DOCTORAL THESIS

Responses of macrobenthic communities to pollution control and fisheries management measures in Hong Kong

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Abstract

Benthic animals have been widely used as health indicators of the marine benthic ecosystems in temperate regions. My PhD thesis mainly aimed to understand the responses of benthic ecosystem in tropical Hong Kong waters to the two management measures - pollution control and trawling ban. My study was based on sediment grab samples collected from 28 stations in three territory-wide surveys conducted in 2001, 2012 and 2015 in Hong Kong waters. I compared the spatial and temporal changes in macrobenthic community structure as well as physical and chemical characteristics of benthic habitats between surveys conducted before and after the pollution control measures in 2001 and 2012, as well as surveys before and after the fishery management measure in 2012 and 2015.

The impacts of sewage pollution to benthic ecosystems had been noted in many studies, which included deteriorated water quality and bottom sediment, and disturbed, less diverse macrobenthic community dominated by opportunistic small-sized species. Therefore, sewage treatment and cessation of sewage effluent discharge were expected to lead to notable improvement in benthic habitats, biodiversity and macrobenthic communities; besides, responses of benthic ecosystems to pollution control may be hydrologically varied. In Hong Kong, a series of sewage treatment schemes, e.g. Stage 1 of Harbour Area Treatment Scheme (HATS), Tolo Harbour Action Plan (THAP), Tolo Harbour Effluent Export Scheme (THEES) and a number of sewage treatment works had been conducted in different areas of Hong Kong. Changes in the community structure were noted in the three focal areas with pollution control measures, i.e. Victoria Harbour, Deep Bay and Tolo Harbour; while apparent recoveries were noted inside the Victoria Harbour, the changes in benthic communities inside the Tolo Harbour and Deep Bay could not be attributed to the pollution control measures. Specifically, a decline in nutrient input to the eastern part of Victoria Harbour due to the implementation of HATS might have led to declined sedimentary total organic matter and the disappearance of the opportunistic species, and hence a recovery of benthic ecosystem therein. But in the sheltered Tolo Harbour and Deep Bay, neither improvement in sediment quality nor biodiversity were noted,

thus indicating a longer duration is needed for the recovery of benthic ecosystems to take place in these land-locked bays.

Degraded marine fishery resources and destruction in marine ecosystems had been noted since the introduction of modern trawling vessels had into Hong Kong since the 1950s and 1960s. Currently, most reports of benthic ecosystem responses to cessation of trawling originate from temperate regions, while it is not well understood for the situation in tropical areas. The territory-wide trawling ban in tropical Hong Kong waters was implemented by the Hong Kong government since December 31, 2012. Although improvement in benthic ecosystems was anticipated after the ban, it was unknown when this would happen and how different parts of the Hong Kong waters would respond to the trawling ban. My study showed that, around 3 years after the trawling ban, sedimentary organic matter content had increased significantly, and bottom water suspended solid loads had decreased in most of the survey stations, indicating territory-wide improvement in the benthic environment. Moreover, significant increases in richness, abundance and functional diversity of macrobenthos, as well as a more aggregated, fewer but larger station groups of macrobenthic communities were also detected after the trawling ban, indicating rapid recovery of the benthic communities.

In conclusion, my study indicates that benthic communities in tropical Hong Kong can be used as bioindicators of environmental changes. Due to their restricted mobility, benthic organisms should be an integral part of the ecosystem monitoring aiming to detect the consequences of management measures to the marine environment. Environmental data including habitat complexity and hydrology are also required to fully understand the spatial and temporal dynamics of benthic ecosystems. Besides, my study has provided two territory-wide baseline data on the biodiversity and macrobenthic community structure in the tropical Hong Kong waters, which will be valuable for detecting future changes in the benthic ecosystems.

My benthic ecology studies have resulted in a published paper and a manuscript ready for submission for publication. Besides focusing on benthic ecology, I have conducted taxonomic studies on benthic polychaetes, resulting in two

published papers. As good taxonomy is the basis of high-quality data in benthic ecology, the training I received from studying these benthic polychaetes has enhanced my understanding of the biology of benthos, which is also important for my career development. However, since these papers do not fall into the main theme of my thesis, they are included in the thesis as appendixes only.

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