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Original Article

Comparison of helminth fauna from three different habitats in the Andaman Sea coastal ecosystem, southern Thailand

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ABSTRACT

Helminths of marine fish are highly diverse, impact food safety and can reflect an environmental change. Some helminths have been recognized as biological markers for coastal ecosystem evaluation. Recently, the coastal area near Tarutao Island, Satun province, southern Thailand, has been reported to be impacted by an ecological change. However, information regarding helminth biodiversity in this area is limited. Therefore, this study investigated helminths in commercially caught marine fish from three ecological areas of the coastal ecosystem near Tarutao Island. Physicochemical factors that may impact helminth diversity were also recorded. In total, 1660 marine fish (36 species) were caught using trapping and netting. Among them, at least 11 species were infected with helminths. In the parasite assemblages of these fish populations, *Ligophorus* spp. and *Metamicrocotyla* sp. specifically infected gills of *Mugil cephalus*, which was found in both mangrove and seagrass areas. *Ligophorus* spp. had the highest prevalence of infection in *M. cephalus* and may be a predominant species and potential biological indicator for the mangrove area. The results also revealed that helminth diversity and physiochemical factors significantly differed between the areas studied; therefore, physicochemical factors may play an important role as contributing factors that affect helminth diversity in the Andaman Sea coastal ecosystem.

Introduction

Helminths of marine fish negatively affect food safety and security, and they have been reported to be biological indicators of environmental factors such as food chain structure, heavy metal contamination, environmental pollution, global climate change, and fish stock assessments (Quiazon, 2015). Although many helminths of marine fish have been reported, only a small proportion of parasites in marine ecosystems have been studied; consequently, the number of marine fish parasites is considered to still be underestimated (Poulin, 2014).

Helminths that infect marine fish include nematodes, cestodes, digenean and monogenean trematodes and acanthocephalans (Cortés, 2012). Among known species of helminths in marine fish, some are reported to be human pathogens (Adams et al., 1997), such as anisakid nematodes (*Pseudoterranova decipiens*, *Contracaecum osculatum*, and *Anisakis* spp.), cestodes (*Diphyllobothrium*), and digenean trematodes (*Heterophyes*, *Stellanchamus*, and *Metagonimus*). All of these have been recognized as parasites that may impact food safety and sustainability, particularly *Anisakis simplex* (Adams et al., 1997; Purivirojkul, 2009). Moreover, some helminths have been identified as biological indicators of heavy metal pollution for aquatic resource management (Quiazon, 2015), such as nematodes (*Hysterothylacium*, *Anisakis*, *Anguillicola*, and *Philometra*), acanthocephalans (*Pomphorhynchus* and *Acanthocephalus*), and cestodes (*Bothriocephalus*, *Monoborthrium*, and *Ligula*). Some helminth parasites have also been recognized as biological indicators of anthropogenically induced stresses (Fajer-Ávila et al., 2006; Hechinger et al., 2007; Palm, 2011; El Hafidi et al., 2013), including monogenean trematodes (*Ligophorus* spp. and *Pseudorhabdosynochus*), digenean trematodes (*Didymodiclinus*), nematodes (*Spirophilometra*, *Philometra,* and *Raphidascaris*), and acanthocephalans (*Serrasentis*). Because of the important roles of helminths in marine fish described above, parasite diversity should be estimated.

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In Thailand, information regarding helminth parasites in marine fish is limited; most has been obtained from the Gulf of Thailand marine ecosystem (Upatham et al., 1989; Nootmorn et al., 2002; Nuchjangreed et al., 2006; Bussarawit et al., 2008; Purivirojkul and Areechon, 2008; Purivirojkul, 2009). A few studies have been conducted and reported on some helminths in deep-sea fish, such as yellowfin tuna and deep-sea sharks from the Andaman Sea in Thailand (Purivirojkul and Areechon, 2008; Purivirojkul et al., 2009). However, there is no information regarding helminths from marine fish in the Andaman Sea coastal areas (Bussarawit et al., 2008).

This coastal ecosystem is composed of mangrove, seagrass and coral reef, which have significantly different physicochemical properties (Sridhar et al., 2008). Helminth parasite diversity in this ecosystem may be related to environmental changes (Doney, 2013). Some physicochemical factors may be associated with the parasite diversity and parasite maturity, particularly water temperature, salinity and concentrations of calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions (Ohashi et al., 2007).

The coastal ecosystem near Tarutao Island, Andaman Sea, Satun province, southern Thailand is an area that is affected by environmental problems. Mangrove areas have been destroyed by drainage for agriculture and aquaculture and excavation for fish and shrimp farming (Barbier, 2003). Coral bleaching around the island has also occurred due to water pollution from shrimp farming on nearby land and also from snorkeling and coastal fishery activity (Barbier, 2003; Akase et al., 2014). The elucidation of the helminth diversity of marine fish in the coastal area near Tarutao Island would provide useful preliminary information to evaluate the effect of environmental change. Therefore, this study first estimated the helminth diversity of commercially caught marine fish collected from three different ecological areas (mangrove, seagrass and coral reef) in the coastal ecosystem around Tarutao Island. Commercial marine fish species and physicochemical factors associated with helminth parasite diversity were also analyzed.

Materials and methods

Study areas and fish collection

Dead marine fish were purchased from local fishermen. The fish had been caught from three areas in this coastal ecosystem: 1) the mangrove-intertidal area at 6°67′N and 99°90′E in La-Ngu district, Satun province, southern Thailand; 2) the seagrass area at 6°40′N and 99°60′E; and 3) the coral reef area of Tarutao National Park, in Mueang district, Satun province, southern Thailand at 6°43′N and 99°32′E. Water temperature, depth of water, salinity level and Ca^{2+} and Mg^{2+} concentrations were recorded in each area. Fish were caught eight times between May 2014 and April 2015 by trap and net. The collected samples were kept on ice and transferred after approximately 12 hr to the Department of Helminthology, Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand. There, the fish were identified to the species level and the body length and weight were measured.

Helminth parasite collection

Fish were examined for both ectoparasites and endoparasites. The fish scales, gill, abdominal organs (intestinal cavity, liver, visceral, stomach, gonads), tail, fish muscle, and head of each fish were separated in a Petri dish. The intestinal cavity of each fish was examined by cutting from the oral cavity through the esophagus behind the oral cavity. The gut was pulled out and straightened, then gradually detached with scissors along the whole length up to the anus. Intestinal organs were opened longitudinally with scissors in a Petri dish, and parasites that were visible by the naked eye were removed from the host using fine-point forceps. The minute parasites were separated and removed under a light microscope. All parasites were washed using 0.85% saline solution and kept in 10% formaldehyde. Helminths were stained with Semichon's acetocarmine, mounted in Canada balsam, then morphologically identified using light microscopy according to the method described by Yamaguti (1963), Yamaguti (1971), Kabata (1979) and Moravec (1994). The prevalence and mean intensity of each helminth species were then determined.

Physicochemical factor data

During each sampling time, the physicochemical parameters were recorded. Water levels were determined using a lead line for mangrove and seagrass areas but using a Hawkeye handheld sonar system (H22Px; NorCross; Orlando, FL, USA) for the coral reef area. Water temperatures of mangrove and seagrass areas were measured using a thermistor (109SS-L stainless-steel temperature probe for harsh environments; Campbell Scientific; Logan, UT, USA), whereas coral reef water temperatures were measured while recording the water level with a Hawkeye handheld sonar system (H22Px; NorCross; Orlando, FL, USA). Seawater was collected monthly using a submerged container to note the salinity and Ca^{2+} and Mg^{2+} concentrations. The salinity values of the collected water were recorded using a salinity meter (YK-31SA; Lutron Electronics Co. Inc.; Taipei, Taiwan) and the Ca^{2+} and Mg^{2+} concentrations were measured using a calcium and magnesium test kit for irrigation water (HI 38081; Hanna Instruments; Carrollton, TX, USA).

Statistical analysis

The physicochemical factors that were recorded in the three study areas (water temperature, water depth, salinity level, Ca^{2+} and Mg^{2+} concentrations) were statistically analyzed to determine their impact on helminth parasite diversity. Correlations between these factors and parasite species diversity were determined using Pearson's correlation coefficient (r) from 24 paired data (eight sampling times for each of the three study areas) and the statistical differences of factors between study areas were analyzed using nonparametric Kruskal-Wallis one-way analysis of variance facilitated by the computer program SPSS v.22.0 (Green et al., 1996).

Fish-parasite interactions

The interactions between marine fish and helminth parasites, and the parasite species assemblages within fish populations were evaluated using a bipartite graph in the “bipartite packages” implemented in R freeware v.3.0.3 (Dormann et al., 2009). Host-parasite interaction presence/absence matrices that combined all habitats were visualized using “plotweb” functions.

Ethics statement

This study did not require approval by an ethics committee as all fish in this study were bought as a part of normal commercial catches in the study areas.

Results

Fish species diversity

The commercial marine fish were caught from mangrove, seagrass and coral reef areas in this coastal ecosystem. Only three