

The Fourth China-Japan-Korea GLOBEC/IMBER Symposium

by Sinjae Yoo, Yasunori Sakurai, Jing Zhang and Hyung-Ku Kang

The fourth China-Japan-Korea (CJK) GLOBEC/IMBER Symposium was held from May 18–20, 2010, at Jeju National University, Korea. The purpose of the meeting was to set the future directions of international ecosystem research in the western North Pacific. About 70 scientists participated in the meeting, and 6 of them, including 5 early career scientists, were supported by GLOBEC (Global Ocean Ecosystem Dynamics) and IMBER (Integrated Marine Biogeochemistry and Ecosystem Research).

During the past decade, China, Japan and Korea have conducted research related to GLOBEC in the western North Pacific and its marginal seas. These efforts have advanced our understanding in various fields. To exchange the research results among the three countries' scientists, CJK-GLOBEC symposia have been held every two years since 2002. As GLOBEC is coming to an end, this year's symposium aimed to summarize the scientific findings of the past and to look ahead into the future.

The symposium began with overviews of GLOBEC and IMBER. Yasunori Sakurai reviewed the history and activities of GLOBEC, focusing on its major scientific achievements. Some examples of GLOBEC's outputs and highlights were shown, and some regional projects that will continue under IMBER, such as ESSAS (Ecosystem Studies of the Subarctic Seas), were emphasized. Jing Zhang explained the organizational structure of IMBER and introduced its science themes, regional programs and publications. He noted that national projects from China and Japan were already endorsed by IMBER, and discussed potential collaboration between IMBER and PICES. Finally, information on IMBIZO-II, the 2nd international conference on "Integrating biogeochemistry and ecosystems in a changing ocean: Regional comparisons", was presented, with explanations of the three workshop themes.

Activities related to GLOBEC/IMBER were reported from each nation. Yasunori Sakurai reviewed the achievements of Japan-GLOBEC. He indicated that Japanese research projects related to GLOBEC/IMBER have been supported by several funding agencies, and summarized the goals and major outcomes of these projects. New research projects, such as "Challenge for Future Fisheries Management", were also introduced.

Chinese GLOBEC activities were reviewed by Jing Zhang. Since 1994, China-GLOBEC projects have been developed in parallel with International GLOBEC in three phases. The last phase, sponsored by the Ministry of Science and Technology, with a budget of \$5,000,000 US, is also a transitional phase to IMBER. The scientific questions and

major outcomes from China-GLOBEC were presented. The scientific findings from the second phase were published recently as a *Deep-Sea Research II* special issue.

Korean GLOBEC/IMBER-like research activities were reviewed by Sinjae Yoo. He noted that although no national GLOBEC/IMBER projects were in place, many studies shared common themes with GLOBEC and IMBER. Several proposals for national IMBER projects have recently been submitted to funding agencies. The most successful activity of the Korean GLOBEC committee was capacity building – 52 early career scientists have been supported to attend various international meetings since 2004.

Scientific sessions began with biogeochemistry of the western North Pacific. Jing Zhang showed how the bio-geochemical processes on the East China Sea shelf were affected by incursion of the Kuroshio, as well as by anthropogenic factors. Jingling Ren presented the results of a survey in the south Yellow Sea, where a spring bloom occurred after an Asian dust event. She showed that the major source of aluminum was atmospheric input, and distribution of dissolved aluminum was mediated by phytoplankton (Fig. 1).

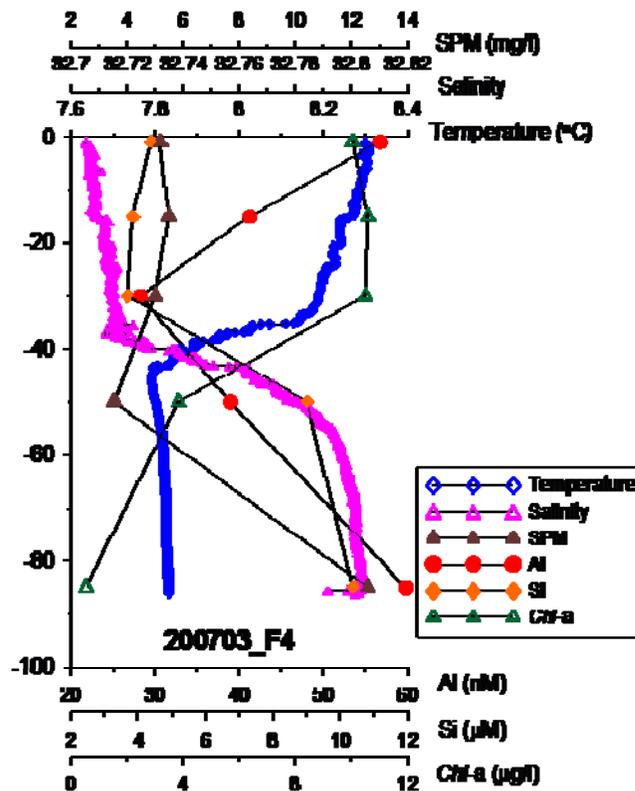


Fig. 1 Vertical distribution of T, S, SPM, Al, Si, and Chl-a from a station in the central Yellow Sea in March 2007 (courtesy of Jingling Ren).

The distribution of nutrients and chlorophyll in the northern East China Sea during 2003–2009 was analyzed by Sang Hwa Choi. Mi Hee Chung showed how the distribution of phytoplankton and zooplankton in the Seomjin estuary changed after heavy rains. Chan Joo Jang compared the projected mixed layer depth by some IPCC AR4 models and, based on this, made a further projection that primary production would be decreased by 10–30% after 100 years.

Jun Sun divided the Chinese Seas into sub-provinces based on the phytoplankton community. He also defined functional groups of phytoplankton and showed the distribution of these groups in the Yellow Sea and East China Sea. Sinjae Yoo discussed the uncertainty of primary production in the Yellow Sea and presented a new estimate of 250–300 gC m⁻² yr⁻¹ calculated using new algorithms of chlorophyll-*a* and primary production. Yunsook Kim presented the phytoplankton community structure using HPLC from a meridional survey in the East Sea in 2007. Similarly, Hyoung Chul Shin presented the phytoplankton and zooplankton distribution on a section across the Ulleung Warm Eddy in the East Sea.

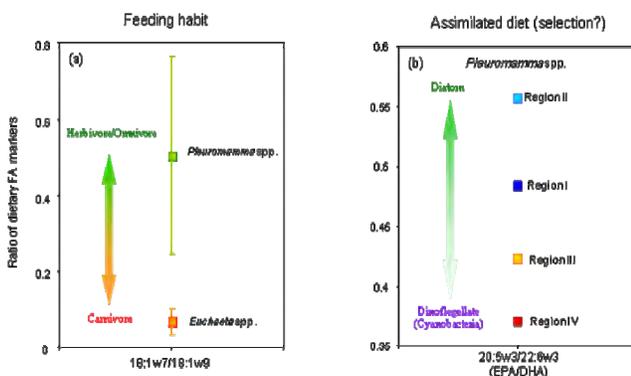


Fig. 2 (a) The ratio of 18:1w/17:18:1w9 has been used to determine the feeding habit of copepods. (b) The ratio of EPA/DHA has been applied to trace the assimilated food type for herbivorous copepods (courtesy of Se-Jong Ju).

Wuchang Zhang studied the seasonal cycle of ciliates and their ingestion by *Calanus sinicus* in the Yellow Sea. The ciliate biomass peaked in May near the tidal and thermal front. He also showed that *Calanus sinicus* may need additional sources of food, as the ingestion of ciliates alone cannot satisfy its energy requirement. Se-Jong Ju presented a study on the latitudinal variation of lipids as a trophic marker of copepods (Fig. 2). The result of this study suggests that the lipid contents and compositions in copepods may indicate their nutritional condition, feeding ecology, and species-specific living strategies. Keun Hyung Choi showed that encounter rates of copepods with mates and prey can be affected by turbulence. He further conjectured that climate change can increase turbulence in coastal areas and influence the population growth of copepods. Hyeon Ho Shin showed that morphological features of resting cysts of *Scrippsiella trochoidea* were changed by

hypoxic conditions at the sea bottom. Seung-Hyun Kim introduced a recent study that shows more warm-water species of dinoflagellates appeared near Jeju coasts. Based on mitochondrial DNA analysis, Yongshuang Xiao argued that the point-head flounder expanded its geographic distribution along the Japanese coastline during the late Pleistocene.

Recently, unusual events began to occur in the Yellow Sea and East China Sea, indicating that the ecosystem structure is rapidly shifting. In June 2008, a massive bloom of the macroalga *Enteromorpha* occurred in the vicinity of Qingdao. Il-Ju Moon showed that unusual wind conditions in 2008, together with nutrient-rich discharges from land, induced the massive algal bloom which then moved to the nearshore area. Since the early 2000s, jellyfish blooms have been increasing in the Yellow Sea, East China Sea and East Sea (Japan Sea). Three papers on jellyfish were presented. Kui You talked about the effect of temperature on scyphistomae strobilation of *Rhopilema esculentum*. The temperature effect on the asexual reproduction of *Aurelia aurita* was presented by Chang-Hoon Han, who also talked about the environmental effects on asexual reproduction of *Nemopilema nomurai*.

The catches of Pacific cod and walleye pollock in Korean waters have been decreasing since the 1980s. After the 1998–99 regime shift, Pacific cod came back, while walleye pollock continued to decline. Sukgeun Jung explained this by three factors: a decrease in the bottom water temperature, an increase in the volume transport of the Tsushima Warm Current (TWC), and increased zooplankton and Pacific herring. Using an individual based model (IBM), Jung Jin Kim studied propagation of hatchlings and paralarvae of common squid (*Todarodes pacificus*) in the northern East China Sea, and showed how the spawning location can affect the distribution of larvae (Fig. 3). Yuheng Wang presented the results of an IBM study indicating that the East Asia monsoon is the major reason for anchovy population dynamics in the Yellow Sea besides over-fishing.

In a study using the Ecopath model, Qun Lin reconstructed the structure and energy flow of the Yellow Sea ecosystem and demonstrated that there was an obvious downward trend in the trophic level for most fishes. The percentage of primary production required to sustain the fishery was 5.14%, which was quite low. Jong Hee Lee analyzed sea surface salinity, sea surface temperature, and fisheries catch data from Korean waters. She argued that the 1976–77 regime shift included shifts in both environmental factors and ecosystem, while the 1988–89 regime shift was identifiable only from biological changes. On the other hand, physical changes after the 1998–99 regime shift were clear, while the ecosystem shift need further analysis. Akihiko Yatsu explained the concept of regime-dependant maximum sustainable yield and argued that an adaptive management

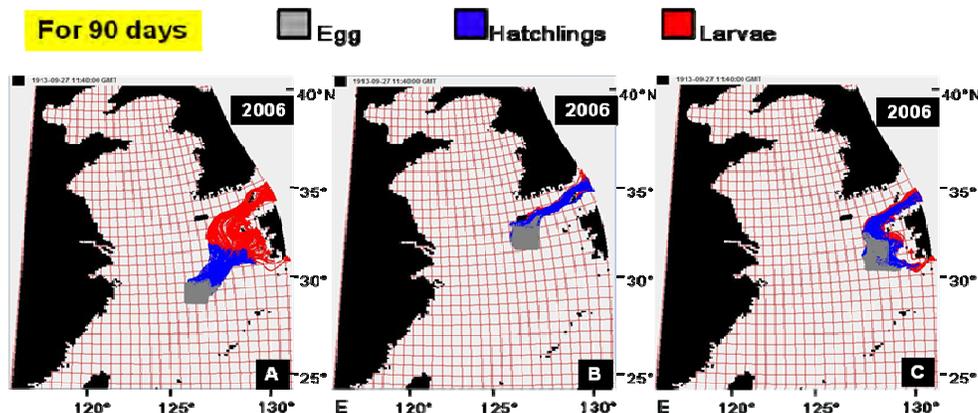


Fig. 3 Distribution of squid larvae under different spawning locations. Simulated with an individual based model (IBM) using the conditions of June 2006 (courtesy of Jung Jin Kim).

strategy depending on the regime is needed. Given the great uncertainties of productivity of a “new regime” at the beginning of the regime, development of robust management procedures (MPs) is required. With these, he also characterized an “Ecosystem Approach to Fisheries” (EAF). Jae Bong Lee introduced IFRAME (Integrated Fisheries Risk Analysis Method for Ecosystems), and applied this scheme to Korean waters. First, he made long-term predictions of habitat changes of chub mackerel and blue fin tuna, and then

estimated future changes of the indices of sustainability, biodiversity, habitat, and socio-economic benefits as functions of fishing mortality. Michio Kishi calculated the optimal release number of Hokkaido chum salmon using an ecosystem approach where carrying capacity of the North Pacific was computed by the two-way NEMURO model. Competition between chum salmon and pink salmon was also considered. The cost function was total income of fishermen. The results showed that the release number in 2007 could be optimal.



Dr. Sinjae Yoo (sjyoo@kordi.re.kr) is a biological oceanographer with the Korea Ocean Research and Development Institute (KORDI). He is interested in the spatio-temporal variations in primary production and its impact on the lower trophic level. Sinjae is Chairman of the Korea GLOBEC/IMBER Committee. In PICES, he has served as a member or Co-Chairman on various expert groups and committees and is Science Board Chairman-elect since 2009.

Dr. Yasunori Sakurai (sakurai@fish.hokudai.ac.jp) is a Professor at the Graduate School of Fisheries Sciences, Hokkaido University, Japan. His research focus is on reproductive biology, strategy, and stock fluctuations of gadid fish (walleye pollock, Pacific cod, and Arctic cod) and cephalopods (ommatrephid and loliginid squids) related to climate change, and the biology of marine mammals (Steller sea lions and seals). He has led a number of national research projects and programs on ecosystem-based management for sustainable fisheries. He had been Chairman of Japan-GLOBEC, and served on the Cephalopod International Advisory Counsel (CIAC), GLOBEC and ESSAS Scientific Steering Committees and the Implementation Panel for the PICES Climate Change and Carrying Capacity (CCCC) Program. Since 2009, Dr. Sakurai has chaired the Japanese Society of Fisheries Oceanography.

Dr. Jing Zhang (jzhang@sklec.ecnu.edu.cn) is a Professor at the State Key Laboratory of Estuarine and Coastal Research (SKLEC), East China Normal University, Shanghai. His research focuses on the land-ocean interaction in China Seas, particularly the biogeochemical dynamics of estuaries and coastal environment. He co-chaired SCOR Working Group 128 on Natural and Human-Induced Hypoxia and Consequences for Coastal Areas (2005–2009), served as a member of the IMBER Scientific Steering Committee (2004–2009) and was a project leader for IOC/WESTPAC Atmospheric Input Studies (1993–2008).

Dr. Hyung-Ku Kang (kanghk@kordi.re.kr) is a principal scientist of the Marine Living Resources Research Department at KORDI. He has been the Executive Secretary of the Korea GLOBEC/IMBER Committee since 2000. He is interested in physiological ecology of marine zooplankton, including reproduction, feeding and population dynamics of copepods, and is a member of PICES Working Group on Comparative Ecology of Krill in Coastal and Oceanic Waters around the Pacific Rim.

Twenty-three papers were presented during the poster session. The topics ranged from observations and modeling of physical phenomena (circulation, mixed layers, typhoons, river discharge, *etc.*), paleoceanography and ocean acidification to lower trophic level processes.

The symposium ended with a discussion session focused on coordination of regional research in the western North Pacific. Most participants agreed that the past activities of CJK-GLOBEC, mainly providing a forum for the western North Pacific science, should continue. There was a consensus that regional coordination should be sought as energetic research will continue in the region. To this end, a science plan and related research proposals have to be developed. It is expected that the perspectives of the

program will be broad, while there will be regional foci. Since the new PICES integrative science program, **FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems)**, is a contributing regional program to IMBER, there are many common scientific interests between IMBER and FUTURE. PICES also has a CREAMS Advisory Panel which focuses on the East Asian marginal seas. It was agreed to have a joint meeting of national IMBER representatives and FUTURE/CREAMS members for development of the regional program during the 5th PEACE (Program of the East Asian Cooperative Experiments) Ocean Workshop to be held September 11–12, 2010, in Gangneung, Korea. Finally, the next CJK-IMBER symposium was tentatively scheduled for November 2011 in Shanghai, PR China.