Coastal environment and human activity in Thailand

Takashi YOSHIKAWA[1], Sukchai ARNUPAPBOON[2], Ratana MUNPRASIT[3], Jintana SALAENOI[4], Kazuya WATANABE[5], Yuki OKAMOTO[6], Udom KHRUENIAM[3], Takafumu ARIMOTO[7], Koetsu KON[8]

1 Tokai University, Japan
2 Southeast Asian Fisheries Development Center (SEAFDEC), Thailand
3 Eastern Marine Fisheries Development Center (EMDEC), Thailand
4 Kasetsart University, Thailand
5 Yamagata University, Japan
6 Kyoto University, Japan
7 Tokyo University of Marine Science and Technology, Japan
8 University of Tsukuba, Japan

▶ Keywords: seawater, bottom sediments, benthos, trophic status, food-web structure, phytoplankton

In Thailand, we have been conducting environmental research in coastal area of Rayong in the east and Bandon Bay in the south. In Rayong, in order to evaluate possible impacts of set-net operation, (1) status of the seawater and bottom sediments within and around the set nets and (2) trophic levels and feeding habits of the catches of set net and other gears have been investigated collaborated with C6 (Set-net component) and other components activities. In Bandon Bay, (1) interactions between shellfish culture and local society, (2) phytoplankton composition and primary productivity, (3) bottom sediment conditions, and (4) food web structure have been investigated.

Coastal area of Rayong

(1) Status of the seawater and bottom sediments

In coastal area of Rayong, potential impacts of the set-net and other fishery activities on biological resources and environment were investigated in the year of 2013-2014 operation. Survey on seawater and bottom conditions was conducted around the set-nets at the beginning (October 2013), midterm (January 2014) and end (April 2014) of set-net. Survey was also conducted during 30 September-02 October 2014 when there was no set-net (reference period). A CTD sensor was used for basic environmental factors. Water sampling was done for suspended solids (SS), chlorophyll *a* and nutrients measurements. Bottom sediment samples were obtained by a grab sampler for acid volatile sulfide (AVS), ignition loss (IL) and water content investigations.

AVS showed constantly much lower than the criteria for identifying critical farms (2.5 mg/g dry proposed by Yokoyama 2003). AVS in the set-net stations increased with set-net operations (0.0011±0.018 mg/g dry in October 2013, 0.0016±0.0024 in January 2014, 0.0034±0.034 in April 2014), but there was no significant differences among them. Macrobenthos were composed of 6 phyla (11 classes) including Nematoda, Annelida (Polycheta), Mollusca (Gastropoda and Bivalvia), Arthropoda (Ostracoda, Copepoda and Malacostraca), Echinodermata (Ophiuroidea, Echinoidea and Holothuroidea) and Chordata (Leptocardii). Numerically dominant class was polychaeta (33.22%) through study period followed by

Malacostraca (23.94%) and Bivalvia (18.22%). Benthos density was 1.4 to 2.0 times higher in the set-net stations than that in the reference stations during the midterm and end of set-net. In contrast, ratio of benthos density in the set-net stations to that in the reference stations was 0.7 to 1.0 during the beginning of set-net and reference period. These results indicate a positive impact of set-net on benthos communities, but it seems not to continue after operation.

(2) Trophic levels and feeding habits of the catches of set net and other gears

Survey on trophic levels of the catches of set-net and other gears was conducted mainly by the set-net groups during Dec 2012-Mar 2013, Oct-Nov 2013 and March 2014. A total of 1030 samples from 36 fish species were collected for later analysis of carbon and nitrogen stable isotope ratios by a mass spectrometer fitted with an elemental analyzer (Delta V advantage and Flash EA 1112, Thermo Fisher Scientific Inc.) at RIHN. Several environmental samples including mangrove leaves were also collected; particulate organic matter (POM) and sedimentary organic matter (SOM) were also measured. Stomach contents of the fish were sorted into taxonomic groups at EMDEC and some of them were used for analysis of stable isotopes. Stable isotope analysis of the all samples has been already completed until the end of fiscal year 2014. Mean trophic level estimated from the fishery record and stable isotope analysis was stable (3.6-3.7) during these 11 years, indicating little or no impact of the set-net operation on status of the fishery resources.

Bandon Bay

(1) Interactions between shellfish culture and local communities

Historical Statistics of the yield and area of blood cockle culture in the bay from 1979 to 2010 showed that the production capacity in the past 30 years was sharply fluctuated. Government policies and natural disaster laid behind this fluctuation were examined in order to understand the relationship between the two and the impacts at present. It has been argued that the production capacity of the bay was reduced according to pollution and natural disaster. Budget from the government to restore the cultivation after hard natural disaster made new farms expand beyond the permitted cultivable areas. Moreover, hard natural disaster was found to cause the transformation of cultivated area, moving in and out of those permitted, both small and big farms.

(2) Phytoplankton composition and productivity

Phytoplankton samples were collected in rainy (August 2013) and summer (March 2014) seasons at 12 stations along the coast of Bandon Bay. Stations 1, 2 and 3 represented the east coast of the Tapi River (Kanchanadit district), stations 4, 5 and 6 were at the Tapi estuary (Mueang Surat District) and stations 7, 8, 9, 10, 11 and 12 were located on the west coast of the river (Chaiya and Tha Chang District). Salinity in the west coast was higher than that in the east during rainy season, while lower during summer. Salinity around the mouth of the Tapi River was low (less than 13 ppt) due to the flow from river. Dissolved oxygen in the west of the bay was higher than those in the east and the estuaries both in summer and rainy seasons. Phytoplankton samples collected vertically by a plankton net of 20 *u*m mesh size showed a total of 79 species in 3 divisions: Cyanophyta (3 species), Chlorophyta (4 species) and Chromophyta (72 species). Dominant genera were *Surirella* (20.34%), *Coscinodiscus* (19.58%), and *Pleurosigma* (12.95%) in the rainy season and were *Rhizosolenia* (32.62%), *Pleurosigma* (18.41%), and *Nitzchia* (14.85%) in the summer season. Richness index, Evenness index and Diversity index of phytoplankton were in the range of 1.416-1.718, 0.415-0.591 and 0.849-1.928 in rainy season and 0.780-2.509, 0.229-0.760 and 1.585-3.185 in summer, respectively.

Photosynthetic rate was measured by *in situ* incubation for 24 hrs and uptake of ^{13}C labeled HCO_{3^-} at 3 vertical layers (surface, middle, and near bottom) of 8 stations in August-September 2012 (rainy season)

and of 9 stations in March 2013 (summer season). In rainy season, values of chlorophyll *a* and primary production at the surface (0.8–19.1μg L^{-1} and 411–2732 mgC m^{-3} d^{-1}) were compared to those reported from Hiroshima Bay and Oginohama Bay in Japan, where intensive oyster cultures were conducted.

(3) Organic matters content and dehydrogenase activities of the sediment

Organic matters content and dehydrogenase activities of the sediment in cockle farms during rainy season (June 2013 and August 2013) and summer (March 2014) were investigated in Bandon Bay. In the east coast (Kanchanadit district), sediments were shown as loamy soil, sandy loam soil and loamy sand, while in the west (Chaiya district), they were sandy soil and sandy loam crumbly. Amount of organic matter accumulated in each sediment layer (depth 1-7 cm) in rainy and summer seasons was not significantly different. Sediment organic matter in the east coast, where cockles have been cultured for long time, was distinctively high comparing to the west during rainy season. Dehydrogenase activity on the surface layer (epipelagic) was quite lower than that in deep layer, hence physical, chemical and biological processes seemed contribute to nutrient cycling in sediments.

(4) Food-web structure

According that the basic features of the bay were related to bivalve production, its food-web was investigated based on carbon and nitrogen stable isotope analysis. Bivalves were collected from 6 sites in March 2013, September 2013, and February 2014. Particulate organic matter (POM) and sedimentary organic matter (SOM) were analyzed. The analysis of variance showed significant differences among bivalve species. This result suggests the difference of food habit by species. There were differences of $\delta^{13}C$ and $\delta^{15}N$ in the shell size of *Geloina* sp. at station 21. Also, correlation between the shell size and $\delta^{15}N$ has been seen in *Ostrea* sp. and *Perna viridis*. The results showed that $\delta^{13}C$ did not cause the difference except for *Geloina* sp.. Bivalves were mostly nonselective filter feeders; each of them tended to prey on different foods. Conceptually, single species in the same bay is regarded as same food habit to share, or not to be considered carefully about it. However, the above results indicate diversity on food source in different area in the same bay due to the characteristics environment of each area.