生物多样性 2010, **18** (1): 60–66
Biodiversity Science http: //www.biodiversity-science.net

福建同安湾潮间带红树林生境与非红树林生境大型底栖动物群落比较

周细平 蔡立哲 傅素晶 王 雯
(厦门大学近海海洋环境科学国家重点实验室, 厦门 361005)

摘要: 底栖动物群落是红树林生态系统多样性研究的重要内容之一。为了解大型底栖动物群落对高有机质含量和富营养的红树林生境的响应, 从2006年4月到2007年1月, 对福建省同安湾红树林生境和非红树林生境大型底栖动物群落及其时空变化进行了研究。我们在同安湾红树林种植区设置了凤林(FL)和山后亭(XA)两条断面, 每条断面在红树林内各设2个取样站(FL1, FL2, XA-A和XA-B), 林外各设1个取样站(FL3和XA-C)。底质研究结果显示凤林3个取样站(FL1, FL2和FL3)的有机质含量均超过底质污染评价标准的临界值3.4%, 且无论凤林还是山后亭, 红树林生境的有机质含量均要高过非红树林生境。共获得大型底栖动物91种, 其中在红树林生境内获得77种, 高于非红树林生境内获得的67种。红树林生境和非红树林生境的大型底栖动物平均栖息密度分别为4,445.8 inds/m^2 和1,707.2 inds/m^2, 平均生物量分别为51.1 g/m^2 和 94.6 g/m^2。独立样本*t*-检验结果显示, 红树林生境和非红树林生境大型底栖动物平均栖息密度和平均生物量均存在显著差异。研究结果指示红树林生境对于寡毛类生存(如在高耐有机污染中能大量繁殖的沼蚓)有积极作用。但由于邻近的非红树林林生境的水淹时间更长, 一些具有移动能力的软体动物和甲壳动物能迁移到更适合生存的非红树林生境中去。其他底质因子如盐度和土壤中值粒径等也会影响大型底栖动物群落变化。

关键词: 底栖动物, 群落, 红树林, 福建

Comparative study of the macrobenthic community in intertidal mangrove and non-mangrove habitats in Tong'an Bay, Fujian Province

Xiping Zhou*, Lizhe Cai, Sujing Fu, Wen Wang
State Key Laboratory of Marine Environmental Science, Xiamen University, Xiamen, 361005, *China*

Abstract: Research on the biodiversity of mangrove ecosystems should include not only the plants but other components, such as the macrobenthos. In order to understand the response of the macrobenthos to a mangrove habitat with high organics and nutrients, we compared the mangrove and non-mangrove macrobenthic communities, and analyzed their spatial-temporal distributions in these two habitats from April 2006 to January 2007 in Tong'an Bay, Fujian. Six sampling stations were set in Tong'an Bay, four of them (FL1, FL2, XA-A and XA-B) were in the mangrove habitat, the other two (FL3 and XA-C) were in the non-mangrove habitat. An analysis of sediment properties showed that total organic matter (TOM) of the three sampling stations at Fenglin exceeded the critical threshold, namely 3.4%, and TOM in mangrove stations was higher than in the non-mangrove ones. A total of 91 macrobenthic taxa were obtained from the six sampling stations in Tong'an Bay, including 77 and 67 taxa from the mangrove and non-mangrove habitats, respectively. Mean macrobenthic densities in the mangrove and non-mangrove habitats were 4,445.8 inds/m^2 and 1,707.2 inds/m^2, respectively. Mean biomasses in the mangrove and non-mangrove habitats were 51.1 g/m^2 and 94.6 g/m^2, respectively. The results of an independent-samples *t*-test showed that mean density and mean biomass were significantly different in the two habitats. The present study revealed that the mangrove habitat has a positive influence on the Oligochaeta, such as *Limnodriloides* sp., that thrives in the high TOM sediments.

Received November 28, 2008; Accepted February 28, 2009
* Author for correspondence. E-mail: zxp020@gmail.com

Because of the shorter inundation period in the mangrove habitat, however, free-living molluscs and crustaceans preferred the non-mangrove habitat. Other sediment properties such as interstitial salinity and median particle diameter also affected the macrobenthic community.
Key words: macrobenthos, community, mangrove, Fujian

Introduction

Mangroves are the dominant intertidal vegetation of low energy shorelines in the tropics and subtropics (Chapman, 1977). However, mangroves are exposed to increasingly human perturbations such as land reclamation, construction of aquaculture ponds, livestock grazing, cutting for timber, and the dumping of rubbish (Saenger *et al*., 1983). From an environmental management perspective, these activities may result in a loss of biodiversity (Gesamp, 1991; Marshall, 1994). In recent years, research on natural or artificial mangrove restoration has become more important. Despite the threats, both restoration projects and natural growth have allowed mangroves to spread in some areas, or have helped decrease the rate of loss in others (Field, 1999).

Macrobenthos is an important component of the mangrove ecosystem. It is a positive consumer, which facilitates the cycling of material and energy flow in the mangrove ecosystem, and is a bio-indicator of sediment quality in mangrove areas. Most research on benthic communities in mangrove ecosystems has examined only a single habitat (Sheridan, 1997). For example, Guelorget *et al.* (1990) and Stoner and Acevedo (1990) examined the benthos of the non-vegetated mud of mangrove-lined lagoons, but neither studies included the benthos within the mangrove habitat. Lin *et al.* (2006) investigated the macrobenthos in the original Fenglin mangrove area, but did not include any data from adjacent non-mangrove habitats. Nonetheless, Lin's study has provided us with a useful reference for the present study. In addition, some approaches to wetland management have considered each habitat type in isolation, ignoring the fact that these systems exist as an inter-linked mosaic (Skilleter, 1996). Consequently, studies focusing only on certain types of habitat will not provide a good understanding of variations in benthic abundance or benthic composition among different habitats, or how modification (natural or anthropogenic) of one habitat type affects overall production or biodiversity in another. Hence, when considering the restoration of mangrove ecosystems, one should not only analyze particular stands of mangroves, but also include considerations of their interrelationships with surrounding habitats. Research on mangrove and non-mangrove macrobenthos will help to provide more information about how different habitats influence these communities.

In the present study, we compared the macrobenthic community of an artificial mangrove habitat with that of a non-mangrove one, to provide ecological data and basis for mangrove restoration, and to better understand biodiversity protection in the mangrove ecosystem.

Material and methods

Study sites

Tong'an Bay is a semi-circular embayment located on the northeast coast of Xiamen. It covers an area of 91.7 km^2, 55% of which is dominated by mudflat (Zhan *et al*., 2003). The two sampling sites, Fenglin (FL, 118º06′E, 24º34′N) and Shanhouting (XA, 118º11′E, 24º38′N), are located on the west and northeast coasts of Tong'an Bay, respectively (Fig. 1). At Fenglin, five mangrove species, *Kandelia candel*, *Sonneratia caseolaria, S. apetala*, *Acanthus ilicifolius*,

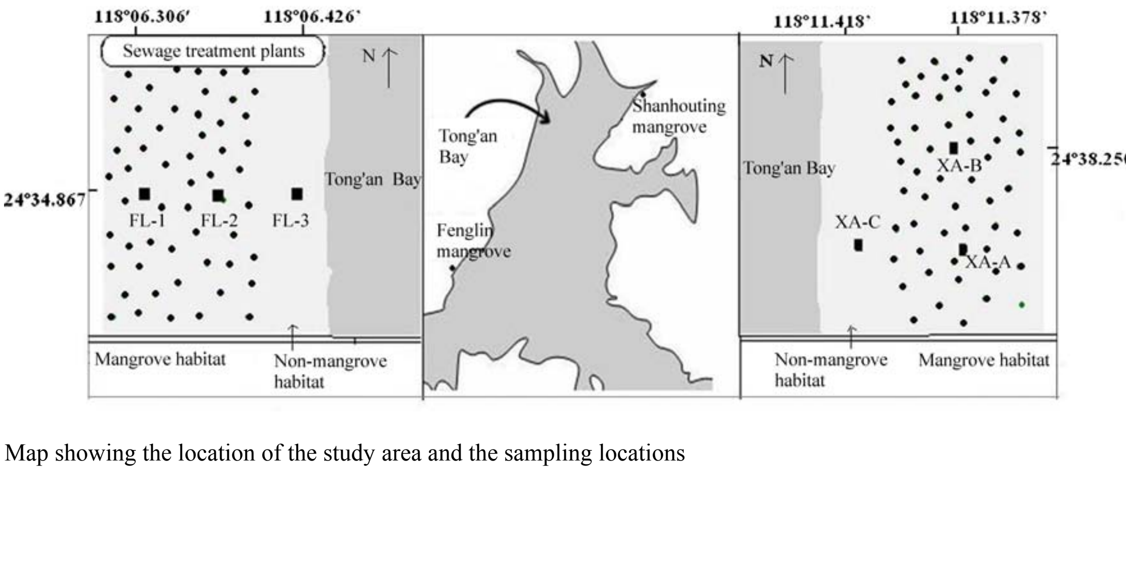

Fig. 1　Map showing the location of the study area and the sampling locations

and *Rhizophora stylosa* were planted in April 2004, while at Shanhouting, *Kandelia candel* was planted in 2005.

A total of six sampling stations were established along the Tong'an Bay, four (FL1, FL2, XA-A, XA-B) in the mangrove and two (FL3, XA-C) in a non-mangrove habitat (Fig.1). All these stations were intertidal and four mangrove sampling stations were located on the edge of the shoreline with shorter flood periods due to their higher intertidal elevations, while the other two non-mangrove sampling stations were located between the mangrove forest and the aquaculture managed mudflat.

Sampling and analysis

The sampling procedure followed the *Specification for Marine Survey* (Gaqsiq, 2007) at the end of July 2006, October 2006, January 2007 and April 2007. At each station, a 25×25 cm^2 core was used to acquire four random replicate samples. These were sieved (0.5 mm) *in situ* and the contained macrobenthic organisms which remained on the sieves were collected and returned to the laboratory for analysis. In April 2007, an additional core was collected from each station for sediment analysis. Total organic carbon (TOC) of the sediment was analyzed using an EA1110 element analyzer (Carlo-Erba Co., Italy) and then converted to organic matter. The freeze-dried and homogenized sediment samples were first acidified with 10% (v/v) HCl overnight to remove carbonate, and then dried at 60℃ and analyzed for TOC (Hedges & Stren, 1984). Granular composition of the sediment was analyzed with a Mastersizer 2000 (Malvern Instruments, UK). Interstitial water salinity was determined using a YS130S-C-T meter.

Results

Sediment properties

The salinity at the Fenglin mangrove area was lower than that in the Shanhouting mangrove area because the former is nearer to a residential district. Additionally, the Jimei Sewage Treatment Plant is located near the Fenglin mangrove area. Based on the *Evaluation Standards for Sediment Pollutants* from the *Concise Regulatios for National Sea Island Resource Comprehensive Surveys*, the critical limits for total organic matter (TOM) is 3.4%. Our study showed that the TOM of the three sampling stations at Fenglin exceeded the critical threshold, while the TOM of the other three sampling stations at Shanhouting did not. In addition, TOM values in the mangrove stations were higher than in the non-mangrove ones (Table 1).

Macrobenthic species composition in Tong'an Bay

A total of 91 macrobenthic taxa were identified from the six sampling stations in Tong'an Bay. Of these, 77 and 67 species were obtained from the mangrove and non-mangrove habitats, respectively. The dominant species in both habitats were *Limnodriloides* sp. and *Corophium* sp. The density of *Limnodriloides* sp. in the mangrove and non-mangrove habitats were 3,422.3 inds/m^2 and 720.5 inds/m^2, respectively. The density of *Corophium* sp. in the mangrove and non-mangrove habitats were 610.0 inds/m^2 and 624.0 inds/m^2, respectively. Some other species were also recorded frequently from the six sampling stations, i.e., *Ceratonereis tripartite*, *Mediomastus californiensis*, *Paraprionospio pinnata*, *Assiminea brevicula*, *Potamocorbula laevis*, *P. laevis*, and *Uca arcuata*.

Macrobenthic density and biomass in the mangrove and non-mangrove habitats

Average macrobenthic density in the mangrove and non-mangrove habitats were 4,445.8 inds/m^2 and 1,707.2 inds/m^2, respectively. In the Fenglin mangrove area, mean mangrove and non-mangrove habitat densities were 7,494.5 inds/m^2 and 1,461.3 inds/m^2, respectively. In the Shanhouting mangrove area, mean mangrove and non-mangrove habitat densities were 1,395.2 inds/m^2 and 1,953.0 inds/m^2, again respectively. It was clear that the average macrobenthic density in the Fenglin mangrove habitat was higher than in non-mangrove one, whereas at Shanhouting, the opposite was true (Fig. 2). An independent-samples *t*-test was used to assess the effects of habitat on

Table 1 Sediment salinity, median particle diameter and total organic matter at the six stations

	Stations					
	FL1	FL2	FL3	XA-A	XA-B	XA-C
Mean salinity	25.20	25.80	26.60	27.30	27.50	27.70
Median particle diameter (Φ: μm)	15.24	18.60	22.54	12.64	14.46	16.34
Total organic matter (%)	4.22	4.56	3.87	2.96	2.79	2.45

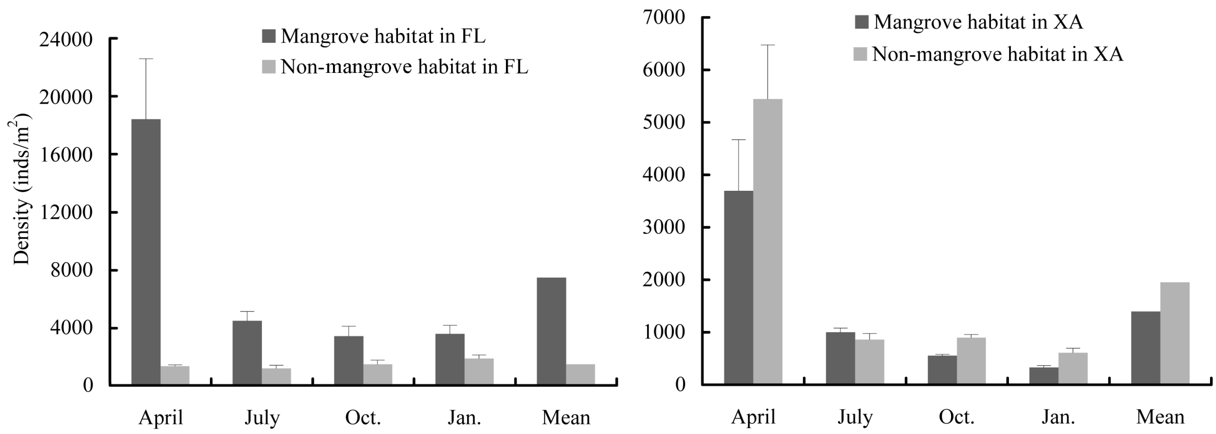

Fig. 2 Macrobenthic densities in the mangrove and non-mangrove habitats

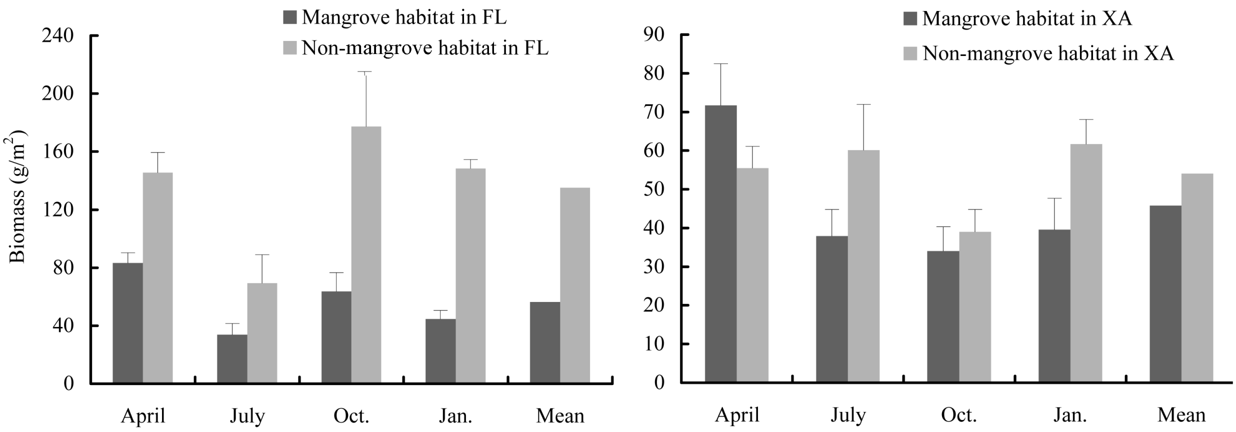

Fig. 3 Macrobenthic biomass values obtained in mangrove and non-mangrove habitats

macrobenthic density, and showed that mean densities were significantly different for the two habitat types.

The average macrobenthic biomasses in the Fenglin mangrove and non-mangrove habitats were 56.4 g/m^2 and 135.1 g/m^2, respectively (Fig. 3). In the Shanhouting mangrove area, the average macrobenthic biomass in the mangrove and non-mangrove habitats were 45.8 g/m^2 and 54.1 g/m^2, respectively. The results showed that the average biomasses in the mangrove habitats were lower than in the non- mangrove ones for both Fenglin and Shanhouting (Fig. 3). The independent-samples *t*-test used to assess the effects of habitat on macrobenthic biomass showed that they were significantly different.

Discussion

Comparison of macrobenthic community structure between mangrove and non-mangrove habitats

The number of macrobenthic taxa was greater in the mangrove habitat, and the mean density and mean biomass of macrobenthos were significantly different between mangrove and non-mangrove habitats. In the Fenglin mangrove, the mean density in the mangrove was higher than in non-mangrove habitats. The high level of organic matter in the mangrove sediment was associated with a high density of *Limnodriloides* sp. and *Corophium* sp. Opposite biomass results were obtained, however, because some free-moving molluscs and crustaceans, such as *Assiminea brevicula*, *Cerithidea cingulata* and *Laternula anatine*, still preferred the non-mangove habitat due to the longer inundation period, resulting in higher and lower mean biomass values for the non-mangrove habitat in Fenglin. Because of the abundance of larger organisms in the non-mangrove habitat at Shanhouting, e.g. *Macrophthalmus dilatum*, *Macrophthalmus definitus* and *Exopalaemon orientalis*, both the mean density and mean biomass in the mangrove habitate were lower.

The mangrove habitat had a shorter inundation period and higher TOM values than the non-mangrove habitat, resulting in differences in macrobenthic community structure. For example, the free-moving molluscs and crustaceans choose the more suitable non-mangrove habitat, whereas the Oligochaeta prefer higher levels of organic matter also thrived in the mangrove.

Comparison of macrobenthic community between the present study and other studies

The original natural Fenglin mangrove area used to be covered by *Avicennia marina,* and then the mangrove plants were removed as a result of road construction. In 2004, the Fenglin area was planted with *Kandelia candel, Sonneratia caseolaria, S. apetala*, *Acanthus ilicifolius*, and *Rhizophora stylosa* ~500 m distant from the original Fenglin mangrove. The 2002 and 2007 studies were both carried out by the same laboratory, using the same sampling tools and methods. In 2007, the study focused on both mangrove and non-mangrove habitats. But in 2002, the study was restricted to the mangrove habitat, accounting for the recording of fewer species. Different dominant groups of macrobenthos (in terms of density and biomass (Table 2) in the 2002 and 2007 studies were revealed because the sediment properties had changed. The sampling stations in the 2007 study were subjected to the discharge from nearby sewage treatment plants, which resulted in lower salinities and higher TOM values. These conditions provided a better environment for oligochaetaes, such as the opportunistic species *Limnodriloides* sp. Although *Limnodriloides* sp. was found in high densities in 2007, each individual was small, so their contribution to biomass was limited. This explains why the mean density in 2007 was higher than in 2002, while the mean biomass in 2002 was higher than in 2007.

Shannon-Wiener diversity index (H') (Shannon & Weaver, 1949) and Pielou's species evenness index (J) (Pielou, 1966) were compared between Fenglin and Shanhouting (Table 2). Species diversity (H') and evenness (J) of the macrobenthic community at Fenglin were lower than at Shanhouting, consistent with the TOM results related to the discharge of sewage from the Jimei Sewage Treatment Plant at Fenglin. Erséus (2002) reviewed the taxonomic, distributional, and ecological functions of oligochaetes in mangrove habitats all over the world. He believed that most mangrove taxa preferred low salinities and/or organically-enriched sediments. The results of the present study showed that the salinity in Fenglin was lower, and the organic matter content was higher. The dominant macrobenthic community groups in terms of density at Fenglin and Shanhouting (Table 2) were oligochaetaes and crustaceans, respectively. The results of the present study confirm the observations of Erséus (2002).

Comparison of macrobenthic communities between present and historical data

The historical data were obtained in January, April, July, and October, 2002 (Lin *et al.*, 2006) from the original natural Fenglin mangrove. Macrobenthic data, TOM and biotic indexes between the present and historical studies are identified in Table 2. More macrobenthic species, higher mean densities and higher TOM were recorded in the 2007 study than in the 2002 study. Mean biomass was, however, higher in the 2002 study than in 2007.

Both annual mean density and biomass of macrobenthos in the Fenglin mangrove area were higher than in the Shanhouting mangrove (Table 2). One-way ANOVA was used to assess temporal and spatial effects on the 2007 macrobenthic density and biomass dataset. The results showed that a significant difference in macrobenthic density existed between April and the other three seasons. Among the six sampling stations, the only significant difference in macrobenthic density was between FL2 and FL3. There was no

Table 2 A comparison of historical data of macrobenthic communities in Tong'an Bay mangrove areas

Parameter	Fenglin (2006–2007)	Shanhouting (2006–2007)	Natural Fenglin (2002) (Lin *et al.*, 2006)
Species number	65	68	42
Mean density (inds/m^2)	5,575	1,625	1,990
Mean biomass (g/m^2)	88.03	49.17	139.00
Dominant group in density	Oligochaeta	Crustacea	Gastropoda
Dominant group in biomass	Gastropoda	Crustacea	Gastropoda
Mean TOM (%)	4.22	2.71	2.22
Mean H' value	1.26	2.31	2.66
Mean J value	0.30	0.55	–

Table 3 Comparison of the macrobenthos between different mangrove areas

Localities	Species number	Mean density (inds/m^2)	Mean biomass (g/m^2)	TOM	Sieve size (mm)
Jiulong Jiang Estuary, Fujian (Gao & Li,1985)	66	534	35.92	–	–
East of Hong Kong (Cai *et al.*, 1998)	73	66	16.57	–	1.0
Dongzhaigang, Hainan (Zou *et al*., 1999)	68	101	98.00	–	–
Leizhou Peninsula, Guangdong (Liang *et al*., 2005)	165	211	223.25	–	–
Ximen Island, Zhejiang (Gao *et al*., 2005)	42	340	74.26	–	0.5
Fenglin (2006–2007)	65	5,575	85.60	4.22	0.5
Shanhouting (2006–2007)	68	1,625	50.59	2.71	0.5

– No data for the present study

significant temporal fluctuations in macrobenthic biomass. Significant spatial differences in biomass were, however, found between the FL3 and FL1 and the FL3 and FL2 sampling stations. Although all were located in Tong'an Bay, the macrobenthic communities of Fenglin, Shanhouting and the original natural Fenglin differed from each other in terms of dominant groups, both in relation to density and biomass. In the Fenglin mangrove, the dominant taxon was *Limnodriloides* sp. (Oligochaeta), at a density of 3,972.0 inds/m^2. *Corophium* sp. (Crustacea) also occurred at a high density, with a value of 521.9 inds/m^2. In the Shanhouting mangrove, in addition to the dominant *Corophium* sp. at a density of 647.0 inds/m^2, *Limnodriloides* sp. also occurred at a high density of 174.7 inds/m^2.

Comparison of macrobenthic community structure between the present study and other relevant studies

Some research has been carried out in China on mangrove macrobenthos. In different mangrove areas (Table 3), macrobenthic species numbers varied dramatically between studies, owing to the temporal and spatial scales of the studies, as well as different environmental qualities. The mean macrobenthic density and mean biomass also varied, with the former being the highest in the Fenglin mangrove. The difference in macrobenthic community composition in different mangrove areas was caused by different environmental factors, such as sediment organic content. In addition, different tools used in the various studies, such as the sieves, may have affected the results.

Relationship between environmental factors and macrobenthos

Research has shown that the distribution and abundance of benthic molluscs is affected by sediment type and tidal character (Tang *et al.*, 2005). Wang *et al.* (2005) has also asserted that zoobenthic survival, composition and species distribution, biomass and biodiversity are affected by water quality, sediment characteristics, water temperature, water depth, biological factors (such as aquatic macrophytes), and intra-specific and inter-specific competition and predation. Cai *et al*. (1998) investigated macrobenthos in an eastern Hong Kong mangrove habitat in 1994 and concluded that different environmental factors such as sediment type, salinity, and tides would result in different epifaunal community compositions. Gao *et al.* (2005) studied the relationship between mangrove and macrobenthos on Ximen Island, Zhejiang Province, revealing that the diversity of macrobenthos had a negative correlation with the mangrove's development status, while the biomass had a positive correlation with it. The present study has revealed that the mangrove habitat has a positive influence on oligochaetaes, such as *Limnodriloides* sp., but with shorter inundation period, free-moving molluscs and crustaceans prefer adjacent non-mangrove habitats.

Acknowledgements

We thank Professor Brian Morton for his assistance in English writing.

References

Cai LZ, Tam Nora FY, Wong YS (1998) Characteristics of quantitative distribution and species composition of macrozoobenthos in mangrove stands in eastern Hong Kong. *Journal of Xiamen University* (Natural Science) (厦门大学学报(自然科学版)), **37**(1), 115–121. (in Chinese with English abstract)

Chapman VJ (1977) *Ecosystems of the World 1: Wet Coastal Ecosystems*, pp. 1–29. Elsevier Scientific Publishing Co., New York.

Erséus C (2002) Mangroves and marine oligochaete diversity. *Wetlands Ecology and Management*, **10**, 197–202.

Field CM (1999) Rehabilitation of mangrove ecosystems: an overview. *Marine Pollution Bulletin*, **37**, 383–392.

Gao AG, Chen QZ, Zeng JN, Liao YB, Yang JY (2005) Macrofauna community in the mangrove area of Ximen Island, Zhejiang. *Journal of Marine Sciences* (海洋学研究), **23**, 33–40. (in Chinese with English abstract)

Gao SH, Li FX (1985) Community ecology of group-dwelling macrofauna of mangrove in the Jiulong Jiang Estuary, Fujian. *Taiwan Strait* (台湾海峡), **4**, 179–191. (in Chinese with English abstract)

Gaqsiq (2007) (General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, Standardization Administration of the People's Republic of China) The Specification for Marine Survey, part 6: Marine Biological Survey, GB12763.6.

Gesamp (1991) (IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution). *Reducing Environmental Impacts of Coastal Aquaculture*. Reports and Studies GESAMP, No.47.

Guelorget O, Gaujous D, Louis M, Perthuisot JP (1990) Macrobenthofauna of lagoons in Guadeloupean mangroves (Lesser Antilles): role and expressions of the confinement. *Journal of Coastal Research*, **6**, 611–626.

Hedges JI, Stren JH (1984) Carbon and nitrogen determinations of carbonate-containing solids. *Limnology and Oceanography*, **29**, 657–663.

Liang CY, Zhang HH, Xie XY, Zou FS (2005) Study on biodiversity of mangrove benthos in Leizhou Peninsula. *Marine Sciences* (海洋科学), **29**, 18–25, 31. (in Chinese with English abstract)

Lin XC, Cai LZ, Ma L, Gao Y, Yang L, Liu WM (2006) The macrofaunal community in Fenglin mangrove area, Xiamen. *Biodiversity Science* (生物多样性), **14**, 128–135. (in Chinese with English abstract)

Marshall N (1994) Mangrove conservation in relation to overall environmental considerations. *Hydrobiologia*, **285**, 303–309.

Pielou EC (1966) The measurement of diversity in different types of biological collections. *Journal of Theoretical Biology*, **13**, 131–144.

Saenger P, Hegerl EJ, Davie JDS (1983) Global status of mangrove ecosystems. *Environmentalist*, **3**(Suppl. 3), 1–88.

Shannon CE, Weaver W (1949) *The Mathematical Theory of Communication*, pp. 123–146. University of Illinois Press, Urbana.

Sheridan P (1997) Benthos of adjacent mangrove, seagrass and non-vegetated habitats in Rookery Bay, Florida, USA. *Estuarine Coastal and Shelf Science*, **44**, 455–469.

Skilleter GA (1996) Validation of rapid assessment of damage in urban mangrove forests and relationships with molluscan assemblages. *Journal of the Marine Biological Association of the United Kingdom*, **76**, 701–716.

Stoner AW, Acevedo C (1990) The macroinfaunal community of a tropical estuarine lagoon. *Estuaries*, **13**, 174–181.

Tang YJ, Lin W, Chen JF (2005) Species diversity of benthic mollusc in different habitats of intertidal zone in Shangchuan Island. *Biomagnetism* (生物磁学), **5**, 4–7. (in Chinese with English abstract)

Wang YD, Xiong BX, Chen CB, Hu HS (2005) The effect of environment factors on life activity of zoobenthos. *Journal of Zhejiang Ocean University* (Natural Science) (浙江海洋学院学报) (自然科学版)), **24**, 253–257. (in Chinese with English abstract)

Zhan LY, Zheng AR, Chen ZF (2003) Estimation of carrying capacity of the oyster in Xiamen Tong'an Bay. *Journal of Xiamen University* (Natural Science) (厦门大学学报(自然科学版)), **42**, 644–647. (in Chinese with English abstract)

Zou FS, Song XJ, Chen W, Zheng XR, Chen JH (1999) The diversity of benthic macrofauna on mud flat in Dongzhaigang Mangrove Reserve, Hainan. *Chinese Biodiversity* (生物多样性), **7**, 175–180. (in Chinese with English abstract)

(责任编委: 李新正 责任编辑: 时意专)