Diversity of meiofauna and its association to seagrass beds characteristics in Pramuka Island, Seribu Islands

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Abstract. Seagrass beds is one of the coastal ecosystem that has many biological benefits for other marine biota, like fishes, shrimps, and shells. Those marine biotas take advantages from seagrass beds as habitat for their communities. One example of marine biota that associated with seagrass beds is meiofauna. Meiofauna is an organism with size between 0.063 to 1 mm and live interstitially between substrate cavities. Ecologically, meiofauna plays important roles as mineral decomposer and food for bigger organisms. This research aims to study the relation between the diversity of meiofauna associated with seagrass beds in Pramuka Island, Seribu Islands. The research was conducted in 3 stations, each consists of 15 meiofauna sampling points. The samples were collected by using PVC core that embedded in the substrate. Meiofauna that has been found in research stations was consisting of 6 phyla, 8 classes, 17 orders, 31 families, and 35 genera. The most abundant phyla was Nematodes. Meiofauna has higher abundance in finer substrate which contain more organic material. Aside from that, the abundance of meiofauna was also affected by the seagrass density.

1. Introduction

Meiofauna is a sedimentarial organisms that can be associated in the seagrass ecosystem. It has individual size ranged between 0.044 to 1 mm and live in bottom layer of soft substrate. It is known to be the most abundant benthic group in marine ecosystem [1]. The characteristic of meiofauna is that they live interstitially on substrate cavities. The life cycle of meiofauna, specifically Foraminifera, plays an important role in the term of biogeochemical cycle and energy flow. Other than that, meiofaunal groups Foraminifera and Nematode are known as potential bioindicators of environmental quality [1, 3].

One of the factors that affect the availability of meiofauna in seagrass beds is seagrass density and other environment variables such as current, substrate types, pH and Eh of substrate, oxygen availability, and organic material in the substrate [4]. Pramuka Island has a community of seagrass that grows on sand substrate. The type of substrate is one of most important factors because it is related to oxygen and organic material concentration. This study aims to learn about the diversity of meiofauna and its association to seagrass beds’ characteristics in Pramuka Island, Seribu Islands.
2. Methods
The data sampling was conducted on March 13–17, 2017 in Pramuka Island, Seribu Islands. There were three sampling stations that was set based on representation of seagrass ecosystem (figure 1). Laboratorium analysis was conducted in Marine Biology Laboratory, Bogor Agricultural University during April–June 2017.

2.1. Sampling procedure

2.1.1. Seagrass density. The observation of seagrass density was done using Seagrass Watch method [5]. In each sampling stations there were three 50 m line transects with 10 m distance between them. In each line transect was placed 1 m x 1 m quadratic transect to observe the seagrass density (figure 2).

2.1.2. Meiofauna. Sampling of meiofauna was conducted using PVC core (ø: 5 cm; height: 30 cm) that embedded in the substrate. Then the substrate was strained using 1 mm mesh size strainer. After that, the sample was given solution of rose bengal and 4% formaldehyde to stain and preserve it so it would be easier to identify. The identification process was performed using a light microscope and book Introduction to the Study of Meiofauna [6].
2.2. Analysis Procedure

2.2.1. Classification of bottom substrate. The type of bottom substrate was classified based on Wenworth Scale [7] into three classes of sand: coarse, medium, and fine. The determination of substrate classification was done by using sieve shaker. Dried sample weighed as much as 20 grams, then sieved for about 10 minutes.

2.2.2. Seagrass density. The seagrass density in each sampling stations was calculated using formula below [8]:

\[
\text{Density}_i = \frac{\text{Total individual}_i}{A}
\]

2.2.3. Abundance of meiofauna. The abundance of meiofauna in each sampling station was calculated using formula below [8]:

\[
\text{Abundance} = \frac{10000 \times \text{total counted individual}}{\text{area}}
\]

2.2.4. Diversity index. The diversity index was calculated using formula below [8]:

\[
H' = -\sum p_i \log_2 p_i
\]

2.2.5. Evenness index. The evenness index was calculated using formula below [8]:

\[
E = \frac{H'}{H'_{\text{max}}}
\]

2.2.6. Environmental data. Environmental data collected in this research including TOC, total phosphate, and nitrate concentration. The Walkley and Black method [9] was used to determine total organic carbon. While to determine nitrate and total phosphate concentration, Kjeldahl distillation and HCl extraction method were used respectively [10, 11].

2.2.7. Association of meiofauna with seagrass beds' characteristics. The association of meiofauna with seagrass density and substrate characteristics was analyzed using principal component analysis and correspondence analysis on XLStat 2016 software. Principal component analysis is factorial analysis method that enable easier data interpretation by using essential information. Displayed matrix consists of sampling stations as individual (row), then seagrass density and substrate types as quantitative variable (column). This analysis was conducted to know the difference of seagrass distribution and substrate type in each sampling stations. Correspondence analysis is factorial analysis that groups statistical units into homogenous groups from some variables or characters. Variables tested in correspondence analysis was the abundance of meiofauna in each sampling stations.

3. Results and discussion

3.1. Classification of bottom substrate
The bottom substrate was classified in to three classes: coarse sand, medium sand, and fine sand. Station 1 consists of rough sand, medium sand, and fine sand with similar percentages. Station 2 is dominated by rough sand (47.35%), while Station 3 is dominated by fine sand (51.88%) (figure 3). Coarse grained sand substrate has higher oxygen concentration compared to fine grained substrate, but it contains less organic material [4].
3.2. Seagrass composition in Pramuka Island
There were 6 seagrass species that found during the sampling in Pramuka Island namely *Thalassia hemprichii*, *Cymodocea serrulata*, *Cymodocea rotundata*, *Halophila ovalis*, *Enhalus acoroides*, and *Syringodium isoetifolium*. Nevertheless, *Thalassia hemprichii* was the most abundant species in all three sampling stations, with composition value 75.82% (Station 1), 56.20% (Station 2), and 61.84% (Station 3). Followed by *C. serrulata* with value 18.67% (Station 1), 32.46% (Station 2), and 29.80% (Station 3) (figure 4).

![Figure 3. Classification of bottom substrate.](image1)

![Figure 4. Seagrass composition in Pramuka Island.](image2)

3.3. Seagrass density in Pramuka Island
Seagrass *Thalassia hemprichii* has highest density value in all three sampling stations (figure 5). Thus, it indicates that *Thalassia hemprichii* is more adaptive to the aquatic environment compared to the
other seagrass species. Density values of *Thalassia hemprichii* respectively are 94 ind/m², 243 ind/m², and 166 ind/m².

3.4. The abundance of meiofauna

Meiofauna found in the seagrass beds in Pramuka Island consists of 6 phyla, 8 classes, 17 orders, 31 families, and 35 genera. The highest abundance of meiofauna was found in Station 3 (figure 6). It is considered that the high abundance in Station 3 was due to fine sand domination, which also contain more organic material. Nematode was the most abundant phyla in each sampling station, while Ciliophora was the most scarce phyla. According to [12], Nematode and Arthropod are the most common meiofauna to be found in sand substrate, although Nematode is actually able to adapt to different substrate types. [13] also explained that Nematode is the most viable meiofaunal group in low oxygen and high organic condition.
3.5. Environmental Data

Table 1. TOC and nutrients in each sampling station.

| No | Variables     | Station 1 | Station 2 | Station 3 |
|----|---------------|-----------|-----------|-----------|
| 1  | TOC (%)       | 0.33      | 0.23      | 0.48      |
| 2  | P-total (ppm) | 37.62     | 55.73     | 49.19     |
| 3  | Nitrate (mg/l)| 2.16      | 3.37      | 2.80      |

The result of analysis in table 1 showed that substrate from Station 3 contained the highest total organic carbon, which is 0.48%. This is linear with the highest abundance of meiofauna in Station 3. The result for nutrient analysis showed different result, as the highest nutrient content was in Station 2. This is also linear with the result of seagrass density calculation, which showed that Station 2 has the most dense seagrass vegetation. Nitrate is considered as one of the primary nutrient for seagrass growth. Nitrate is resulted from decomposition of organic, which involved the reaction of ammonia and bacteria. This process produces nitrate that is used to support seagrass growth [14].

3.6. Diversity and evenness index of meiofauna

Diversity index in Station 1, 2, and 3 respectively are 3.91, 3.95, and 4.55, thus the diversity of meiofauna in Pramuka Island can be categorized as high category (table 2). It can be said that meiofauna in Pramuka Island is evenly distributed and there is no dominance of any species. All three sampling stations have evenness index respectively 0.83, 0.81, and 0.89. The value can be interpreted that the meiofauna community in Pramuka Island is tend to be stable [15].

Table 2. Diversity and evenness index of meiofauna.

| Station | H' | E  |
|---------|----|----|
| 1       | 3.91 | 0.83 |
| 2       | 3.95 | 0.81 |
| 3       | 4.55 | 0.89 |

3.7. Association of Meiofauna with Seagrass Beds' Characteristics

The result of PCA analysis showed that the distribution of substrate types and seagrass in all sampling stations can be explained through axis 1 (F1) and axis 2 (F2) with total variance 70.65% (figure 7). At axis 1 (50.68%), it showed that Station 2 is dominated by *Thalassia hemprichii*, *Syringodium isoetifolium*, and *Halophila ovalis* that distribute in mixed substrate consists of medium and fine sand. [16] explained that *Thalassia hemprichii* is able to grow well in sand substrate. Otherwise, in axis 1 *Enhalus acoroides* is found in Station 3 which has fine sand dominated substrate. *Enhalus acoroides* tends to grow well on fine or muddy substrate [17]. It is due to the ability of fine or muddy substrate to bind more organic material than coarser substrate [18]. 2013). Axis 2 (F2) showed that *Cymodocea serrulata* and *Cymodocea rotundata* commonly found in Station 3 which has fine sand dominated substrate. [16] explained that fine sand with few mud can supports the growth of *Cymodocea serrulata*. 
The result of the correspondence analysis showed the distribution of meiofauna at sampling stations centered on axis 1 and 2 with total variance of 87.13% (figure 8). Nematode, Arthropod, Foraminifera, and Xenacoelomorpha are commonly found in Station 1 and 2 which have mixed substrate of coarse and medium sand. Nematode and Arthropod are common meiofauna that usually found on sandy beaches [12]. Nematode has highest abundance at the study station, followed by Arthropod and Foraminifera.

Annelid is commonly found in Station 1 and 3. Similarly with Nematode, members of the Annelid phylum generally found on finer substrate. Types commonly found in marine waters are from Polychaeta class, which inhabit various types of substrates such as mud, sand, or corals [19]. Ciliophora is found only in Station 3 with very small number, so it is not characterized on any station (figure 8).

**Figure 8.** Results of correspondence analysis.

4. Conclusion
Meiofauna associated with seagrass beds in Pramuka Island consists of 6 phyla, 8 classes, 17 orders, 31 families, and 35 genera. The abundance of meiofauna is higher in seagrass beds with finer substrate. It is due to the ability of finer substrate to bind more organic material that become one of the factors that support the increase of meiofauna in seagrass beds.
Acknowledgment
This research was fully funded by Ministry of Research, Technology, and Higher Education through BOPTN 2016 funding scheme, with contract number 079/SP2H/LT/DRPM/II/2016.

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