THE IMPORTANCE OF HYPERBENTHOS AS FOOD SOURCE FOR *Silago sihama* AND *Toxotes chatareus* IN PALIAN MANGROVE ESTUARY, TRANG PROVINCE, THAILAND

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ABSTRACT

The hyperbenthos was examined as food source for Silago sihama and Toxotes chatareus in Palian mangrove estuary, Trang Province, Thailand. Hyperbenthos and fishes were collected during February 2015 using sledge net and fishes trap, respectively. A total of 19 different in hyperbenthos groups, belonging in seven phyla were found. Cuamcean was the major compartment of hyperbenthos community followed by prawn, mysid shrimps, polychate and crab. Stomach content analysis revealed that both Silago sihama and Toxotes chatareus were carnivorous fed mainly on polychate, prawn, crab and other benthic organisms. It can be concluded that hyperbenthos in Palian mangrove estuary was the importance food source for Silago sihama and Toxotes chatareus.

Keywords: Hyperbenthos, palian estuary, *Silago sihama*, stomach content, *Toxotes chatareus.*

INTRODUCTION

Palian Mangrove Estuary is located in Trang Province, southern of Thailand. This mangrove estuary is an important mangrove ecosystem in Thailand. As we known, mangroves are an important ecosystems found along the coastal tropical and subtropical regions. The mangrove ecosystem supports a diversity of life [1]. This estuary is source of high valued fisheries resources. Mangroves support many aquatic lives by serving as both habitat and food source. From previous studied, [2] reported that zooplanktons, including larva stages for aquatic animals such as fish, crab and prawn, was high diversity and abundance in Palian Estuary. In addition, [3] reported that fishes diversity in Palian Mangrove Estuary was more than 30 species, most of them are commercial fishes. Thus, this mangrove ecosystem is very important as a nursery habitat for young animals.

Hyperbtnthos also called suprabenthic fauna or demersal benthic zooplankton, includes small swimming animals, mainly crustaceans, is the faunal element of the benthic boundary layer, which living in the lowest strata of the water column and dependent on the proximity of the bottom [4]. Hyperbenthos plays an important role in the trophodynamics of coastal environments [5]. They are shaping the benthopelagic community as predator, e.g. feeding on zooplankton [6]. In turn, they sever as prey food for demersal fishes [7] thus providing a trophic link between primary producer and secondary consumers

In spite of their important in the coastal ecosystem, hyperbtnhos are poorly studies. This is because of their small size, non-economic value, and difficult to identification. Published works on hyperbenthos in Thailand are markedly lacking. Reference [8] reported seasonal variations of hyperbenthos in mangrove and sandy beach, Tanyong Po, Satun Province. In addition, [9] reported Diel distribution of the dominant hyperbenthos in Rai Canal, Satun Mangrove Area. There is no study of hyperbenthos in Palian estuary, Trang province. Therefore, the aim of the present study was to evaluate the diversity of hyperbenthos in estuary ecosystem and evaluated their role in this ecosystem as a food source for *Toxotes charareus* and *Silago sihama*.

MATERIAL AND METHODS

Sampling Area

Three sample stations were established from station 1 (S1), located at river mouth, through station 2 at the middle estuary and station 3 (S3) at the upper estuary in the main channel of the Palian River (Figure 1).

Hyperbenthos and fish collections

Hyperbenthos was sampling on February 2016, during low tide using sledge net had a 0.53 x 0.16 m. mouth area and a 2.35 m. long net of 500 micrometer mesh size. It was pulled over the mud bottom by first paying out a fixed 30 m length of a tow line from the moving boat, stopping the boat, and then pulling in the net by hand onto the desk. The collected sample was completely emptied into the pail before large mangroves and debris were removed, and the entire contents were then washed into 1 L sample bottle containing a borax-buffered 4% seawater-formalin solution [10]

Two more replicate samples following the same sampling procedure were also taken. In addition, water quality data such as salinity, pH, and DO (Dissolved Oxygen) were measured just above the mud bottom with muti probe water quality equipment (YSI Company).

Fish samples were collected using fishes trap. This gear is considered the most appropriate for fishes by local fisheries man. Fish trap were sitting during night-time and in the morning, fishes samples were immediately preserved in ice box and transported to the laboratory.

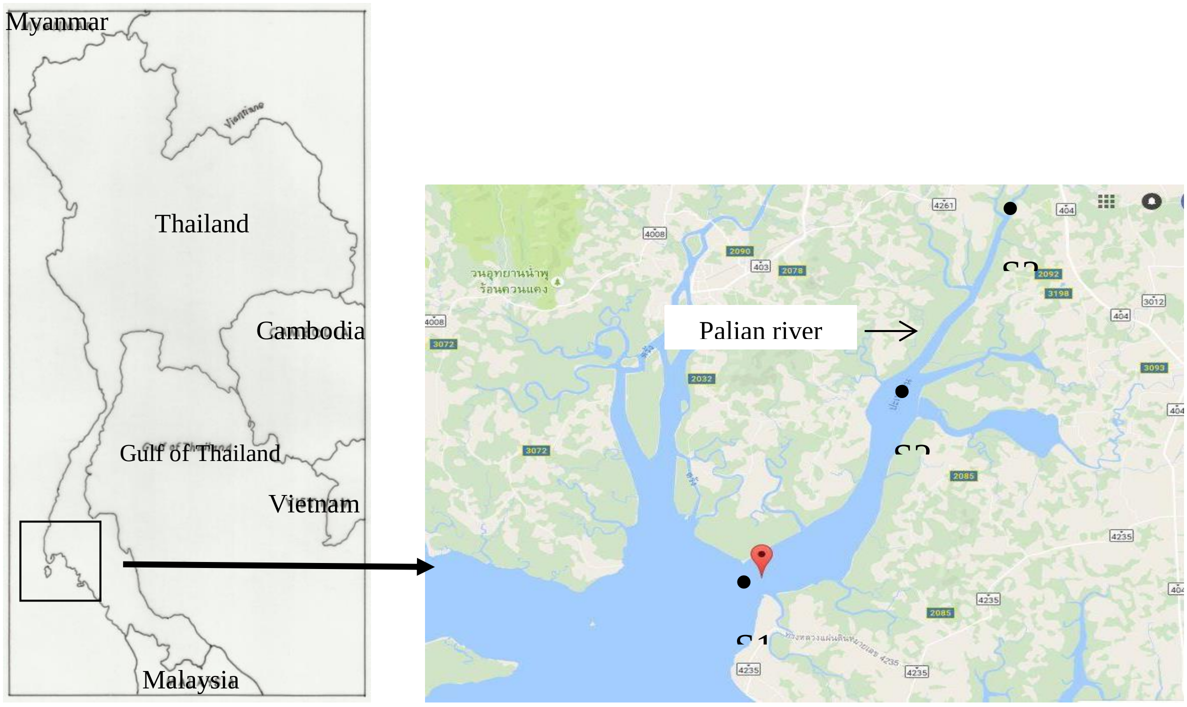

Figure 1. Map showing the sampling area and stations during study period in the Palian Mangrove Estuary, Tang Province, Thailand. S1 = river mouth, S2 middle estuary, and S3 = upper estuary.

Laboratory analysis

In the laboratory, hyperbenthos was sorted out and counted under a stereo and compound microscope. All identification was based on outer morphological characteristics.

For fish samples, fish species were identified. Standard length (SL) of each fish was measured. After that, stomach was removed and preserved in 4% formalin solution. The stomach contents were analyzed under the microscope and quantified according to [11]. Stomach contents were sorted taxonomically and counted using light microscope (400x) after sedimentation on a slide. Two transects (about 100 fields) were examined on a slide. The frequency of occurrence method was employed by recording the number of stomach containing one or more individuals of each food item, and the total was expressed as a percentage of the total number of stomachs examined (%FO) [12]. The weight of a consumed item was then determined by weight using electronic balance.

Data analysis

Hyperbenthos abundance was expressed as number of individuals per m^2 using the following equation:
Abundance = Number of hyperbenthos (individuals) / swept area (m^2)
Where swept area is the sledge net mouth width (0.53 m) x towed distance (30 m) [10].
The weight of a consumed item taken by a fish population was given as a percentage of the total weight of the stomach content (%W). Using both frequency of occurrence and weight percentage for a consumed item can provide an indication of the homogeneity of feeding within a fish population [13]. Empty stomachs of fishes were excluded from analysis. However, percentage empty stomach was calculated using followed equation:
% empty stomach = (empty stomach/No. of stomach) x 100
Analysis of Variance (ANOVA) was conducted to compare difference in water parameters and zooplanktons abundance among sampling stations. All data set were first tested for normality and homogeneity as a required for parametric analysis [14].

Results

Water quality

Recorded of water parameters were presented in Table 1. Water temperatures were rather stable for all sampling station. While salinity showed clear horizontal gradient along sampling station, with the highest mean salinity at the river mouth (25.45±0.10 ppt) and the lowest mean salinity at the upper estuary (15.17±0.90 ppt). DO values recorded at S1 and S2 were not significance different ($p>0.05$), while DO values was lowest at the upper estuary with mean 3.55±0.85 mg/L.

Table 1. Water parameters during February 2015 at Palian Estuary, Trang Province, Thailand. S1= river mouth, S2= middle estuary, S3= upper estuary. Homogenous groups indicated by superscript a,b, c and d.

Water quality	S1	S2	S3
Temperature (°C)	29.50±0.09[a]	29.78±0.04[b]	29.03±0.06[b]
pH	7.54±0.02[a]	7.24±0.02[a]	6.89±0.02[b]
Salinity (ppt)	25.45±0.10[a]	23.59±0.08[b]	15.17±0.90[c]
DO (mg/L)	8.90±0.28[a]	7.80±0.30[a]	3.55±0.85[b]

Hyperbenthos abundance and distribution

A total of 19 hyperbenthos taxa belonging to seven phyla were found. There are Phylun Nematoda, Phylum Annelida (polychate), Phylum Mollusca (gastropod larva and bivalve larva), Phylum Arthropoda (ostracods, cumaceans, isopod, amphipod, Lucifer, mysids shrimps (*Notacanthomysis hodgarti*), prawn (*Palemonetes* sp.), branchyuran (zoea and megalopa stage), Phylum Chaetognatha (*Sagitta* sp.), Phylum Echinodermata (bristle star larva), and Phylum Chordata (fish larva).

Percentage composition of the hyperbenthos is presented in Figure 2. Phylum Arthropoda was numerically dominant (76% of hyperbenthos community) followed by Phylum Annelida (7%), Nematoda (6%), and Chaetognatha (5%). Phylum Mollusca, Echinodermata and Chrodata altogether represented <6% of the overall hyperbenthos composition.

The composition of hyperbenthos varied at stations (Figure 3). However, cumacean was the dominant taxa at all sampling station (20-31% of heperbenthos community), followed by prawn (18-23%), and mysid shrimps (8-21%).

In term of abundance, results from ANOVA showed that there was no significant difference (p>0.05) in the abundance of hyperbenthos among stations. Mean density of hyperbenthos were 13.10±5.42, 11.51±4.69 and 12.44±4.85 individuals/m^2 at the river mouth, middle and upper estuary, respectively. However, hyperbenthos distribution showed great spatial variations in Palian Estuary during sampling period (Figure 4). Nematode, Branchyurans (zoea stage) and Chaetognathans were prefer more saline water, usually presented a high density at the river mouth (S1). Mollusca and cumaceans were found at the middle estuary. On the other hand, Lucifer, prawn and mysid shrimps preferred less saline water, presented in high density at the upper estuary.

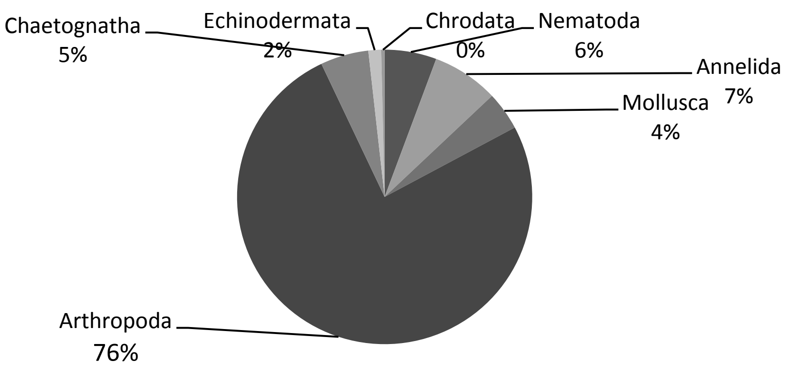

Figure 2. Overall percentage composition of hyperbenthos in Palean Estuary, Trang Province, during study period.

Fish samples

75 of *Silago sihama* were examined with mean standard length was 12.77±0.17 cm and mean weight was 27.00±0.96 g. 54 samples of *Toxotes chatareus* were investigate. Mean standard length was 12.84±143 cm and mean weight was 83.12±20. 50 g.

Diet composition of *Silago sihama* and *Toxotes chatareus*

Of all fish stomachs examined, *Silago sihama* and *Toxotes chatareus*, 30.67% and 28% of stomachs were empty, respectively. These empty stomachs were excluded from stomach content analysis in present study.

A diversity of food items were found in fish stomachs. There were three broad categories of food items found in the fishes stomachs examined, namely, diatoms, animal prey (Nematodes/flukes, Annelids, Prawn, insects, amphipods and crabs) and digested food items (included detritus and digested food items). In addition, small gravity and garbage were also found in fish stomach; however, both of them are not food items (Table 2).

In general, both fishes were carnivore, feeding mainly on animal preys, but consumption of these food items differed between fish species. Preferred food items for *Silago sihama* was annelids (25.7%W) and prawn (29.73%W). On the other hand, *Toxotes chatareus* consuming a high weight of crab, up to 81.74%W and insects ranked a second as consumed item in this fish species (1.57%W).

Figure 5 showed diet composition (by weigh) in both fish species. Prawn and Annelids showed similar %FO (40.38 and 51.92%FO) in *Silago sihama*, while crab was the most frequently consumed food items (71.71%FO) in *T. chatareus*.

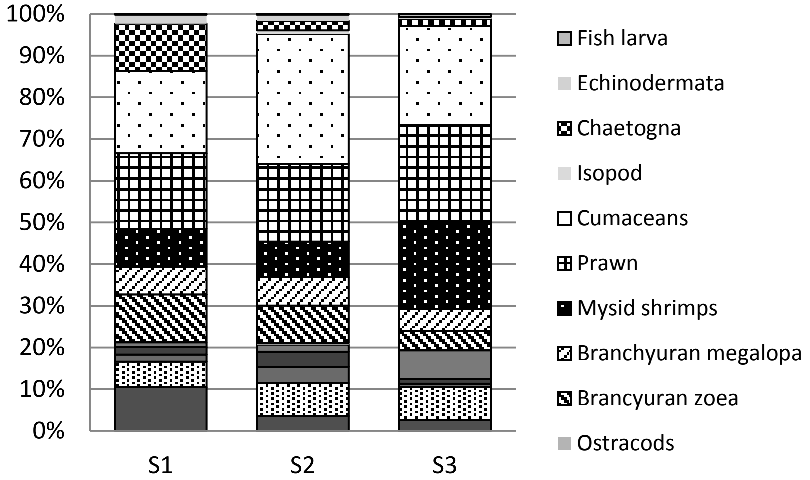

Figure **3.** Hyperbenthos composition based on sampling stations at Palian Estuary, Trang Province, during February 2015. Station S1= river mouth, station S2 = middle estuary and station S3 = upper estuary.

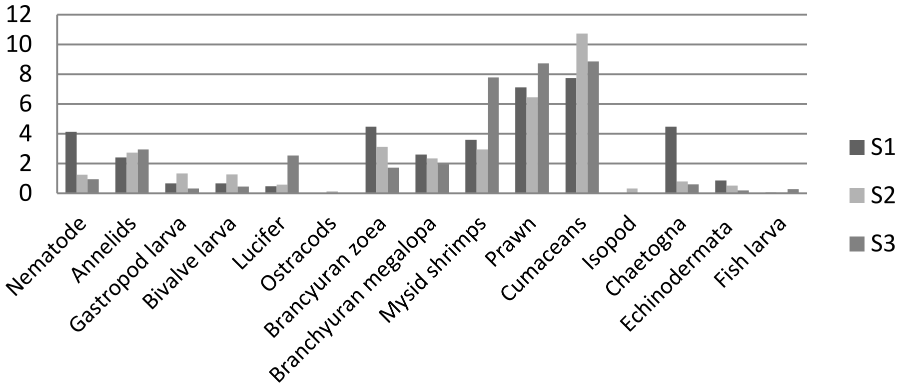

Figure **4.** Spatial variations in hyperbenthos density at different sampling stations in Palian Estuary, Trang Province, during February 2015. S1= river mouth, S2 = middle estuary, S 3= upper estuary

Table 2. Food items in fish stomach, frequency of occurrence (%FO) and weight composition (%W) of food items in stomach of *Silago sihama* and *Toxotes chatareus*.

Food items	*Silago sihama*		*Toxotes chatareus*	
	%FO	%W	%FO	%W
Diatoms	7.69	<0.01	3.77	<0.01
Nematode	5.77	<0.01	5.66	<0.01
Annelids	51.92	25.70	-	-
Insect	-	-	54.71	1.57
Spider	-	-	1.88	0.32
Amphipods	-	-	1.88	0.04
Prawn	40.38	29.73	1.88	0.01
Crab	9.62	4.14	71.70	81.74
Digested items	100	39.36	71.70	16.04
Small gravity	3.85	1.07	-	-
garbage	-	-	1.88	0.22

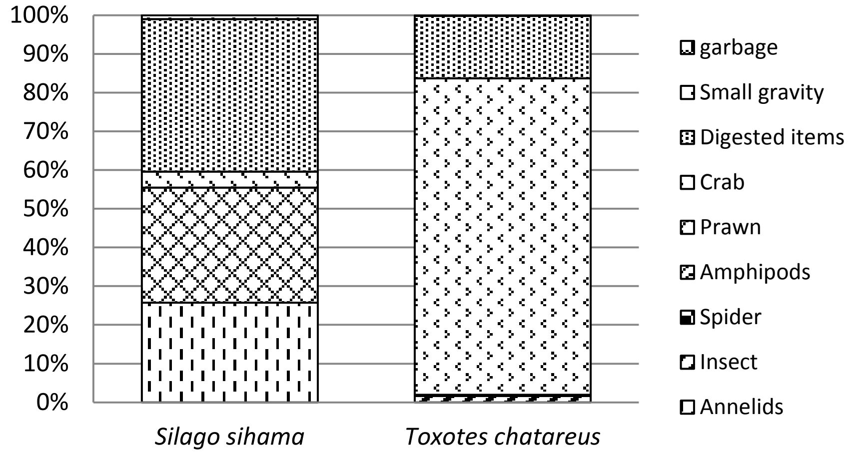

Figure 5. Percentage of weight (%W) composition of food items for *Silago sihama* and *Toxotes chatareus* in the Palian Estuary, Trang Province, during February 2015.

DISCUSSION

The hyperbenthos in the Palian mangrove estuary show distinctive spatial distribution pattern, with specie clearly separated by specific habitats in the mangrove. This kind of distribution pattern has previously been reported in other estuaries [15, 16]. The spatial of the hyperbenthos in the Palian mangrove estuary has been related to a number of factors, but results from the correlation analysis (data not showed) showed that among the physical parameters, only salinity had a significant effect on the spatial distribution of the hyperbenthos in the Palian mangrove estuary. Salinity controlling hyperbenthos spatial distribution has been reported from Matang mangrove, Malaysia [17].

The results from present study indicated that *Silago sihama* in Palian mangrove estuary is carnivorous fed mainly on polychate, prawn and other benthic organisms. Most food items reported for *S. sihama* from Kwazulu-Natal, South Africa [18], from Karachi, India [19], from Persian Gulf [20] and from Sikao Bay, Trang Province, Thailand [21] were also reported as carnivorous. However, diet composition for *S. sihama* showed variation among regions. [20], [21] an [22] founded high number of diatoms and copepods in the stomach of *S. sihama*, however, these food items were not found from present study. Our result showed that annelids, especially polychate, and prawn forms comprised the major part of *S. sihama* stomach, it was concluded that *S. sihama* in the Palian estuary is carnivorous and feeding on a wide range of food of benthic organisms.

From present study, *Toxotes chatareus* fed verities of food, including benthic organism (crab and prawn) and terrestrial animal (insect and spider). However, it feed heavily on crab (81.74%W). Our results agree well with [23] which studied trophic position of two archer fishes from Malaysian estuarine. Except many organism were observed in *T. chatareus*, garbage, small piece of foam, was observed in *T. chatareus* stomach as well. This garbage may be taken by fish during feeding on other organism. In last recent year, increasing of plastic pieces is found from several fish e.g. *Xiphias gladius*, *Thynnus thunnus* and *T. alalunga* [24].

Analysis of stomach contents of *Silago sihama* and *Toxotes chatareus* in this study showed that both fish species preferred animal preys which not abundance in environment where cumacean is the most abundance in this area. In addition, [2, 3] studied diversity and abundance of zooplankton from Palian estuary during 20014-2015 and their results have shown that copepod is occurred in high numbers. The stomach content analysis from present study suggested that *S. sihama* and *T. chatareus* are selected feeder not opportunistic feeder.

CONCLUSIONS

Our study showed that Silago sihama and Toxotes chatareus living in the mangrove estuary are carnivorous fishes and fed mainly on benthic organism, especially hyperbenthos were collected from present study as well. These results confirmed the importance of hyperbenthos as food source for fish in Palian mangrove estuary. However, as we known, feeding habits of fish are varied in term of season and life stage so further work will be working on seasonal variation in diet composition and ontogenic changes in feeding of these fish species, would provide better understanding of their role in ecosystem.

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