

The China GLOBEC/IMBER programme implementation in 2006

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The China GLOBEC/IMBER programme "Key Processes and Sustainable Mechanisms of Ecosystem Food Production in the Coastal Seas of China" was launched in January 2006 with a duration of 5 years. The programme is sponsored by the Ministry of Science and Technology, PR China under the "National Key Basic Research Programme", also known as the "973 Programme". It is referred to by Chinese scientists as the China GLOBEC III Programme or the first combined GLOBEC/IMBER National Programme, China GLOBEC/IMBER I.

The core research is aimed at the interactions between marine biogeochemical cycles and key processes in the entire food web of coastal marine ecosystems. Synthesis research will cover the whole food web extending from the lowest to the highest trophic level, leading to an ultimate focus on food production. 68 scientists and about 100 postgraduate students from 6 major research institutions and universities are involved in the programme. The GLOBEC/IMBER programme will address the following issues:

- the supporting role of the main biogeochemical processes in food production;
- key physical processes of biogenic element cycles;
- primary production coupling with the main biogeochemical processes; and
- food production processes of biological functional groups together with their sustainable models.

The programme is operating over two phases (2 years and then a further 3 years) with a budget of 2.2 million USD in the first two years. The emphasis of China GLOBEC/IMBER I in the first 2 year period (2006-2007) is on first-hand field data collection. Six special field survey themes are designed to facilitate integrated multidisciplinary research. The themes are as follows:

Theme 1: Bloom processes of phytoplankton, with emphasis on the development of the bloom and its contribution to food production of the ecosystem.

Theme 2: The relationship between zooplankton and higher trophic level living resources, including the determination of key species and major functional groups at various trophic levels and their trophodynamic interactions in the food web. A typical ecological region of Yellow Sea Cold Water Mass (YSCWM) in the Yellow Sea has been selected as the main survey area. Two types of survey were designed under this theme, they include theme 2.1, a holistic survey covering the entire Southern Yellow Sea, and theme 2.2 which is dedicated to a zooplankton study with two transects intersecting the YSCWM where seasonal variations of the main zooplankton functional groups and their relationship to the physical environment will be observed.

Theme 3: Nutrient supply processes to the East China Sea Shelf, with an emphasis on the hydrodynamic processes of nutrient supply from the Kuroshio Current and the Taiwan Warm Current.

Theme 4: Nutrient supply processes in the coastal spawning ground in the East China Sea, including those due to land sources and to upwelling.

Theme 5: Mechanisms of the formation and harmfulness of coastal hypoxia off the Changjiang estuary, including the development of hypoxia off the Changjiang estuary, with an emphasis on the role of nutrient over-enrichment on the formation of hypoxia and its negative effect on the structure and function of the coastal ecosystem.

Theme 6: Biogeochemical cycles and ecological carrying capacity in typical mariculture areas, including shellfish/algae polyculture and sea-pen fish culture areas. This survey will be carried out in Sanggouwan Bay in the north and Xiangshangang Bay in the south.

During 2006, a total of 140 days of sea-going observations were carried out onboard the R/V Bei Dou. They included two cruises for theme 2.1 and two cruises for theme 2.2 in the Yellow Sea, one cruise for theme 3 in the East China Sea shelf, and three cruises for theme 5 in the Changjiang estuary and adjacent waters. In addition, three cruises totalling 66 days of observation were carried out in the typical shellfish/algae polyculture area in the Sanggou Bay in the Yellow Sea for theme 6.

All of the fieldwork for theme 5 was completed during 2006. Hypoxia and its relationship with food-web dynamics becomes an important topic as nutrient over-enrichment from land-based pollution of coastal/marine waters is resulting in "dead zones" within large marine ecosystems, which is one of the priority global concerns now. Among the Chinese IMBER/GLOBEC surveys, three cruises took place to examine the development of coastal hypoxia off the Changjiang estuary in June, August and October 2006, each with ship-time of 15 days. The aim of this work was to contribute towards the understanding of one of the scientific issues raised by the programme: "biogeochemistry in food-web dynamics".

In June 2006, low dissolved oxygen (DO) waters were found in the southern part of the Zhoushan Islands with levels of DO of approximately 4 mg/l in near-bottom waters, although the overall coastal area off the Changjiang estuary had no incidences of hypoxia. In August, low DO waters were found in the northern part of the Changjiang estuary with DO in near-bottom waters as low as 1-2 mg/l which was accompanied by stratification in the water column. In October the DO profile showed an increase in concentration from surface to near-bottom waters together with strong vertical mixing.

The coastal waters affected by the Changjiang effluent plumes are eutrophic in character and show reduced concentrations of nutrients, particularly nitrate and silicate with an increase in salinity. However, in near-bottom water, concentrations of phosphate and nitrite show a reverse relationship with DO. Ammonia can also have higher levels in DO depleted waters, suggesting that hypoxia off the Changjiang estuary accelerates the regeneration of nutrients and hence changes the nutrient species ratio within the water column. Hence it can be expected that changes in nutrient regimes related to the development of hypoxia cause a change in the food web through competition for nutrients among phytoplanktonic species.

The distribution of photosynthetic pigments shows eutrophication with values of chlorophyll a up to 5-10 µg/l in surface waters. As

shown by Fuco pigment distribution, diatoms are dominant in phytoplanktonic biomass in most of stations off the Changjiang estuary, while dinoflagellates, shown by Perid, occupy stations further offshore. It was found that in the period of coastal hypoxia off the Changjiang estuary, when the chlorophyll a is higher than 4 µg/l, the near-bottom water DO becomes <3 mg/l, i.e. the higher the pigment concentration in surface waters, the lower the DO in near-bottom waters.

The field-data collection will continue to be the main task of studies in 2007. However, data analysis and synthesis research will be another important task during the second year of China GLOBEC/IMBER I. Several seminars for each of the survey themes will be held to facilitate integrated multidisciplinary studies, and to lay the foundation for future synthesis research.

Sustainable aquaculture study in Sang Gou Bay, China

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Sang Gou Bay, located at the eastern end of the Shan Dong peninsula, China, is an important aquaculture base along the Yellow Sea coast, with a mean depth of 7-8 m. Supported by the China GLOBEC III programme, sustainable healthy aquaculture is studied to provide more seafood. Two field observations have taken place during April-May 2006 and July 2006, in order to investigate the effects of shellfish and algae aquatics on the hydrology and resuspended sediments/regenerated nutrient materials under different hydrodynamic conditions. There are five stations in this area, as shown in Figure 1, including northern Xun Shan (122°33'E, 37°08'N), southern Chu Dao (122°32'E, 37°03'N), Inner (122°29'E, 37°06'N), Outer (122°33'E, 37°06'N) and Centre (122°31'E, 37°06'N) of the bay.

At stations Xun Shan and Chu Dao, water level data were collected by an Aanderra water level gauge from 17 April - 17 May and 20 June - 20 July. A SonTek 1.5MHz Mini ADCP/Nortek 2MHz ADCP was mounted looking downward to measure velocity profiles at the Xun Shan and Chu Dao sites during each deployment (28 April-7 May and 13-20 July). However, at station Chu Dao in July, an RDI 1200kHz Workhorse Sentinel ADCP was mounted on a platform looking upward from the seabed, and a LISST-100 and an OBS were also mounted on the platform to measure the time series of the size and concentration of suspended particulate matter, turbidity and chlorophyll.

At the Inner and Outer stations, a chain was deployed to measure currents on the surface and bottom layers using two Alec velocimeters. An RBR 420 CTD was used to measure salinity and temperature in the median layer during the spring/neap period (25 hours) of each field observation. Unfortunately, data was not collected during the July observation at the Inner station due to a technical problem.



Figure 1. Aquaculture study sites in Sang Gou Bay, China.

At the Centre station, a platform was located above the seabed to collect near-seabed current and turbidity profiles near the bottom by an RBR Turbidity (XR 620), a LISST-100 and a NorTek 6M ADV for the spring period (25 hours) in May. At the same time, an RDI 1200kHz Workhorse Sentinel ADCP was mounted on the ship (downlooking) to measure the current profiles. Seawater was sampled from three layers (surface, median and bottom). All the data from the study are currently being analysed.

Prof. Jilan Su, from the Chinese Academy of Sciences and Prof. Qisheng Tang (Chinese Academy of Engineering) visited the observation stations personally to supervise the staff during the first cruise.