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Macrobenthic fauna in shrimp-farms adjacent mangroves, Kradae Chae Canal, Ban Don Bay, Southern Thailand

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Abstract: An investigation was made into the fate of macrobenthic fauna in shrimp-farms adjacent mangroves, Kradae Chae Canal, Southern Thailand, to examine the fauna between the mangrove floor and mangrove cut-down floor. The density and diversity of macrobenthic fauna per m^2 were higher on mangrove floor than those on mangrove cut-down floor. The species composition of benthic fauna at the former in each season ranged from 16-17 species while at the latter ranged from 1-12 species. Polychaetes and crustaceans were predominant. Most abundant of these two groups were capitellid polychaetes and grapsid crabs. The latter was dominant only in the wet season. Although the density of benthic fauna found on mangrove floor was high (1088-2080 individuals m^{-2}), the species composition of crustaceans and molluscs was low compared to other typical mature mangrove forests.

1. Introduction

Macrobenthic communities in mangrove areas have been studied in Thailand both on the west coast (FRITH *et al.*, 1976; FRITH, 1977; CHATANANTHAWEJ and BUSSARAWIT, 1987) and on the east coast (SRISUCHAT, 1981). Some previous studies have focussed on the effects of off-shore tin mining on benthic communities (PRASERTWONG, 1984; HYLLEBERG *et al.*, 1985).

The present work was undertaken to study the benthic communities at shrimp-pond construction area along Kradae Chae Canal, Ban Don Bay. The study was required because of the increasing exploitation of mangrove areas for aquaculture; a comparative study of benthic fauna between the mangrove floor and mangrove cut-down floor might provide a basis for estimation of the importance of mangroves to benthic communities.

2. Materials and Methods

Study area

Kradae Chae Canal is located in Ban Don Bay, Suratthani Province (9°12'N, 99°25'E). The water temperature and salinity ranges in the year of the study were 24-33°C and 16-34 ppt, respectively. The depth of the canal ranges from 0.7 to 4.0 m., and the linear distance from the canal mouth to the upper stream is 4 km. On both banks of the canal, there are sparse populations of mangrove trees and scattered group of houses, among which many shrimp ponds have been constructed.

For this study, six stations were established along the canal (Fig. 1). These stations differ by their distance from the seawater entry point into the canal. Stations 1-5 were within the canal, while station 6 was located at the mouth of the canal adjacent to one of the few remaining stands of mangrove, with approximately 50 cm of water remaining at low tide.

Six samples were collected along the bank of each station during the dry (March) and wet (October) seasons, using a 0.05 m^2 Tamura grab. This method was found to be most suitable for this type of environment. The samples were sieved consecutively through 3 orders of screens of 5 mm, 1 mm and 0.5 mm mesh. The macrobenthic fauna were removed with forceps, and the 0.5 mm mesh screen residue was also collected. The samples were fixed in 10% rose bengal formalin and transferred to 70% ethyl alcohol before identification.

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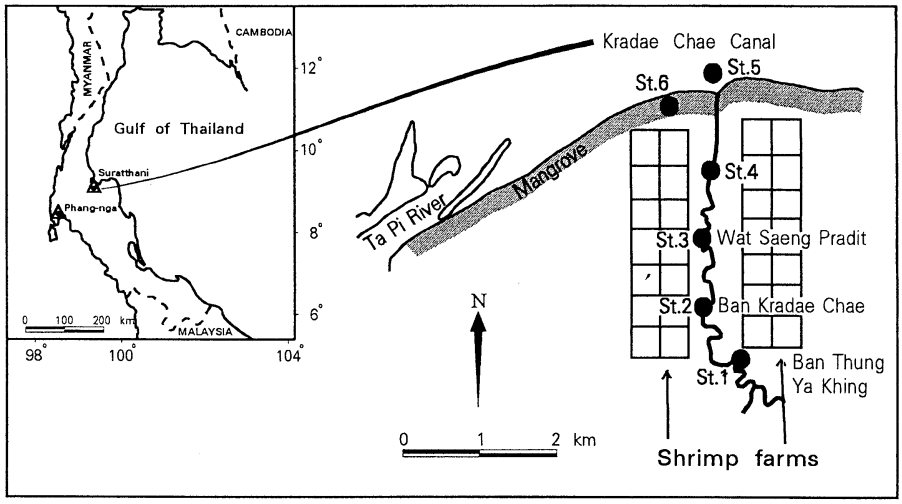

Fig. 1. Location of stations in the study of benthic fauna at Kradae Chae Canal.

Results and Discussion

Table 1 shows the distribution of benthic fauna in Kradae Chae Canal in the dry season. A total of 5 phyla (Platyhelminthes, Annelida, Arthropoda, Mollusca and Chordata) consisting of 23 species were identified, including 9 species each of polychaetes and crustaceans with *Heteromastus* sp. and *Eupogebia* sp. respectively as the dominant. The remainder was composed of 3 species of pelecypod, 1 species of eel and 1 species of flat worm. The number of species obtained at each station ranged from 1 to 17. The lowest fauna diversity was found at station 5 (1 species), while the highest was at station 6 (17 species). The total density of benthic fauna at each station ranged from 42 (St. 5) to 8560 (St. 2) individuals per m^2.

Table 2 shows the distribution of benthic fauna in Kradae Chae Canal in the wet season. A total of 5 phyla (Coelenterata, Platyhelminthes, Annelida, Arthropoda and Mollusca) containing 22 species were identified. Crustacea showed the highest number of species (12 species) followed by Polychaeta (6 species). Grapsidae was the most abundant crustacean, with Spionidae as the dominant polychaete. The number of species found at each station ranged from 1 to 16. The lowest fauna diversity was found at station 1 (1 species) while the highest was once again found at station 6 (16 species). The total density of fauna at each station ranged from 14 (St. 1) to 1088 (St. 6) individuals per m^2.

Total macrobenthic fauna (33 species) for the study area (Sts. 1–6) in two seasons consisted of Coelenterata (1 species), Platyhelminthes (1 species), Polychaeta (10 species), Crustacea (15 species), Insecta (1 species), Pelecypoda (3 species), Gastropoda (1 species) and fish (1 species). Twelve species were found in both seasons. The total species composition of fauna between the dry and the wet season was not significantly different while their abundance was greater in the dry than in the wet season.

The average abundance and the diversity of benthic fauna varied widely among the stations, with both higher in the mangrove forest area (St. 6) than in the canal (Sts. 1–5) where the mangroves have been cut down.

The diversity of benthic fauna at Stations 1–5 was slightly less than that at the sand and mud flat biotopes of Koh Surin Nua (11 species) while that at Station 6 was slightly higher but less than that at the mangrove biotope of Koh Surin Nua (38 species) which has been recognized as a low species diversity area (FRITH, 1977).

The average abundance of benthic fauna found in Kradae Chae area was similar to that in the reports of previous studies in other coastal and mangrove areas, such as the west

Table 1. Diversity and density (individuals m^{-2}) of benthic fauna at 6 stations in the Kradae Chae Canal, Suratthani on March 7, 1993.

Taxa	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6
Platyhelminthes						
Unidentified sp.	—	—	—	—	—	8
Annelida						
Capitellidae						
Capitella sp.	96	231	—	—	—	—
Heteromastus sp.	—	—	65	108	42	926
Eunicidae						
Unidentified sp.	—	—	4	—	—	65
Nephtyidae						
Nephtys sp.	4	4	4	8	—	8
Nereidae						
Unidentified sp. 1	4	4	—	—	—	—
Unidentified sp. 2	—	4	11	4	—	—
Opheliidae						
Unidentified sp.	—	—	—	—	—	8
Sabellidae						
Unidentified sp.	—	—	—	21	—	215
Spionidae						
Unidentified sp.	—	11	8	—	—	172
Arthropoda						
Cyclopoida						
Unidentified sp.	—	—	—	—	—	8
Amphipoda						
Eriopisa sp.	—	18	4	—	—	115
Unidentified sp. 1	—	—	—	—	—	86
Unidentified sp. 2	—	—	—	—	—	46
Isopoda						
Apanthura sp.	—	4	—	—	—	158
Spheroma sp.	—	—	—	—	—	21
Caridea						
Unidentified sp.	8	—	—	—	—	—
Anomura						
Upogebia sp.	—	8	—	—	—	194
Brachyura						
Grapsidae						
Unidentified sp. 1	—	—	—	—	—	8
Mollusca						
Pelecypoda						
Modiolus sp.	—	—	—	—	—	21
Unidentified sp. 1	8	8276	—	—	—	—
Unidentified sp. 2	—	—	—	—	—	21
Chordata						
Eel larvae (1 species)	—	—	4	—	—	—
Total density	120	8560	100	141	42	2080
Number of species	5	9	7	4	1	17

Table 2. Diversity and density of benthic fauna at 6 stations in the Kradae Chae Canal, Suratthani on October 16, 1993.

Taxa	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6
Coelenterata						
Anemone	—	—	—	4	—	—
Platyhelminthes						
Unidentified sp.	—	—	—	—	—	10
Annelida						
Capitellidae						
Heteromastus sp.	—	—	100	206	10	260
Nephtyidae						
Nephtys sp.	—	4	10	—	—	—
Nereidae						
Unidentified sp. 1	—	—	—	14	4	2
Dendronereis sp.	14	—	—	24	36	36
Sabellidae						
Unidentifies sp.	—	—	—	4	—	—
Spionidae						
Unidentified sp.	—	—	—	364	—	300
Arthropoda						
Acarina						
Unidentified mite	—	—	—	—	—	10
Cyclopoida						
Unidentified sp.	—	10	—	—	—	—
Amphipoda						
Eriopisa sp.	—	—	—	24	—	36
Unidentified sp. 1	—	4	—	14	—	18
Isopoda						
Apanthura sp.	—	—	—	4	—	10
Mysidacea						
Unidentified sp.	—	20	—	40	10	30
Caridea						
Unidentified sp.	—	4	—	—	—	—
Penaeidea						
Penaeus (post larvae)	—	—	—	—	—	26
Anomura						
Upogebia sp.	—	—	—	4	6	54
Brachyura						
Grapsidae						
Unidentified sp. 1	—	—	—	—	20	264
Unidentified sp. 2	—	—	—	—	—	20
Ocypodidae						
Unidentified sp. 1	—	—	—	—	—	6
Mollusca						
Pelecypoda						
Unidentified sp. 2	—	—	—	—	—	6
Gastropoda						
Cerithidea sp.	—	—	—	4	—	—
Total density	14	42	110	706	86	1088
Number of species	1	5	2	12	6	16

coast of Thailand (CHATANANTHAWEJ and BUSSARAWIT, 1987), Ao Nam-Bor shore, Phuket (FRITH *et al.*, 1976), Ko Yao Yai, Phuket (NATEEWATHANA and TANTICHODOK, 1980), Ko Maphrao, Phuket (TANTICHODOK, 1981) and Phang-nga Bay (PAPHAVASIT and SETTI, 1981), but the diversity was very low compared to those areas.

Although the abundance of macrofauna on the mangrove forest floor at Station 6 did not appear significantly different from that found in typical mangrove areas, the number of species is comparatively low, particularly for crabs and molluscs (FRITH, 1977; PAPHAVASIT and SETTI, 1981) and amphipods (BUSSARAWICH *et al.*, 1984). This may be due to several factors: there is information that crabs have been over-harvested for food processing (personal communication by fishermen), and there is a difference in the forest floors. The mangrove floor of the collecting site is often submerged during low tide. The presence of mangrove trees and associated microhabitats accounts for the high diversity and abundance of grapsid crabs within the habitat, such as beneath dead wood, among rotting vegetation, and on prop roots and tree trunks (FRITH *et al.*, 1976). Although these crabs feed on mangrove leaves, mangrove seedlings and fine plant and animal detritus, members of Grapsidae are well adapted to aerial beathing and are able to withstand longer exposure periods, an adaptation which allows them to colonize the more landward intertidal areas (MACNAE, 1968). Some grapsid crabs, *Chiromanthes indiarum* and *Helice leachi*, were notably more abundant in the landward rather than the seaward mangrove forest areas (FRITH, 1977). The low species diversity of grapsid crabs at Station 6 may therefore be due to the mentioned factors.

It is noteworthy that the members of several gastropod families such as Littorinidae, Neritidae, Assimineidae and Potamididae, which are dominant in the mongrove biotope (FRITH *et al.*, 1976; PAPHAVASIT and SETTI, 1981; SHOKITA *et al.*, 1983), were not encountered in the present study. The type of substrate(FRITH, 1977) and inundation during low tide might, to some extent, be attributable to the absence of some gratropods. The majority of gastropods found with in the mangrove environment are able to breathe air and thus withstand long exposure periods (BERRY, 1972). This adaptation may allow them to be active during low water periods and to colonize the more landward shore areas (FRITH *et al.*, 1976). Then, tree-dwelling gastropods are often observed in mangrove microhabitats as leaves, prop roots, tree trunks and branches (FRITH *et al.*, 1976; FRITH, 1977; SHOKITA *et al.*, 1983; COOK and GARBETT, 1989). Unfortunately for the present study, the tree-dwelling animals have not been investigated. Thus, in this case a comparative discussion with previous reports may be difficult.

At Stations 1－5, it was found that the polychaete population was dominant while crustaceans were rare. This was different from Station 6 where crustaceans were more abundant in both density and diversity. Such levels of polychaetes with reduced numbers of crustaceans reflect high pollution or stress in the environment; the opposite state results in the reverse condition (AMIO, 1979). Although capillellid polychaetes have been found in mangroves in Malaysia (SASEKUMAR, 1974), on Phuket Island (FRITH *et al.*, 1976) and on Koh Surin Nua (FRITH, 1977), Capitellidae, such as *Capitella capitata*, have been recorded as an indicator species for organically polluted waters (KIKUCHI, 1991). CHAREONPANICH *et al.* (1994) suggested that *Capitella* sp. I has the ability to be utilized as an effective biological treatment for poor oxygenated sediment below fish net pen culture areas. The treatment of organically polluted sediment is particularly appropriate (CHAREONPANICH *et al.*, 1993). It would seem, therefore, that the presence of other species of Capitellidae such as *Capitella* sp. and *Heteromastus* sp. within Kradae Chae Canal may be due to the enrichment of organic matter from shrimp ponds and households there. Especially in the dry season, the capitellid population was more abundant than in the wet season.

The density and diversity of benthic fauna in general within the Kradae Chae Canal (Sts. 1－5) itself were markedly low, with the exception of Station 2 (dry season) where the highest total density was found. This included a large

number of small dead bivalves (8 mm in length). Dredging of the canal for water pumping to shrimp ponds was the major factor in the reduction of benthic fauna. Recolonization should be possible if the dredging is prevented. Tidai currents would serve as a source of larval stock and food, with the stations closer to the sea being colonized faster than the inner stations. Estimation of the time required for complete recolonization will need further study. Coastal areas affected by off-shore tin mining need to be allowed more than one monsoon period for full recolonization by benthic polychaetes (HYLLEBERG *et al.*, 1985).

Although it has not yet been demonstrated that benthic fauna provide a supplementaly source of protein in shrimp ponds, macrobenthos are a major natural source of food for penaeid shrimp (IKEMATSU, 1963). For shrimp, epifaunal suspension feeders and deposit-suspension feeders are preferred to infaunal deposit feeders (KUWABARA and AKIMOTO, 1986). Such species as macrobenthos *Perinereis quatrefagesi* have been used as food for cultured shrimp (HYLLEBERG *et al.*, 1986). Moreover, crustaceans, bivalves, gastropods and polychaetes have been reported as the most common food items in the guts of both juvenile and adult *Penaeus merguiensis* (WASSENBERG and HILL, 1993). This suggests that benthic fauna are useful to shrimp production. The soft bottom under mangrove trees is more productive of benthic fauna. The present study suggests that there is a positive relation between the density of the mangrove trees and the density and diversity of benthic fauna produced. The low diversity of crustaceans on mangrove floor at Kradae Chae Canal found in this study seems to be different from the typical mangrove forest. The intensive research on the effect of shrimp-pond effluent on benthic fauna may be necessary.

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References

AMIO, M. (1979): Macrobenthos and aquatic animals. p. 2–3, 59–83. *In* Report on the effect of waste water effluent from sewage disposal plant in Takamatsu City to fishing grounds. Res. Org. on the Effect of Waste Water Effluent from Sewage Disposal Plant in Takamatsu City to Fishing Grounds. Takamatsu. (in Japanese).

BERRY, A.J. (1972): The natural history of west Malaysian mangrove faunas. Mal. Nat. J., **25**, 135–162.

BUSSARAWICH, S., A. NATEEWATHANA and J. HYLLEBERG (1984): Distribution of marine benthic amphipods off Phuket Island, with emphasis on tin mining and a model of species-individual relationships. Phuket Mar. Biol. Cent. Res. Bull., **32**, 1–21.

CHAREONPANICH, C., S. MONTANI, H. TSUTSUMI and S. MATSUOKA (1993): Modification of chemical characteristics of organically enriched sediment by *Capitella* sp. I. Mar. Pollut. Bull., **26**, 375–379.

CHAREONPANICH, C., S. MONTANI, H. TSUTSUMI and H. NAKAMURA (1994): Estimation of oxygen consumption of deposit-feeding polychaete *Capitella* sp. I. Fish. Sci., **60**, 249–251.

CHATANANTHAWEJ, B. and S. BUSSARAWIT (1987): Quantitative survey of the macrobenthic fauna along the west coast of Thailand in the Andaman Sea. Phuket Mar. Biol. Cent. Res. Bull., **47**, 1–23.

COOK, L. M. and S. B. GARBETT (1989): Patterns of variation in mangrove littorinid molluscs on Phuket Island. Phuket Mar. Biol. Cent. Res. Bull., **53**, 1–14.

FRITH, D. W. (1977): A preliminary list of macrofauna from a mangrove forest and adjacent biotopes at Surin Island, western Peninsular Thailand. Phuket Mar. Biol. Cent. Res. Bull., **17**, 1–14.

FRITH, D. W., R. TANTANASIRIWONG and O. BHATIA (1976): Zonation of macrofauna on a mangrove shore, Phuket Island. Phuket Mar. Biol. Cent. Res. Bull., **10**, 1–37.

HYLLEBERG, J., A. NATEEWATHANA and S. BUSSARAWIT (1986): Polychaetes of Thailand. Nereidae (Part 1) ; *Perinereis* and *Pseudonereis* with notes on species of commercial value. Phuket Mar. Biol. Cent. Res. Bull., **43**, 1–22.

HYLLEBERG, J., A. NATEEWATHANA and B. CHATANANTHAWEJ (1985): Temporal changes in the macrobenthos on the west coast of Phuket Island, with emphasis on the effects of offshore in mining. Phuket Mar. Biol. Cent. Res. Bull., **38**, 1–32.

IKEMATSU, W. (1963): Ecological studies on the fauna of Macrura and Mysidacea in the Ariake Sea. Bull. Seikai Reg. Fish. Res. Lab., **30**, 1–117. (In

Japanese with English summary)

KIKUCHI, T. (1991): Macrobenthic succession in the organically polluted waters, and ecological characteristics of some pollution indicator species. p. 145–163. *In*: MAUCHLINE, J. and T. NEMOTO (eds.). Marine Biology. Its Accomplishment and Future Prospect. Pro. Internat, Marine Biology Symposium, Tokyo, 29–30 Nov. 1989. Hokusensha, Tokyo.

KUWABARA, R. and Y. Akimoto (1986): The offshore environment of Tungkang Southwest Taiwan. II Macrobenthos. p.193–198. *In*: Prec. First Asian Fisheries Forum, Manila, Philippines, 26–31 May 1986. MACLEAN, J.L., L.B. DIZON and L.V. HOSILLOS (eds). The Asian Fisheries Society Manila, Philippines.

MACNAE, W. (1968): A general account of the flora and fauna of mangrove swamps in the Indo-West Pacific region. Adv. Mar. Biol., **6**, 73–720.

NATEEWATHANA, A. and P. TANTICHODOK (1980): Species composition, density and biomass of macrofauna of a mangrove forest at Ko Yao Yai, Southern Thailand. Paper presented at the Asian Symposium on Mangrove Environment. Research and Management, held at Kuala Lumpur, 25–29 August 1980. 32 pp.

PAPHAVASIT, N. and N. SETTI (1981): Marine benthos in the mangrove ecosystem of Phang-nga Bay. p. 198–216. *In*: Report of the Fourth National Seminar on Mangrove Ecology, held at Suratthani, 7–11 July 1981, National Research Council of Thailand. (in Thai)

PRASERTWONG, P. (1984): Recolonization of Marine Benthic Fauna after Offshore Tin Mining. Master Thesis, Chulalongkorn University, Thailand. 80 pp. (in Thai)

SASEKUMAR, A. (1974): Distribution of macrofauna on a Malayan mangrove shore. J. Anim. Ecol. **43**, 51–69.

SHOKITA, A., K. NOZAWA, N. YOSHIKAWA and S. LIMSAKUL (1983): Macrofauna in mangrove areas of Thailand. Mangrove Ecology in Thailand, Japanese Ministry of Education, Science and Culture. pp. 33–61.

SRISUCHAT, P. (1981): Species, Quantities and Distribution of Benthic Fauna in Mangrove Forest at Amphoe Khung, Changwat Chantaburi. Master Thesis. Kasetsart University, Thailand. 89 pp. (in Thai)

TANTICHODOK, P. (1981): Spesies Composition, Density and Biomass of Mangrove Macrofauna at Ko Maphrao, Phuket. Master Thesis. Chulalongkorn University, Thailand 98 pp.

WASSENBERG, T. J. and B. J. HILL (1993): Diet and feeding behaviour of juvenile and adult banana prawns *Penaeus merguiensis* in the Gult of Carpentaria, Australia. Mar. Ecol. Prog. Ser., **94**, 287–295.

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