to diatoms pathway, the nitrogen from *Trichodesmium* N₂ fixation could be the source that supplies the nutritional needs of pelagic fish in the Kuroshio.

The talk, "Export flux of particulate organic carbon in the Kuroshio off Taiwan" was presented by Dr. Chin-Chang Hung; seasonal change in particulate organic carbon export fluxes in the main stream and lower Kuroshio near northeastern Taiwan was reported (being high in spring) and the mechanism (wind-driven vertical mixing) was proposed.

Wen-chen Chou reviewed a decadal change in seasonal CO₂ absorption in the inner shelf of the East China Sea near the Changjiang Estuary. The difference of pCO₂ between the atmosphere and the surface water was appreciably increased in spring and summer, but decreased in autumn and winter from the 1990s to the 2000s in the East China Sea shelf. It was suggested that this season-

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al shift in pCO₂ may be associated with the increased eutrophication/hypoxia in the Changjiang plume and the impact shelf over recent decades.

Dr. Yi Chang presented an important and interesting talk on the long-term observation of the Kuroshio front in the northern Taiwan. Satellite-derived sea surface temperature (SST) during the period of 1985 to 2010 was used for investigating the seasonal and annual variation of Kuroshio in northern Taiwan. The results indicated that the Kuroshio in this region varied seasonally, and it might have shifted further offshore in recent years. This offshore movement of Kuroshio may reduce its subsurface upwelling along the continental region, and has resulted in an increasing SST and decreasing net primary production.

The subject of the talk, "Socioeconomic, ecological and institutional impacts of super typhoon Reming on a community-based mangrove rehabilitation project in Malinao, Albay, Philippines", presented by Ma. Josefa Pelea, differed from the main topic of this session. This study dealt with the economic effects of typhoons in the Kuroshio related region and their impact on a community-based mangrove rehabilitation project in the coastal municipality of Malinao, southern Luzon. Damages to crops, physical assets, and livestock, property were estimated. The old mangrove forest population was found to be slightly impacted but the forested mangrove was dramatically reduced. The ecological impacts showed a decline in fish catch and reduced production of nypa leaves for nypa-shingle making. Institutional performances in resource management and livelihood sustainability plans were negatively impacted. With regard to overall NRM goals, the typhoon resulted in slight positive changes on stakeholders influence on mangrove resource management, control over resources, collective decision-making, and knowledge. Coping mechanisms and implications for disaster mitigation and sustainable management were discussed. (Hin-Kiu Mok)

Session II - Global Change and Kuroshio Ecosystem

Organizer: Yoshinori Morooka and Allen Chen
Summary of this session is written as a separate article following this summary report.

Session III - Biodiversity

Organizer: Keryea Soong

A total of 11 papers were presented in this session of Biodiversity; most speakers were from Taiwan, with one from the Vietnamese/Chinese coast, many of the works were results of international collaborations.

Kuroshio is an effective dispersal agent, this is exemplified in the work of Professor Hsi-Te Shih from National Chung-Hsing University. His works focused on the distribution of fiddler crabs in east Asian islands. At the species and the population levels, there is no evidence of differentiation between crabs from the localities in the Kuroshio and the Kuroshio Branch in the Taiwan Strait. Presumably, these crabs originated from southern localities upstream of Kuroshio.

Professor Showe-Mei Lin, National Taiwan Ocean University, has been working on marine plants of Taiwan. Among the over 500 species of macroalgal species recorded in southeastern Taiwan, a close resemblance to that of northern Philippines and the Indo-Pacific basin is noticed. The role of Kuroshio in the distribution of these marine benthic species is clear. Using molecular tools, Showe-Mei Lin is presently focusing on the phylogeny of red algae.

The work of Dr. Chienhsun Chen, Taiwan Ocean Research Institute, National Applied Research Laboratories, along with Professors Chang-Feng Dai, Chaolun Allen Chen, Ruby Moothien Pillay, Sakanan Plathong and Avigdor Abelson of different countries, on a hermatypic stony coral, *Seriatopora*, revealed that Kuroshio is a powerful vector in mixing the populations in the northwestern Pacific. Their work, based on mitochondrial DNA, studied lineage diversification and phylogeography. Results of haplotype network and pair wise comparison revealed a panmixia and population differentiations depending on the regions of samplings. Generally, populations from the South China Sea and the Kuroshio form a panmixia with little genetic differentiation; in contrast, genetic breaks among populations from the Red Sea, Mauritius, Similar Island, and New Caledonia were obvious.

Dr. Hsiu-Chin Lin presented a paper coauthored by Drs. Jeng-Ping Chen, from the Taiwan Ocean Research Institute, National Applied Research Laboratories and Mr. Cheing-Hua Huang, Miss

Jen-Wei Kuo, Jing-Yi Chen, and Dr. Kwang-Tsao Shao, from the Biodiversity Research Center, Academia Sinica. They suggest that there are two marine fish assemblages, one representing northern Taiwan and northern Pescadores Island (in the Taiwan Strait), and the other comprised of the southern Pescadores, southern Taiwan, Orchid Island, Green Island, as well as Dongsha Island and Spratly Island in the South China Sea. The mechanisms of this division, in addition to Kuroshio, are temperature, substrate type and the Southwestern Monsoon Current. A transitional zone in Taiwan Strait has been identified; it occurs at the "Southern Four Islands" in the southern Pescadores.

For the gobies that inhabit river habitats, the story is different. This is the work of Professor I-Shiung Chen, National Taiwan Ocean University. At the species level, in Taiwan, the Ryukyu Islands and mainland Japan, some speciation was an obvious result of isolation as exemplified by several endemic species. Presumably, Kuroshio is not able to facilitate the exchange genes among populations of these gobies adapted to totally freshwater life histories. However, they are related at more than the species level. Dr. Chen suggested that during glacial periods, when the water level was much lower, a certain extent of migration may facilitate movements and exchanges among the three regions, especially in northern Taiwan.

As a strong current, Kuroshio also carries species that are considered a threat to the coral reef ecosystem. One such possible case is the black sponge *Terpios hoshinota* which is known to cover and cause mortality of stony corals. Mr. Guan-Yu Chen and Professor Keryea Soong of Institute of Marine Biology, National Sun Yat-sen University, tested different hypotheses which explain the decline of the sponge despite the lack of obvious negative factors. Their experiment suggested that typhoons play a key role in inhibiting the sponge population. A shortage of typhoons, together with other factors, on the other hand, may explain the outbreak of the sponge.

The team of Jih-Terng Wang, Euichi Hirose, Chia-Min Hsu, Yi-Yun Chen and Chaolun Allen Chen from both Taiwan and Japan investigated the same sponge but used a different approach.

They focused on the fronts between the sponges and the affected corals. Different behaviors of the sponge could be distinguished when it encountered different corals. They reported that the larvae of sponges have very limited dispersal potential due to their negative buoyancy, and the short duration of the larval stages. This seems counter-intuitive, since *Terpios hoshinota* is distributed mainly along coasts of the Kuroshio region. It remains to be studied how the sponge cross the ocean.

Also in the Kuroshio are the shallow hydrothermal vents (HV) at Kueishan Island to the northeast of Taiwan. Professor Jiang-Shiou Hwang and his colleagues of National Taiwan Ocean University, studied the effects of HV seawater on the survivorship of copepods. In addition, the effects of HV seawater on the morphology of a scleractinian coral *Acropora valida* were investigated. Their results indicated that the erosive effects on coral skeletons are obvious, leading to the conclusion that HV seawater inhibits coral growth. This explains why there are so few corals near the hydrothermal vents.

Professor Li-Lian Liu and her colleagues, on the other hand, were interested in the vent crab *Xenograpsus testudinatus* which is abundant near the hydrothermal vents. Besides the local food chain relationship, they discovered that the protein expression of the crabs was dependent on the types of vents the crabs were found in. The protein expression patterns, however, could change after 12 hours of treatment.

Professor Jen-Chieh Shiao and Shi-Wei Wang of Institute of Oceanography, National Taiwan University, and their collaborators Kotaro Yokawa, Momoko Ichinokawa, and Yukio Takeuchi from the National Research Institute of Far Seas Fisheries, Japan, used stable isotopes to identify the natal origins of Pacific bluefin tuna *Thunnus orientalis*. This was possible because there are two spawning grounds, for the species one in the northwest region of the Philippines Sea, and the other is in the Japan Sea. Although the spawning seasons in the two regions differ, being earlier in the former than in the latter, there is still a water temperature difference which is reflected in $\delta^{18}\text{O}$ in the otolith. Thus, the origin of individual fish

could be identified even years after they were born.

Ayu, a popular fish in Japan and Taiwan, also occurs on the coast of mainland China and Vietnam. Mr. Hau D. Tran and his colleagues in Japan (Izumi Kinoshita, Kensaku Azuma) and Vietnam (Thuy T. TA) studied their temporal distribution along the northern coast of Vietnam. There was little differentiation between *Plecoglossus altivelis altivelis* and *P. a. ryukyuensis*. The pelagic larvae occurred from December to February, and the immigrated larvae, from early January to late February.

Professor Hsing-Juh Lin and his colleagues from the Department of Life Sciences, National Chung Hsing University, studied the seagrass ecosystem at Dongsha Atoll, in the north part of the South China Sea. Extensive areas of seagrass occur in the shallow waters of Dongsha Island. Adopting an ecosystem approach, they assessed the leaf production, detrital export, herbivory, decomposition and carbon storage rates. In short, the carbon storage rate was approximately 282 g C m⁻² yr⁻¹. Their data suggested that seagrass beds are important carbon sinks.

Session IV-Marine Resources and Management Organizer: Shui-Kai Chang

The session of Marine Resource and Management was coordinated by Prof. Shui-Kai Chang of National Sun Yat-sen University. The session had five subjects (sub-sessions): marine fish resources in the Kuroshio Current, marine non-fish resources including both precious coral and deep ocean water, marine protected areas and the social impact from changes in marine resources. Each subject had three to four presentations, and altogether there were 17 presentations in this session.

1. Marine Fish Resources

The first sub-session was on marine fish resources in the Kuroshio Current off Taiwan and was chaired by Prof. Shui-Kai Chang. This subject had four presentations on four marine target species by the Taiwanese offshore fisheries in the region: flyingfish, dolphinfish, billfish and sunfish. Among them, three presentations were from

Taiwan and one from the Philippines.

The first presentation on flyingfish "Species composition and distribution of the dominant flyingfishes (Exocoetidae) in the Kuroshio Current off Taiwan and growth estimation of the *Hirundichthys oxycephalus*" was provided by Prof. Shui-Kai Chang of the National Sun Yat-sen University. It introduced the species composition of the flyingfish in the Kuroshio Current off eastern Taiwan, and the horizontal/vertical distribution of the dominant species, based on a nation-wide in-port sampling program and a fishery-independent at-sea survey program between 2008 and 2010. Six species were identified as the dominants: spotwing flyingfish (*Cypselurus poecilopterus*), limpidwing flyingfish (*Cheilopogon unicolor*), blackwing flyingfish (*Cheilopogon cyanopterus*), bony flyingfish (*Hirundichthys oxycephalus*), greater spotted flyingfish (*Cheilopogon atrisignis*) and sailfin flyingfish (*Parexocoetus brachypterus*). The presentation also introduced results of growth estimation and cohort dynamic of the bony flyingfish. The asteriscus was determined to be the most suitable one for determining the age of the fish. Age (in days) was calculated by counting the number of growth increments, using the whole otolith method, and adding 11. Bony flying fish caught off the southeastern coast of Taiwan ranging in length from 54.0 mm to 229.2 mm were subsequently estimated to be between 38 to 254 days old. The L_{∞} and growth coefficient K of these fish was estimated to be 253.86 mm and 0.0075 d⁻¹, respectively.

The second presentation "Dolphinfish fisheries in Batanes: coping with climate change through Mataw fishing tradition" was offered by Dr. Evelyn Amy of the Bureau of Fisheries and Aquatic Resources of the Philippines. It posited that Mataw, which is a cultural tradition of the Ivatans, has contributed in ensuring sustainability of dolphinfish stocks in Batanes. The social values espoused by the tradition, such as patience, discipline, cooperation and fair play together with simple rules which islanders follow in their fishing operations resulted in efficient climate change mitigating strategies more effective than the modern day Coastal Resources Management (CRM) implemented in the Philippines. These

strategies included the use of environment friendly fishing gear, non-motorized fishing boats, the maintenance of environmental integrity, the imposition of close and open fishing season, and a collective marketing scheme which all edounded to increase the income of fishers. The Mataw fishing on the dolphinfish stocks allowed the fish to reach its length at 1st maturity (67.9cm) and maximum yield (102.3cm) above the exploited length. This meant that the dolphinfish caught in Batanes waters were already able to spawn at least once and permitted to contribute to the recruitment process prior to being caught. If this practice is continue, it will greatly adds to the overall income of fishers.

The third presentation "The research and resource status of billfish in the waters around Taiwan" was introduced by Prof. Sheng-Ping Wang from National Taiwan Ocean University. It concluded that the main species of billfishes caught by the fishery operating in the waters around Taiwan are black marlin (*Istiompax indica*), blue marlin (*Makaira nigricans*), sailfish (*Istiophorus platypterus*), striped marlin (*Kajikia audax*) and swordfish (*Xiphias gladius*). The catches of sailfish and black marlin are substantially more than those of other billfishes. Sexually dimorphic growth is commonly found for most billfish. Generally, females grow faster than males and reach a larger body size. In addition, billfishes grow very fast during the young stage and fish one year old can grow to about 100 cm in body length. Sexually dimorphic maturity is also common in billfish. Compared with females, males generally mature at a smaller body size. Based on the stock assessment of swordfish in the waters around Taiwan, the fishing mortality is at the level below the target reference point and the spawning biomass per recruit is about 65% of its unfished level. The stock status of swordfish in the north Pacific is also in a relatively stable condition. Assessment results also show that blue marlin in the Pacific Ocean is in a condition of health. In addition, analyses on environmental effects indicate that seasonal variation in the distribution of blue marlin appears to be related to shifts in sea surface temperature. The results of tagging experiments on sailfish indicate that depths and ambient water temperatures visited by sailfish ranged from 0 to 214 m and 17 to 30°C, respectively.

The fourth presentation, "Study of ocean sunfish in Taiwan waters" was made by Dr. Yung-Chou Chang from Tzu-chi University. It showed that there were three species of ocean sunfish, the common mola (*Mola mola*), the sharp-tailed mola (*Masturus lanceolatus*) and the slender mola (*Ranzania laevis*), which are usually caught by setnet and drift-gillnet in Taiwan. The sharp-tailed mola is very common in Taiwan's eastern waters, but rare in other parts of the world. The relationships between whole weight (W) and standard length were expressed as: $W = 9.98 \times 10^{-4} SL^{2.45}$ for females, and $W = 3.33 \times 10^{-4} SL^{2.68}$ for males. The VBGF had the best fit and predicted an asymptotic length (L_{∞}) = 262.5cm SL, growth coefficient (k) = 0.046 yr⁻¹, age at zero length (t_0) = -3.350 yr for females, and L_{∞} = 231.0cm SL, k = 0.059 yr⁻¹, t_0 = -1.852 yr for males. The age of maturity was > nine years old of age for males. The breeding season seems to be from May to June. The sharp-tailed mola always appears in water above 200 meters and with a temperature 20 C.

2. Marine Protect Area

The second sub-session contained three presentations from Taiwan relating to the experiences of establishing marine protected areas in this region, and was chaired by Dr. Yi-Che Shih from the Coast Guard Administration of Taiwan.

The first presentation, "National system planning for marine protected areas in Taiwan - experience and prospects", was given by Dr. Shao-Liang Hsu of the Marine National Park Headquarters of Taiwan. It introduced part of a wider research project that is a completed plan on the Marine Protected Area experiences in Taiwan. The author works at Marine National Park Headquarters. And he shared the experiences of establishing Taiwan's first Marine Protected Area in Dongsha Atoll National Park and setting up a "Marine National Park" for Dongsha conservation and management by Taiwan's government. In the meanwhile, he also suggested establishing a cross-border Kuroshio marine protected areas network to ensure that the "Black Current ecological corridor" ecosystem would be protected. These concepts of marine protected areas system planning can be applied not only at the national level but also to

larger marine ecosystem covering the entire area and receive help from international researchers.

The second presentation "The local scale experiences to implement the marine protected areas network in the future in Taiwan" was presented by Dr. Yi-Che Shih who has marine law enforcement experiences of protecting marine environment and of preventing marine oil pollution. He talked about the reasons for establishing MPAs, the threats to the marine environment and the role of MPAs in protecting marine ecosystems. He also offered local scale experiences of MPAs (e.g. Penghu's four Southern Islands, three Northern Islands, Dongsha Atoll Marine National Park, and Chinwan MPA, Penghu cases) . These experiences can help the international readers to implement an the MPA in the future. On the other hand, this work also examines the role of the MPA in various marine policies, essentially those regarding fishing, marine resources and environmental conservation in Taiwan.

The last presentation in this sub-session "Preservation in action - Houbihu Demonstration Area" was given by Mr. Tzai-Chuan Hsiao of the National Park Police Department of Taiwan. He shared his personal experiences in achieving effective marine conservation in local communities for sustainable resource use and showed his successful performance in this area. He dedicated his life to preserve the marine environment of Houbihu area and helped to successfully complete the Houbihu Demonstration Area in order to maintain its habitat and marine biodiversity. Finally, he gives suggestions for how to create win-win policies in local communities, and with concerned groups and industries. These experiences and concepts are important for readers to understand how to implement the MPAs in order to protect local marine resources in Taiwan.

3. Non-fish resources - precious corals

Fisheries of precious corals in Asia were started in the beginning of 1870s in Kochi, Japan, although it has a long history of several 1,000 years in the Mediterranean. Before the middle of the 19th century, all precious corals were supplied to Asia from the Mediterranean. In Taiwan, precious coral fishing was started in 1923. Both Japan and Taiwan are currently two of the most active coun-

tries with precious coral fisheries in Asia. In 2007 the US government proposed a request to the CoP14 mentioning many precious coral species on the Appendix II of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). This US proposal was reflected at the CITES meeting. Three years later, the US government proposed to the CoP15 in 2010 to mention all species under Coralliidae in the Appendix II of CITES. The result of this proposal was not approved again.

Under these circumstances, we have recognized that it is urgent to supply scientific information on precious corals to the CITES meeting for establishing sustainable fisheries of precious corals in the near future. Since precious corals in Asia inhabit the area affected by the Kuroshio Current, we have decided to have a sub-session on precious corals in this symposium in order to enhance our mutual understanding as well as encouraging cooperative research between countries.

There are four presentations in this sub-session; three from Taiwan and one from Japan. The first presentation was entitled with "Introduction of precious red corals in Taiwan" was presented by Dr. Chin-Chang Hung of the Institute of Marine Geology and Chemistry of the National Sun Yat-sen University. He gave an overview of the culture of precious corals in Asia including Chinese royal families, and mentioned major fishing grounds around Taiwan as well as Midway Island in the middle of the Pacific Ocean and showed major fishing gear used in this area. There were two active fishing periods of precious corals in Taiwan in the past; one was from 1925 to 1940 fishing for an average harvest of about 10 tons/year, and the other was from 1965 to 1990 fishing for about 60 tons/year, and having a maximum of over 200 tons/year in the early 1980s. Annual harvesting of precious corals in recent years was less than 10 tons/year. He then suggested further studies on (1) the inventory of precious corals, (2) factors affecting precious corals, (3) the determination of the growth rate of precious corals, and (4) precious coral species in the Kuroshio region.

The second presentation, entitled "Distribution of Japanese red coral, *Paracorallium japonicum* and its sustainable management", was given by Dr. Nozomu Iwasaki of the Faculty of Geo-Envir-

onmental Science of Rissho University. He mentioned three important precious coral species for fishing within eight species inhabiting the area around the Japanese islands as well as showing the locations of major coral fishing ports. He has organized a three year research project on precious corals to study a wide range of topics, supported by the Fisheries Agency of Japan since 2010. He found that *P. japonicum* was distributed in an aggregate with a density of ca.0.005 colonies/m², much smaller than 0.02-0.3 colonies/m² of *P. secundum* around the Midway Island and 43-100 colonies/m² of Mediterranean corals. Based upon an obtained growth rate of 0.30mm/year, a recovery time of 10-20 years for fishing was estimated. All these basic results will be supplied for the discussion at the next CITES meeting to be held in 2013 in Thailand.

The third presentation entitled "A revision of the family Coralliidae Lamouroux, 1812 (Octocorallia: Alcyonacea) from the West Pacific Ocean" was given by Ms. Tzu-Hsuan Tu of the Institute of Oceanography of National Taiwan University with coauthorships of Dr. Chang-Feng Dai of the National Taiwan University and Dr. Ming-Shiou Jeng of the Academia Sinica. According to careful morphological analyses of 22 species collected in the West Pacific Ocean (out of 33 known species), she found remarkable evolutionary plasticity of precious coral species. However, gene analyses of two mitochondrial markers of 11 species of precious corals did not support the morphological characteristics, and she found that the applied mitochondrial markers did not have good resolution at species level.

The fourth presentation entitled with "The management of precious coral fisheries in Taiwan" was given by Dr. Mao-Cheng Wang of the Fisheries Resources Management Section of the Fisheries Agency of Taiwan. The Taiwanese government initiated extremely strict regulation of precious coral fishing from January 2009, including enforcing input controls by licensed vessel, output controls by

licensed vessel, output controls by annual harvesting limit of 200 kg/vessel and technical measures by monitoring with VMS and so on in five designated fishing grounds around Taiwan, including mandated observers check of logbook and harvest on board. The penalties for violating the regulation include the confiscation of fishing gear and the revocation of licenses for fishermen and fishery operation.

As a result of having the sub-session on precious corals in this Kuroshio symposium, scientists interested in precious corals in Taiwan and Japan now have developed interests in cooperative research as well as the goal of exchanging ideas and data from now on. They are also interested in extending the cooperative research rink into much wider areas in other Asian countries including the Philippines. Scientific information and fishing regulations on precious corals obtained from a wide range of geographical areas and aspects could help the discussion at the forthcoming CITES meetings in finding out how to establish a sustainable fishing of precious corals in the world.

4. Non-fish resources - deep ocean water resources

In Taiwan, two national institutes of deep ocean water (DOW) resources for research and technology developments have now nearly finished construction in Taitung. There are also three private companies having their own DOW pumping facilities in Hualien since 2005/6, and running businesses using DOW resources. Under these circumstances we have decided to have a sub-session on DOW in this Kuroshio symposium with participating specialists from the advanced country of Japan for DOW resource utilization in order to deepen our understanding of DOW resources and to exchange our ideas between countries as well as making cooperative research plans for the future.

There were three presentations from Taiwan presented in this sub-session although one paper within the three was on DOW resource applications in Japan.

The first presentation was entitled with "Novel renewable resources of deep ocean water and their current and future practical utilizations in Japan" and was presented by Dr. Masayuki

Takahashi of the Asia-Pacific Ocean Research Center of the National Sun Yat-sen University. Dr. Takahashi has been involved in the R&D challenges of DOW resources since the early 1980s in Japan, and he is the president of Deep Ocean Water Applications Society. He mentioned a variety of DOW resources such as energy, fertilizers, minerals, metals, water and salts as well as unique characteristics of cleanliness, constancy and rapid regeneration time such as 100s to 1000s years of DOW. Challenges of those DOW resource applications carried out in Japan since 1980s were then introduced. He stressed the need to change our currently un-renewable resource utilizations such as petroleum, natural gas, metal ores into renewable DOW resources at our earliest convenience to increase the sustainability of our society with the least environmental disaster.

The second presentation entitled with "Current situation of deep ocean water industrial development in Taiwan" was presented by Dr. Chih-Shan Lin of the Stone and Resource Industry R&D Center with co-authorship of Dr. Ping-Yi Huang. Dr. Lin mentioned that R&D challenges of DOW resources in Taiwan were carried out by several research institutes and universities from 2005 with financial support mostly from the federal government. Three private companies constructed pumping stations and factories independently in Hualien in 2005/2006 followed by the production of various kinds of commercial goods such as drinking water and cosmetics. The leading institute, Stone and Resource Industry R&D Center, has focused their efforts on producing raw materials from DOW for various commercial goods, including medicines, and on challenging pilot studies of producing bio-fuel from unicellular algae cultured using DOW and low temperature energy utilization. Many of their activities will be transferred to the newly constructed DOW pumping and R&D facility by the Water Resource Agency of Taiwan in Taitung with the cooperation of several universities and private enterprises. DOW pumping capacity is ca 12,000ton/d from 700m. Pumped DOW will also be supplied to the neighborhood industrial park planned by the Taitung provincial government. Multi-step utilization of DOW resources is another goal.

The third presentation, entitled "The establishment of the aquatic genetic resource bank of Eastern Marine Biology Research Center, Fisheries Research Institute" was presented by Dr. Wei-Chuan Ching of the Eastern Marine Biology Research Center of Fisheries Research Institute with co-authorship of Dr. Wen-Yi Chen and Dr. Wei-Cheng Su. A pumping and R&D facility of DOW using 3,000 tons/day from 700m under construction in Taitung by the Fisheries Research Institute is expected to be completed by early next year. The Fisheries Research Institute is planning to conduct two major subjects using clean, low temperature and nutrient rich DOW. One is to maintain the genes of important fisheries species, and the other to establish complete culture of some important fisheries species which have not yet been utilized successfully. Applications of DOW resources for agriculture are also planned.

Since the two DOW facilities in Taitung are located along the coast with a distance of about 5 km between them, it is highly recommended to exchange ideas with each other as well as having cooperative works in the future.

DOW is the most promising novel renewable natural resource containing not just energy such as solar and wind but various important resources which human beings essentially require in extremely large quantities. Although fairly low concentrations of most DOW resources have prohibited practical applications, some DOW resources have now been used practically due to recent improvement in our knowledge and technology. Thus we should accelerate further the improvement of our knowledge and technologies. The geographical location of southern Taiwan, south of the Tropic of Cancer is an ideal situation for improving the practical application of the low temperature energy of DOW. With the establishment of new two national R&D institutes of DOW constructed in Taitung, Taiwan could take the initiative in developing the DOW resource utilization with the cooperation of Japan and other countries such as the USA and France. We believe this sub-session could open the door for active exchanges of data and information and for cooperation between countries.

5. Social impact

The last sub-session contained three presentations on the subject of social impact; two from Japan and one from Taiwan.

The first presentation "Governing the commons: a Japanese revision" was given by Prof. Yoshiaki Iiguni from the Multidisciplinary Cluster of Kochi University. ----

The second presentation "Reproducing masculinities: Taiwanese seafarers' work and family" was given by Prof. Hong-Zen Wang of Department of Sociology of the National Sun Yat-sen University, co-authored by Kuo-Tung Luo. ----

The third presentation "Invasive alien catfish in Zapata swamp, Cuba" was given by Prof. Satoshi Kubota of the Multidisciplinary Science Cluster Kuroshio Science Unit of the Kochi University.

Session V - Biomedicine and Bioactive Molecule Organizer: Akira Tominaga and Tse-Min Lee

This session consisted of eight topics. The first three topics were concerned with molecular biomedicine or its functional assay.

Tominaga et al. established a new culture model of intestinal inflammation using epithelial cells from a tubular adenoma from a male familial polyposis coli patient. They found human epithelial cells produce IL-22 to ameliorate their own damages caused by bacterial peptidoglycan, suggesting an autocrine repair system. Details are written as a research note in this issue.

Leo Lai Chan et al. from State Key Laboratory in Marine Pollution, City University of Hong Kong reported that Ciguatera fish poisoning (CFP) has increased globally due to 1) greater international trade and consumption of coral reef fish; 2) increased proliferation of the CFP causative benthic dinoflagellate, *Gambierdiscus* spp., as reefs continue to degrade due to coral bleaching processes/events, ocean acidification and global warming. They have developed a rapid analytical method for the quantification of ciguatoxins in fish blood. This method has the advantage of being less-destructive and allows for repeated sampling for continuous monitoring. A number of neurological, gastrointestinal and cardiovascular disorders have been reported already following consumption of ciguateric fishes. However, there

limited information available concerning the chronic exposure mammals to Pacific-ciguatoxins. Leo Lai Chan et al. showed that chronic exposure of most toxic Pacific-ciguatoxin-1 impaired affective components of visceral pain memory in rats. The absence of signs of intoxication and overt pathology in ciguateric fishes suggests that the carrier species are immune to the effects of ciguatoxins. However, only certain toxic-resistant species, such as the groupers *Cephalopholis argus*, *Epinephelus spilotoceps* and the moray eel, *Gymnothorax undulatus*, have been found to contain high levels of Pacific-ciguatoxin-1 equivalents and appear in the highly ciguateric areas. In addition, dominant herbivores are frequently observed in ciguateric areas. In conclusion, Leo Lai Chan et al. suggest that ciguatoxins could cause damage to resistant species and lead to depletion of sensitive species.

Jyh-Horng Sheu et al. from Asia-Pacific Ocean Research Center, National Sun Yat-sen University, reported bioactive marine natural products from soft corals of Taiwan waters. Soft corals are one of the major sources for bioactive compounds. The collected soft corals were extracted with organic solvents and the crude extracts were purified by column chromatography. The molecular structures of the pure marine natural compounds isolated were determined by extensive spectral analysis using NMR, UV, IR and MS. These structural analyses revealed that purified molecules from soft corals were highly diversified. The researchers evaluated these compounds for their cytotoxic activity or anti-inflammatory activity. Some of the bioactive compounds have therapeutic potential for inflammatory diseases in rats. Jyh-Horng Sheu et al. found that some molecules are active in reducing the accumulation of pro-inflammatory induced NO synthase and prostaglandin endoperoxide synthase-2 proteins in lipopolysaccharides-stimulated macrophages.

Farah Diba et al. from Tanjungpura University reported the importance of gut bacteria of termites in methane gas emission. Termites are important decomposers specializing in the degradation of recalcitrant components of plant residues through their association with symbiotic gut microorganisms. The major gut bacteria of the worker caste of lower and higher Indonesian

termites were isolated and identified. All species were facultative anaerobes or strict anaerobes. The major bacterium from the lower termites *Coptotermes curvignathus* Holmgren (family Rhinotermitidae) was *Enterobacter* and *Flavobacterium* and from higher termites, *Macrotermes gilvus* Hagen (family Termitidae) was *Sporocytophaga* and *Staphylococcus*. Farah Diba et al. reported that the bacterial population and the methane production are correlated to the termites' nutrition and environment. The environmental change on earth may cause the higher methane emission. We have to remind ourselves that methane has a much higher greenhouse effect than carbon dioxide.

Reika Abe et al. from Kochi University reported on the medicinal plants and traditional therapy in the Batan Islands. As described in "The Origins of Human Diet & Medicine" by Timothy Johns (1996, University of Arizona Press, Tuscon), many traditional cultures do not make a strong distinction between food and medicine, and nutritional and pharmacological properties of plants are not readily distinguishable. By examining the current status of traditional therapy and the use of medicinal plants in Batan Islands, they think that self-medication with medicinal plants is useful to improve economic development, health maintenance, and health care systems in developing countries. Coordinated usage of medicinal plants among people, public health doctors, and public health nurses are necessary. As suggested by the author, it is probably possible to improve health care systems by this coordinate usage of self-medication with medicinal plants.

Elvira et al. from the Cell Biology Laboratory, Graduate School of Kuroshio Science, Kochi University have examined the development of a giant-celled green alga, *Valonia aeagropila* after it was anchored to rock. Starting from a mother cell, protoplasm concentrated in a specified area and cell swelling was followed by the formation of septum and the formation of a lenticular cell with upward elongation. The formation of rhizoid on the agar of different concentration suggested that the substratum hardness but not wettability was the factor influencing branching of elongating rhizoids. Multiple tip outgrowth on the agar treated with aminophosphomethyl (APM), a microtubule

inhibitor, demonstrated the involvement of microtubules for the branching of rhizoids after contacting onto the rock. This experiment can be a model in studying cellular regulation of rhizoid development in the green alga.

The team of Dr. Tse-Min Lee in the Institute of Marine Biology, National Sun Yat-sen University, Kaohsiung, Taiwan, has initiated a series of studies on the molecular experiments for the physiological responses in the green macroalga, *Ulva fasciata* Delile to stressful environments. Because *Ulva fasciata* is dominant in the intertidal regions along the coasts in the regions affected by the Kuroshio Current it is the optimal material for such study. Over the past decade, Lee laboratory has created the EST library in response to hypersalinity and the regulation of gene expression and their relative protein function, that is, enzyme activity. They have found that the genes related to protein destination and modification, antioxidant defense, and photosynthesis could be up-regulated by hypersalinity stress in *U. fasciata*. Details are written as a review article in this issue.

Dr. Mine from Kochi University introduced the usage of coenocytic green algae as a potential indicator of coastal environment in the Kuroshio Current region. The representative species of coenocytic algae, *Valonia*, *Caulerpa* and *Acetabularia*, are mainly distributed along the coasts in the subtropical regions in the world. The possible merits of using coenocytic algae as a coastal indicator are the following: (1) the composition of the algae is usually simpler and more common than of other seaweed, (2) the representative species are usually growing in the intertidal zone, and (3) laboratory culture strains are available for many species. This research project will include the field survey in Philippines, Taiwan and Japan from the viewpoint of natural and social sciences, biogeographical studies, and laboratory culture experiments.

Session VI - Humanities and Societies

Organizer: Jeng-Di Lee

People-oriented studies in the Kuroshio region Two of main reasons for holding sessions related to humanities and societies were first, that people living along with the Kuroshio show abundant and

diverse culture and social content, and the second, after four symposiums of the international Kuroshio study, an extension to the field of social science was needed. Nonetheless, as the first time in the symposiums, the session appeared with multiple disciplines which included and researchers from the area of aboriginal literature, island development, marine education, history, integrated ocean and coastal management. The session also intended to use the island - Pongso no Tao -, as an integration of these varied study fields. The chairman and woman, Prof. Hiroshi and Prof. Huang, separately led the session into two parts, i.e., the humanities and the societies. In the section on the humanities, speaker Prof. Hisnya Huang from Taiwan gave us a lecture reading of the writings of Syaman Rapongan, who also one of the invited speakers. Syaman's writings are related to an identity of Tao spirit and living experience. Tao people have been living on the island for generations and have developed complicated social systems that can cope with island sustainability and adapt to the ocean environment. Prof. Huang had presented on this topic in the session with the topic "Trans-Pacific Ecological Imaginary". Two

other presentations in the first part also focused on the fishery history (Prof. Yoshio, Hiroshi) and fisher's account (Miss Hui-Chun Chang) around Pongso no Tao giving us more content on the relationship between local people and the ocean in Kuroshio. One paper presented by Prof. Ai-Hua Chiang was related to a general model of marine education in Taiwan.

The second part is to integrate those topics with governance and management of Pongso no Tao. Mr. Sutej Hugu made a complete explanation of the situation of the TAO society now and in the past, and the development of this society in the future was also discussed. In particular, with the topics from Syaman and Miss Victoriya, a scenario was revealed that similar to that of the other small islands in the Phillipines or Okinawa (Japan); Pongso no Tao and its people process rich ecological resources and traditional knowledge. Therefore, more understanding of these factors is needed in the Kuroshio studies in the future. There is only one model in the 5th Symposium, collaborated work among Japan, Taiwan and the Phillipines is expected.



The village Ivarinu shows a village-based marine culture and costal management in the Pongso no Tao.