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Preliminary Studies on the fluctuation of the biomass of size-fractionated zooplankton in sea grass bed of Pulau Tinggi, Malaysia

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Abstract

Zooplanktons biomass was extensively studied in the sea grass bed of Pulau Tinggi, Malaysia for six months. In 2015, sampling months were April, June, October, whereas in 2016, April, June, August were the sampling months. A cone shaped plankton net was used with 0.30 m mouth, 1.00 m length and 100 µm mesh size. The fractionation of zooplankton size was carried out in to >2000 µm (large), 501-2000 µm (medium) and <500 µm (small). Zooplankton was classified as copepods, larvaceans, chaetognaths, cnidarians, ctenophores, decapods and polychaetes. Copepods were categorized as Calanoida, Poecilostomatoida, Cyclopoida and Harpacticoida but identified as a total of 54 species, 26 genera and 19 families. We conclude that among the biomass of 3 size fractions; medium (36%) was dominant followed by large and small (32% each) throughout the study period.

Keywords: Size-fractionated, sea grass bed, zooplankton, copepods.

1. Introduction

Zooplankton have key position in the aquatic environment, as they trophically link phytoplankton and higher order consumers. Zooplankton are consumers lying at the second trophic level (Manjare, 2015). Zooplankton play an important role in aquatic food chains and respond to a wide variety of disturbances, including nutrient loading (Dodson, 1992; Hossain *et al*., 2006; Begum *et al*., 2007; Paulose and Maheshwari, 2008). Zooplankton serve as food for benthic invertebrates and many other important, commercial fishes in their larval, juveniles and adult stages (Hossain *et al.,* 2007; Duarte *et al.*, 2014). Many fish species use zooplankton as food during their larval stages, and some of them depend on zooplankton prey throughout their lives (Bates, 2007).

Menon and Pillai (2001) discussed the role of zooplankton as food for both juvenile and adult fishes. Zooplankton play a pivotal nutritional role both in captive fisheries and aquaculture (Imaobong, 2013). Rajagopal *et al.* (2010) suggested that zooplankton serve as a (a) bio-indicator and (b) tool for understanding the status of water pollution. Similarly, Ahangar *et al.* (2012) reported that zooplankton react strongly to environmental changes and can be used as an indicator of water health. According to Bhavimani. (2016), the zooplanktons are microscopic in size, ranging from micrometers to millimeters (Figure 1).

Sea grass habitats are essential in maintaining environmental and economic functions. Here, habitat is defined as a major ecological area occupied by the sea grass community (Ooi *et al*., 2011). Sea grasses trap sediment due to terrestrial runoff. It is considered as a nursery for many invertebrates and fishes. Sea grass beds are important ecosystems in tropical coastal waters for biological production and diversity. This complex ecosystem shows highest biodiversity for zooplankton (Metillo *et al*., 2018).

Metillo *et al.* (2018) studied the relationship of zooplankton community structure to environmental conditions in Pulau Tinggi, Malaysia. As there is paucity of information regarding biomass in size fractionated zooplankton there, therefore our research was carried out there to determine the zooplankton biomass in various size fractions.

Figure 1. Image of a zooplankton taken in the UTHM Laboratory with the help of a compound microscope (Olympus model SZX16)

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2. Materials and Methods

Sampling site

Johor is the southernmost state of Peninsular Malaysia and on the East coast as surrounded by the South China Sea (Mohamed *et al.*, 2015). The coastline of Johor is ~436 km. The state government has identified ~72 islands in Johor state, 13 of them declared as Marine Parks, collectively known as the Sultan Iskandar Marine Park (SIMP).

Pulau Tinggi is included in one of the six main Marine Park Islands in Johor. Sampling for the zooplankton was done there at ten sea grass stations (Figure 2). The sampling site is a protected area; unapproved collection of living animals is restricted.

Figure 2. Map showing the station locations in Pulau Tinggi, Johor, Malaysia

Collection of Water Samples

Zooplankton sampling was conducted in the morning on each trip. Sampling was performed by using a plankton net with a mouth of 0.35 m, 1.00 m net length and 100µm mesh size. The plankton net was lowered to possible depth (9.4 m) for a while, then pulled to the surface where the filtered water was put in to a 250 ml bottle. Three aliquots of each water sample were collected from each station. Water samples were immediately preserved in 10% buffered formalin with a pH of 8.0-8.2.A total of 6 water samples were collected; April, June and October of 2015 and April, June and August of 2016 from the sea grass bed of Pulau Tinggi. Sampling was not carried out during rough weather, as caused by heavy rainfall and high tides. Physico-chemical parameters were measured *in situ*; dissolved oxygen (DO), temperature, pH, salinity, turbidity and conductivity with the help of a multiparameter meter (Hanna model HI 9829).

Water samples processing in the laboratory

The collected zooplankton samples were taken to the laboratory of University of Tun Hussein Onn Malaysia (UTHM) and further analyzed for density and biomass of 3 size fractions. In the laboratory, the water in each bottle was divided into two equal parts with a Folsom plankton splitter (Nakajima *et al.*, 2008), as shown in Figure 3. One part was used for identification and enumeration and the second part was used for biomass determination. The samples were examined with the help of a dissecting microscope. One sample was divided into three aliquots and zooplanktons were size fractionated into three fractions; > 2000 µm (large), 501-2000 µm (medium) and < 500 µm (small). The pH of the samples were checked for three consecutive days and maintained in the range of 8-8.2 in the laboratory. The pH of the preservative must be in this range to assure that the water samples are in good condition (Turner, 1976).

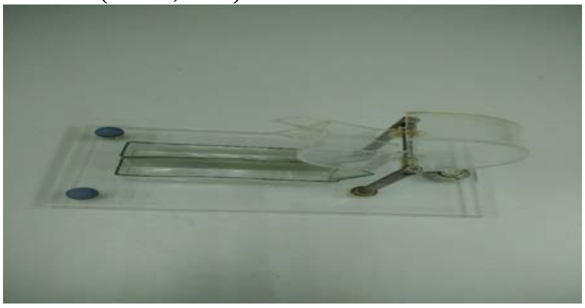

Figure 3. The Folsom plankton splitter used to divide the sample into two halve

Biomass determination

Biomass determination of zooplankton involved the ash-free dry mass method of Harris *et al*. (2000). For this purpose, ~100 ml distilled water was passed through a glass fiber filter (GFC) with the help of low pressure vacuum pump. Then each filter paper weight was noted and the filter papers were dried for two hours in an oven at 60 ºC. Then a desiccator was used to cool the filter papers before reweighing. The filtrates were transferred to a porcelain evaporating dish and combusted for two hours at 500°C inside the muffle furnace. The resultant ash was allowed to cool, then weighed with an electronic balance (Harris *et al*., 2000). The biomass of zooplankton was calculated using the following formula:

Ash-free dry mass (mg/ m^3) = A-B/V

A = Dried sample with filter in porcelain evaporating dish (mg)

B = Ash on filter in porcelain evaporating dish (mg)

V = Amount of filtered water (m^3)

Identification

Zooplankton were identified into seven taxonomic groups. Copepods were further identified up to species level following Conway *et al*. (2003), Boxshall and Halsey (2004) and Razouls *et al.* (2005, 2020). The identification of copepods was performed by examining the body shape, antenna segments and caudal rami structure (Maqbool *et al.*, 2015).

3. Results

The monthly zooplankton biomass ranged from 2.11± 0.45 to 7.47± 2.38 mg/m^3 during the present study. The physico-chemical parameters study showed that high temperature was recorded in April 2015, April 2016 and June 2016. The average water temperature for the sampling area ranged from 28.87 ± 0.99 to 31.50 ± 0.99 ˚C (Figure 4). Salinity ranged from 30.94 ±1.55 to 34.79±1.55 ppt in our study. The highest salinity value was observed in June 2016. Two salinity peaks, 33.00 ±1.55 and 34.79 ±1.55 ppt were recorded in June 2015 and June 2016 respectively. In other months the salinity was comparatively lower. Dissolved oxygen was in the range of 6.0 ± 0.30 to 6.9 ± 0.30 mg/L during the sampling months. The highest oxygen concentration was observed in June 2016 (Figure 4). The highest biomass was recorded in June 2016, a month in which the highest temperature, salinity and dissolved oxygen were recorded from the study site (Figure 4). Meanwhile, the lowest biomass was observed in August 2016, a month in which the lowest temperature and oxygen was recorded at the study site. Based on total biomass, the medium size fractioned zooplankton was somewhat dominant over the large and small fractioned zooplankton (Figure 5). The medium sized fractioned was represented by 35.54%, of the total fractioned biomass followed by the large sized fraction (32.42%) and small sized fraction (32.03%) as shown in Table 1. In the year 2015, the samples of April and June 2015 showed the dominance of the small sized fraction followed by large and medium size fractions. In the samples of October 2015, the large sized fraction was highest in abundance followed by the medium and small sized fractions. In the year 2016, all the three samples obtained in April, June and August yielded consistent results, as the medium sized fraction dominated in the biomass (Figure 6).

Zooplankton were identified as copepods, larvaceans, chaetognaths, cnidarians, ctenophores, decapods and polychaetes. Copepods were further classified as Calanoida, Poecilostomatoida, Cyclopoida and Harpacticoida. A total of 26 genera and 19 families of copepods were found in the samples of zooplankton collected from the sea grass bed of Pulau Tinggi.

Table 1. Average biomass and percentage of zooplankton size fractions during our study at the Pulau Tinggi sea grass bed. (N) number of fraction repetition, (SE) standard error

Fraction (μm)	Biomass ± SE	Percentage	N
<500	1.46 ± 0.77	32.03 %	6
501-2000	1.62 ± 1.05	35.54 %	6
>2000	1.47 ± 0.76	32.43 %	6
Total	4.55	100 %	18

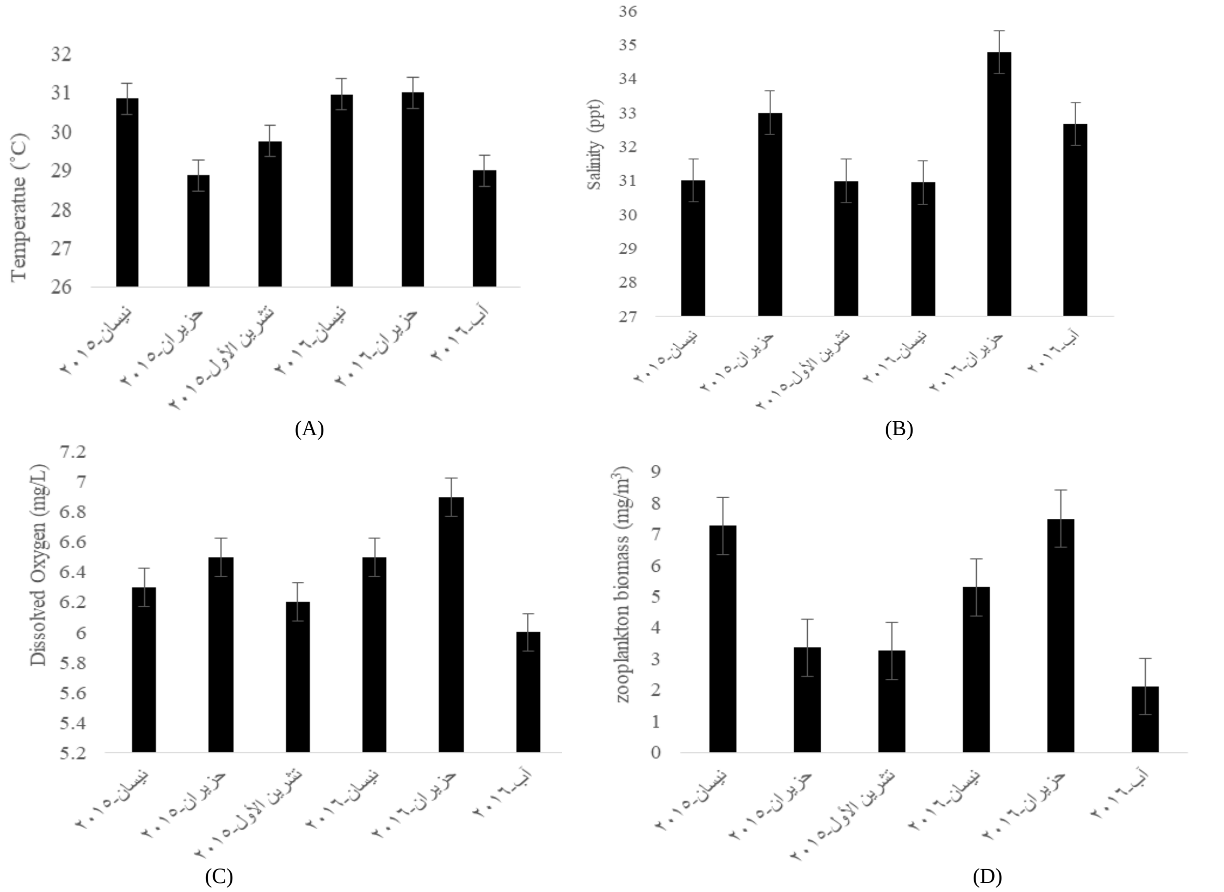

Figure 4. Fluctuations of physico-chemical parameters and zooplankton biomass (A= temperature; B= salinity; C= dissolved oxygen; D= zooplankton biomass)

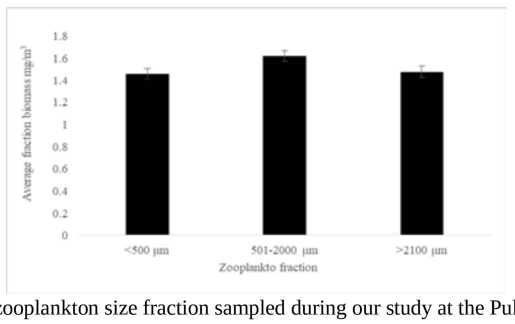

Figure 5. Average biomass (mg/m^3) of zooplankton size fraction sampled during our study at the Pulau Tinggi sea grass bed

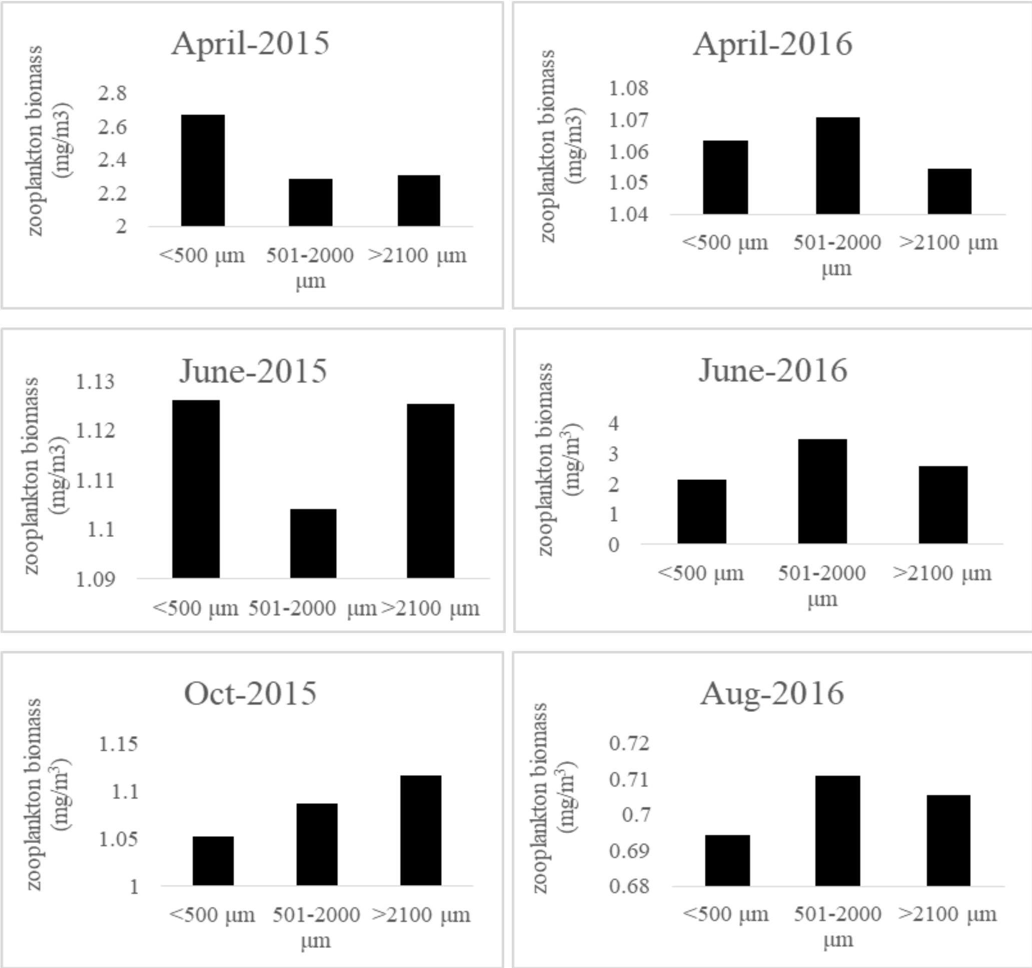

Figure 6. Fluctuation of the average biomass (mg/m^3) in zooplankton size fractions sampled at the Pulau Tinggi sea grass bed

4. Discussion

In the present study, higher biomass was observed in those months when the temperature, salinity, and DO were higher in the study area. This may be related to the fact as reported earlier that the zooplankton biomass is regulated by physico-chemical parameters and tide in the estuary (Fatema *et al*., 2016). Similarly, in one study there was a statistically significant difference in zooplankton biomass across seasons, being highest in autumn 2009 but in spring for other years (Kurt and Polat, 2015). Furthermore, the study was done in the Straits of Malacca where zooplankton biomass was higher in coastal than offshore areas via river runoff and mangrove forests (Rezai *et al*., 2003). But the biomass recorded in our study (Figures 4-6) was lower than for the tropical mangroves estuary in the Straits of Malacca (Balqis *et al*., 2016). This may be related to the fact that their study (Balqis *et al*., 2016) was conducted for one full year while in our present study we have covered three months in a year. In our results, the biomass of medium sized zooplankton (501-2000 µm) yielded the highest biomass in most months of our study. Abundance of different sized zooplankton has been reported in different habitats, for example, Nakajima *et al*. (2008) found that the 200-335 µm sized zooplankton were dominant yielding 74.3% of the total abundance in the coral-reef ecosystem of Redang Island. Another study in the coastal waters of the Gulf of Aqaba by Al-Najjar and El-Sherbiny (2008) reported that zooplankton with size fraction > 500 µm were dominant, yielding 67% to the total biomass. Zooplankton abundance, biomass, and size structure were studied in the coastal waters of the Northeastern Mediterranean Sea, where, small-sized zooplankton (200–500 µm) were dominant (Kurt and Polat, 2015). On the other hand, small copepods (100-335µm) were greatest in number in the sea grass beds of Pulau Tinggi (Metillo *et al*., 2018), where we found that biomass of medium size zooplankton (501-2000 µm) was highest in most months of our study.

5. Conclusion

Zooplankton was classified into seven taxonomic groups; copepods, larvaceans, chaetognaths, cnidarians, ctenophores, decapods and polychaetes. The copepods were categorized into four orders; Calanoida, Poecilostomatoida, Cyclopoida and Harpacticoida. This included a total of 54 species 26 genera and 19 families of copepods. We conclude that the medium fraction was somewhat dominant in biomass for the whole study period, as compared to the large and small size fractions.

6. Conflicts of Interest

The authors declare that there is no conflict of interest in publishing the current paper.

Acknowledgments

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