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Status of Planktonic Copepod Diversity in the Merambong Seagrass Meadow, Johor, Peninsular Malaysia

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Abstract The diversity and abundance of planktonic copepods were analysed from zooplankton samples collected within six times throughout the year in the Merambong seagrass area. A total of 48 species from 20 genera and 15 families comprising an average of 78.8%, of the total zooplankton populations were recorded throughout the sampling period. Among the copepod groups, calanoids were the most abundant inhabiting all the stations, taking an average of 51.2% of the total copepod populations. The most common species observed in the area were *Paracalanus parvus*, *Paracalanus elegans*, *Oithona rigida*, and *Euterpina acutifrons*. The highest copepod density was recorded at $17.0 \pm 2.8 \times 10^4$ individuals/m^3. Copepod species diversity (H') and species richness (d) were highest at H' = 3.58 and d=7.08, respectively. Species evenness (J) was, however, relatively constant (0.9) during the entire sampling period. The findings from this study provide important baseline information for future research and monitoring programs.

Keywords Copepod, Seagrass area, Diversity, Abundance

1. Introduction

Copepods are one of the most important components of the zooplankton in marine ecosystems. Particularly, the planktonic marine copepods with size less than 1 mm in length are considered the most abundant metazoans on Earth [1]. Ubiquitous throughout the world's ocean systems, they form an integral link in marine food webs by bridging the production of the phytoplankton with the meso- and macroplankton [2]. In addition they are the principal conduit for the flow of energy between primary producers and the higher trophic levels. Studies of zooplankton in coastal and even oceanic waters of the world have shown that copepods constitute the most important group in marine zooplankton communities [2]. Copepods dominate the zooplankton of most tropical waters including Malaysia. In fact, studies in the coastal and neritic waters along the Straits of Malacca of the Malaysian Peninsula show that planktonic copepods accounted for more than 60% of the zooplankton collected [3]. The studies also showed that abundance of copepods and meroplanktonic forms in the inshore waters are higher compared with offshore waters [3].

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Seagrass beds are a major feature of shallow marine and estuarine areas throughout the world, which support and provides nursery and feeding areas for many species of fish assemblages particularly of those with high commercial values [4-6]. Moreover, the seagrass ecosystems are of great importance to many of the world's coastal areas because of their important role in enhancing biodiversity through seagrass associated organisms [7], [8]. In Malaysia, the Merambong seagrass meadow which is considered the largest contiguous seagrass meadow and the only one remaining in all of Peninsula is home to many important commercial fish species and crustaceans. In addition, a myriad of microinvertebrates such as zooplankton, particularly planktonic copepods inhabits this ecosystem. Many studies [9-11], have shown the importance of planktonic copepod as food for many species of fish inhabiting the seagrass areas. However, despite their apparent importance in this ecosystem, planktonic copepods have rarely been assessed. Therefore, the objective of this study is to provide the status of planktonic copepod diversity in the seagrass ecosystem in the Merambong shoal, Johor of the Peninsular Malaysia.

2. Materials and Method

2.1. Sampling Location

The seagrass meadow popularly known as Merambong shoal is approximately 40-ha oval shaped meadow which stretches almost 2 km long at the largest patch located between the Causeway second link and the Pulau Merambong, Southwest of Johor in Peninsular Malaysia [12]. It is the most extensive seagrass covered subtidal shoal in Malaysian waters. The seagrass bed occurs on sandy, muddy banks of Sungai Pulai mangrove estuary on shallow water with an average depth of 2-3 m and a maximum depth of 5 m. The seagrass bed is vegetated by seagrass species which were mainly *Enahulus acroides*, *Halopila* spp. and *Syringodium* spp. among others (Figure 1). Around the area nearby the seagrass meadow is slated for heavy industry – a large port, chemical processing plants, oil and gas refineries and storage and a power plant.

2.2. Sample Collection and Processing

Samples collection was undertaken for a period of one year on a bi-monthly basis (from September 2005 – July 2006). Copepod samples were collected using conical shaped (with mouth opening size of 45.0 cm and 1.0 m length) plankton net with 100 µ mesh with acrylic plastic cod end. Samples were collected by vertical tows from the deepest depth (≈ 4.0 m during the highest high tides when water can go up 4.5m in depth) to the surface at every station. Samples were collected from four randomly selected stations (between 1°20'13.20"N 103°36'6.24"E and 1°19'0.51"N 103°35'5.36"E) in the seagrass ecosystem. The samples were then transferred in labelled bottles and preserved with 10% buffered (pH 8.0-8.2) formalin.

Samples were filtered in a 350 µm mesh size net filter to separate the bigger organisms (in this case the entire copepod portion passed through the net due to their smaller size). After which the remaining portion were sorted out under dissecting microscope (Nikon model SMZ645) to separate the copepod from non-copepod portions.

2.3. Analyses

Copepod species were identified and counted in a Bogorov counting chamber under dissecting microscope (up at least 500 x magnifications). The copepod density was calculated using standard formula [6]. Three biodiversity indices were calculated for each sample: number of species, the Shannon-Weaver Diversity Index, Margalef's species richness [(d = (S-1)/log(N)] and Pielou's evenness [(J=H'/loge(S)].

3. Result

In this study, copepods comprised an average of 78.8% (ranging from 77.7% to 81.9%) of the total zooplankton populations throughout the study period (Figure 2). From the copepod samples, a total of 48 species from 20 genera and 15 families were identified (Table 1). Among the copepod groups, calanoids were the most abundant inhabiting all the stations, contributing 51.2% of the total copepod populations. Although, the percentage of calanoids varied from highest 61% to the lowest 28%, throughout the sampling period, they still contribute the highest total average among the other groups. Likewise, calanoid copepods were the most diverse group represented by 33 species (Table 1).

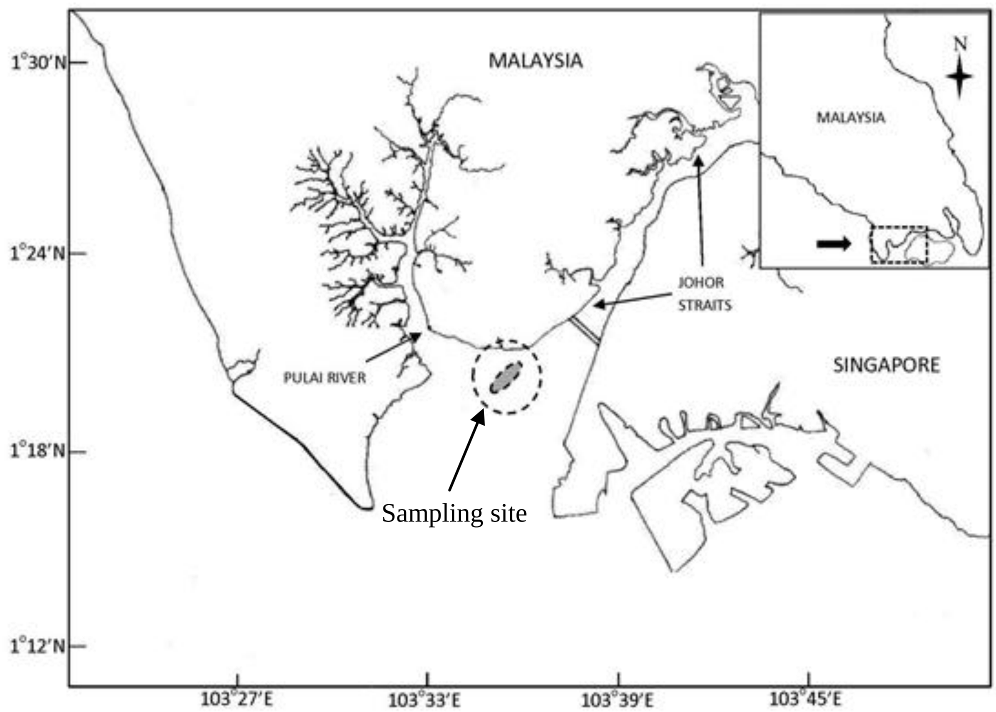

Figure 1. Map showing the location of the sampling site

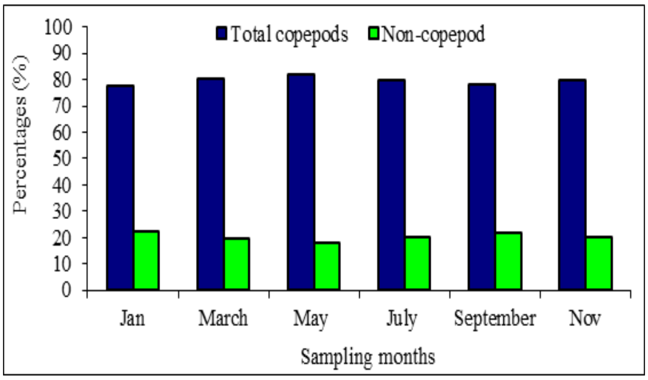

Figure 2. Percentages of copepods and non-copepod portion of the total zooplankton collected throughout the sampling period in the seagrass area

Table 1. List of copepod species found in the seagrass meadows

CALANOIDA		
i.	Acartiidae	
	1	*Acartia bispinosa* Giesbrecht, 1889
	2	*Acartia erythraea* Carl, 1907
	3	*Acartia pacifica* Steuer, 1915
ii.	Calanidae	
	4	*Canthocalanus pauper* (Giesbrecht, 1888)
	5	*Nannocalanus min*or (Claus, 1863)
	6	*Undinula vulgaris* (Dana, 1849)
iii.	Centropagidae	
	7	*Centropages furcatus* (Dana, 1849)
	8	*Centropages orsinii* Giesbrecht, 1889
	9	*Centropages sinensis* Chen & Zhang, 1965
	10	*Centropages tenuiremis* Thompson & Scott, 1903
iv.	Clausocalanidae	
	11	*Clausocalanus farrani* Sewell, 1929
	12	*Clausocalanus furcatus* (Brady, 1883)
	13	*Clausocalanus minor* Sewell, 1929
v.	Paracalanidae	
	14	*Acrocalanus gibber* Giesbrecht, 1888
	15	*Acrocalanus gracilis* Giesbrecht, 1888
	16	*Acrocalanus longicornis* Giesbrecht, 1888
	17	*Paracalanus aculateus* Giesbrecht, 1888
	18	*Paracalanus crasirostris* (F. Dahl, 1894)
	19	*Paracalanus elegans* Andronov, 1972
	20	*Paracalanus parvus* (Claus, 1863)
vi	Pontellidae	
	21	*Labidocera acuta* (Dana, 1849)
	22	*Labidocera euchaeta* Giesbrecht, 1889
	23	*Labidocera jaafari* Othman, 1986
	24	*Labidocera javaensis* Mulyadi, 1997
	25	*Labidocera krǒyeri* (Brady, 1883)
	26	*Labidocera minuta* Giesbrecht, 1889
	27	*Pontellopsis regalis* (Dana, 1849)
vii	Temoridae	
	28	*Temora discaudata* Giesbrecht, 1889
	29	*Temora stylifera* Dana, 1849
	30	*Temora turbinate* (Dana, 1849)
viii	Tortanidae	
	31	*Tortanus barbatus* (Brady, 1883)
	32	*Tortanus forcipatus* Giesbrecht, 1889
	33	*Tortanus gracilis* (Brady, 1883)
CYCLOPOIDA		
ix.	Oithonidae	
	34	*Oithona aruensis* Nishida & Ferrari, 1983
	35	*Oithona brevicornis* Nishida, 1985b
	36	*Oithona rigida* (Giesbrecht, 1896)
	37	*Oithona simplex* Farran, 1913
HARPACTICOIDA		
x.	Clytemnestridae	
	38	*Clytemmnestra scutellata* Dana, 1848
xi.	Euterpinidae	
	39	*Euterpina acutifrons* (Dana, 1848)
xii.	Miraciidae	
	40	*Macrosetella gracilis* (Dana, 1848)
	41	*Miracia efferata* (Dana, 1848)
POECILOSTOMATOIDA		
xiii.	Sapphirinidae	
	42	*Copilia lata* Dana, 1849
	43	*Copilia mirabilis* Dana, 1849
xiv.	Corycaeidae	
	44	*Corycaeus crassiusculus* Dana, 1849
	45	*Corycaeus longistylis* Dana, 1849
	46	*Corycaeus pacificus* F. Dahl, 1894
	47	*Corycaeus speciosus* Dana, 1849
xv.	Oncaeidae	
	48	*Oncaea media* Giesbrecht, 1891

The copepod community in the seagrass area was characterized by the dominance and abundance of *Paracalanus parvus, Paracalanus elegans, Oithona rigida* and *Euterpina acutifrons* (Fig. 4). Both *P. parvus* and *P. elegans* contributed more than 11% of the total copepod abundance, while, *O. rigida* and *E. acutifrons* contributed 9% and 8%, respectively to the total copepod abundance (Fig. 4). On the other hand, copepod diversity (Shannon Weiner index (*H'*) ranged from H' = 3.41 to H' = 3.62, being highest during the month of January (Fig. 5). Similarly, the species richness was highest at d = 7.34 during the month of January. Species richness varied from d=5.95 to d=7.34. However, species evenness was found relatively constant at J'=0.97-J=0.99.

4. Discussion

In accordance with other studies [13-16, 3] in the Malaysian coastal waters, copepods were found to dominate the zooplankton population in the seagrass area. The planktonic copepods in the seagrass bed contributed more than 75% of the total zooplankton populations throughout the year. According to [16] planktonic copepods are considered to play a key role in the transfer of energy between primary producers and higher trophic levels in coastal, shelf, and oceanic waters. Calanoid species are the most abundant and widely distributed vertically. They are probably the most ecologically significant animals at the first consumer level of the marine plankton and are also the most prominent among the primary carnivores. Studies have suggested that successful growth and reproduction of these planktonic organisms can occur throughout the year both during the wet and dry seasons.

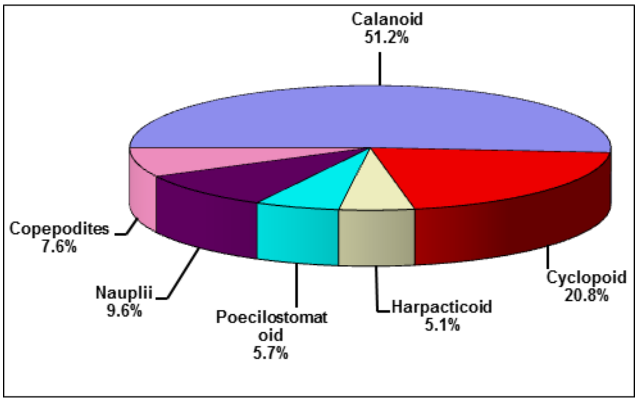

Figure 3. Overall percentage abundance of different copepod groups in the seagrass area

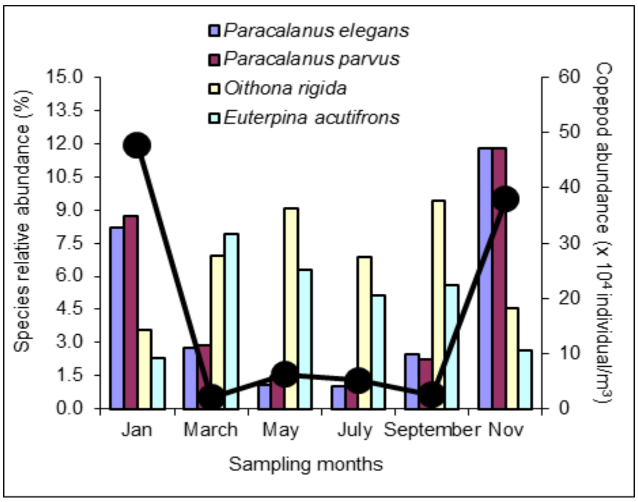

Figure 4. Monthly variations in species relative abundance (%) of the four most dominant species in the seagrass meadows and the monthly variations in mean total copepod density (individuals/m^3)

In the present study, the smaller copepods such as *Oithona* spp and *Paracalanus* spp were very common in the seagrass area, which conforms to those of [17-19] who reported significant contribution of smaller copepods not only in terms of dominance and abundance but also sometimes in terms of biomass and grazing pressure on the phytoplankton. These copepods are common in the coastal and estuarine waters [17-19], indicating nearness and linkage to the mangrove environments [20]. Together with *Euterpina acutifrons*, *Paracalanus parvus*, *Paracalanus elegans* and *Oithona rigida* were responsible for the variation in the total number of the copepod community in the study area.

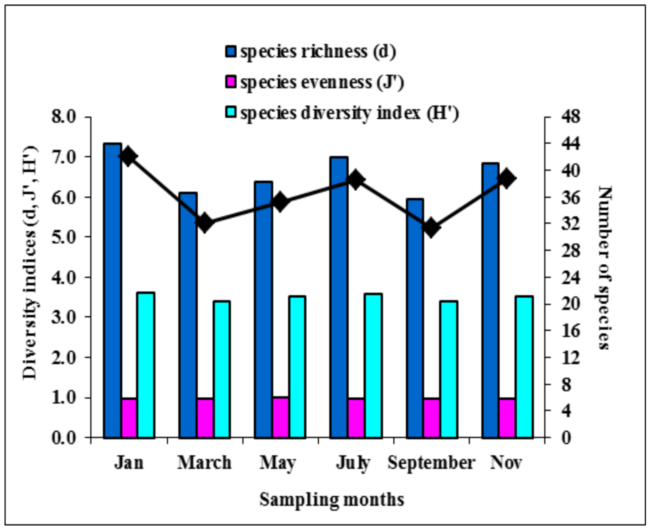

Figure 5. Monthly variations of different species diversity indices (species richness, evenness, and Shannon-Weaver diversity index) and variations in the total number of species present in the seagrass meadows

Copepods have been regarded as being good indicator of climatic trends and anomalies although they are generally considered as part of zooplankton community [21]. According to [22], copepods are excellent candidate for the study of ecosystem response to climate variability because their life cycle is short. This characteristic makes copepod populations potentially capable to respond to environmental changes and reflect event-scale changes in environmental conditions, hence provide early indications of biological response to climate variability [23]. Moreover, many copepod species are known to be indicator species, whose presence or absence may represent the relative influence of different water types on ecosystem structures [24].

5. Conclusions

Due to the great importance of copepods in the coastal ecosystems and for the reasons that diversity of planktonic copepods is rarely assessed in the seagrass area, investigation on their status is essential. The result of this study will provide important baseline information for future scientific research and monitoring programs particularly in the productive seagrass ecosystems

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