Community structure of Gastropods in mangrove ecosystem of Pulo Sarok Village, Aceh Singkil Regency, Indonesia

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Abstract. The purpose of this study was to determine the community structure of gastropods in the mangrove ecosystem in Pulo Sarok Village, Singkil District, Aceh Singkil Regency, Indonesia. This research was conducted in April 2018 located in the coastal mangrove ecosystem of Pulo Sarok Village, Singkil District, Aceh Singkil Regency. The purposive random sampling was used in this study. The results showed there were 564 individuals Gastropod in all stations consisted of 4 species of Gastropod, namely Faunus ater as many as 354 individuals, Terebralia palustris as many as 123 individuals, Neritina turrita as many as 58 individuals and Neritina semiconica as many as 29 individuals. The highest density (D) was found at station 3 with a value of 2.44 Individuals per m⁻². The diversity (H') obtained from the three stations ranged from 0.50 to 1.77 which was categorized a the low and medium levels. Evenness index (E) from 0.14 to 0.37 which were in the low category. Furthermore, Domination index (C) of Gastropods range from 0.32 - 0.83. The level of similarity index (IS) ranges from 85.71% - 100%. It is concluded that based on the biological indices the structure of the Gastropods community in the Pulo Sarok Village is at the poor category.

1. Introduction
Aceh Singkil regency has an area of 2.185 km² and the position is 2°20' - 2°27'30" N and 97°04' - 45°00' E [1]. Aceh Singkil regency has several mangrove ecosystem areas which cover an area of 3162.965 ha. One of the areas of the mangrove ecosystem in Singkil District is the Pulo Sarok Village. Pulo Sarok Village has extensive mangrove forests and has potential biodiversity, furthermore this mangrove is located close to fishing boats port that potentially affect the mangrove ecosystem.

Mangrove forest is one of the tropical and subtropical coastal ecosystems that is very dynamic and has high productivity, economic and ecological value [2]. Mangrove forests as high-productivity areas make a major contribution as an energy source for the biota that live around them. Mangrove forests are also ideal places for care, foraging, nursery, spawning, providing shelter and reducing the pressure of predators, especially predatory fish [3]. One of the dominant and groups of aquatic organisms in mangrove forests is Mollusks, especially from the Gastropod class. This aquatic animal has potency as the protein resources for local people [4]. Most Gastropods live in mangrove areas, some live on muddy or waterlogged soil,
and some are attached to roots or stems, some even climb. Gastropods are associated with mangrove ecosystems as habitat for living, sheltering, spawning and also as a food supply area that supports their growth [5-7]. Some marine biology studies that have been carried out in Aceh Singkil Regency include the structure of the bivalve community in Nibung Bay [8], the macrozoobenthos community structure in Gosong Lake Village [9], and relationship between carapace width and weight of mangrove crab (*Scylla serrata*) and the condition factors [10].

Considering the importance role of gastropods in the food chain towards organisms living in the mangrove ecosystem, and the limited of information about the presence of gastropods in the mangrove area of Pulo Sarok Village, it is necessary to conduct a study of gastropod community structure in the mangrove ecosystem of Pulo Sarok Village, Singkil District, Aceh Singkil Regency.

2. Materials and Methods

2.1 Site and time

This research was conducted in mangrove area of Pulo Sarok village, Singkil District, Aceh Singkil Regency on April 2018 (Figure 1). Determination of the sampling location was carried out based on purposive random sampling methods.

![Map of research location in Pulo Sarok Village](image)

**Figure 1.** Research location in Pulo Sarok Village

2.2 Tools and materials

The tools and materials used are meters, stationery, raffia, sample plastics, shovels, GPS, identification books such as *The Living Marine Resources of the Western Central Pacific* [11], DO meters, cameras and 70% alcohol.

2.3 Methods

Determination of the research station was carried out using a purposive random sampling method, then this research station consist 3 stations, where station 1 located in the estuary mangrove area which is far from the residential area, station 2 was located in a mangrove area adjacent to the residential area and in the berthing area of cargo transport vessels, and station 3 was located in an area that is a mangrove rehabilitation area.
Sampling was carried out at 3 different stations to the coastline with a distance between stations of 100 meters and each station carried out 3 repetitions (Figure 1) where each research location was placed a 10 m x 10 m quadratic transect, then inside the plot is placed in 1m x 1 m squared transect to take a sample of gastropods. Gastropods observed include tree fauna and Epifauna. Observations were made on gastropods on the surface substrate as well as those in the stands of mangrove trees vertically. Furthermore, tree fauna measurements were limited to a height of 2 meters or to the highest tide limit [12]. Each type found on transect was calculated, observed and recorded the number and species of gastropods. For unknown types of gastropods, they were put into sample bags and labeled with 70% alcohol for preservation, then identified using identification books that refer to Jeffery et al. [13], Dharma [14], Rintelen et al. [15], and Rintelen et al. [16].

2.4. Data analysis
Data analysis used in this research is the biological index, such as:

Density of Gastropods. The density calculation refers to [17-20], using the following formula:

\[ D = \frac{\sum N_i}{A} \]

Where, \( D \) is Gastropods density (ind/m²); \( N_i \) is number of individuals (individuals); and \( A \) is area (m²).

Diversity of Gastropods. The diversity calculation refers to Shannon-Weiner formula [13-20]:

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

Where, \( H' \) is Shannon-Wiener Diversity Index; \( P_i \) is number of individuals i/total number of individuals; \( n_i \) is number of individuals of a type; \( N \) is total number of individuals; \( \log_2 pi = 3.321 \times \log pi \). Diversity index values can be classified as follows [17-20]; \( H'<1 \) is small diversity and low community stability; \( 1<H'\leq 3 \) is moderate diversity and moderate community stability; and \( H'>3 \) is great diversity and high community stability.

Evenness Index using the following formula [18-20]:

\[ E = \frac{H'}{H_{max}} \]

Where, \( E \) is Similarity Index; \( H' \) is Diversity Index; \( H_{max} \) is 3.321928 Log \( S \); and \( S \) is number of species that found. Evenness Evenness index values range from 0 - 1. If the Evennesss index approaches a value of 0, then the individual distribution of each species is not the same and in the ecosystem there is a tendency for species domination to be caused by instability of environmental and population factors. If the Evenness index approaches a value of 1, then the ecosystem is in a relatively stable condition, i.e. the number of individuals per species is relatively the same [18-20].

Dominance of Simpson using the following formula [19, 20]:

\[ C = \left[ \frac{n_i^2}{N} \right] \]

Where, \( C \) is Dominance Index, \( n_i \) is number of individuals of a type; and \( N \) is total number of individuals. Dominance index values can be classified as follows [18-21], where \( 0 < C \leq 0.5 \) is Low dominance; \( 0.5 < C \leq 0.75 \) is Medium dominance; and \( 0.75 < C \leq 1 \) is High dominance.

Similarity Index (SI). The Similarity Index (SI) calculation refers to [18], using the following formula:

\[ IS = \frac{2C}{A + B} \]
Where, $SI$ is Similarity Index, $A$ is number of species in A zone, $B$ is number of species in B zone, and $C$ is number of species between A and B zone. The criteria of Similarity Index is if $IS < 50\%$ is low, and if $IS > 50\%$ is height.

3. Results and Discussions

3.1 Density of Gastropods ($D$)

Based on the analysis of Gastropoda research data on the three stations carried out in the mangrove ecosystem of Pulo Sarok village, Singkil District, Aceh Singkil Regency, can be seen in Table 1. Gastropod density in the mangrove ecosystem of Pulo Sarok Village, Singkil District, Aceh Singkil District ranged from 0.29 to 3.54 individual/m$^2$. The species with the highest density was *Faunus ater* with a value of 3.54 individual/m$^2$, while the species with the lowest density was *Neritina semiconica* with a value of 0.29 individual/m$^2$. The highest density in was station 3 with average 2.44 individual/m$^2$, while the lowest density was station 2 with average 1.22 individual/m$^2$. This is caused the station 3 is a mangrove rehabilitation area that has the same type of mangrove and has a dense density due to reforestation results, while at station 1 has a low mangrove density because natural mangroves that grow wildly are still small and station 2 mangroves around it farms and human activities, so the density of these two stations is low. According to Wilhm [19] mangrove plants are a potential food source, in various forms (nutrients and organic matter) for all biota that live in mangrove forest ecosystems, so that their density greatly affects the density of Gastropods and other biota.

| No | Species          | Density of Gastropods (Individual/m$^2$) | Total  |
|----|------------------|-----------------------------------------|--------|
| 1  | Faunus ater      | 1.80 0.54 1.20 | 3.54   |
| 2  | Terebralia palustris | 0.30 0.93 | 1.23   |
| 3  | Neritina turrita | 0.04 0.30 0.24 | 0.58   |
| 4  | Neritina semiconica | 0.40 0.08 0.07 | 0.29   |
|    | Total            | 1.98 1.22 2.44 | 5.64   |

3.2. Diversity Index, Evenness Index, and Dominance Index

Diversity index ($H'$), Evenness ($E$) and Dominance ($C$) indicates of Gastropods from the three observation stations in the mangrove ecosystem of Pulo Sarok village, Singkil District, Aceh Singkil Regency, can be seen in Table 2. The diversity index value ($H'$) obtained during the study of the three stations ranged from 0.50 - 1.77 which was included in the low and medium categories. Gastropod Evenness values at each station ranged from 0.14 - 0.37 which included the low category and the Gastropod dominance index value at each station ranged from 0.32 - 0.83.

| Station | $H'$ | Category | $E$ | Category | $C$ | Category |
|---------|------|----------|-----|----------|-----|----------|
| 1       | 0.50 | Low      | 0.14| High     | 0.83| High     |
| 2       | 1.77 | Moderate | 0.37| Low      | 0.32| Low      |
| 3       | 1.50 | Moderate | 0.27| Low      | 0.39| Low      |
The diversity index value of the data obtained in the three stations has no high diversity. The value obtained is ranged from 0.50 to 1.77 that is showed if diversity of Gastropods is low until moderate. Low diversity index is found at station 1 and the moderate diversity index is being found at stations 2 and 3. This is due to the unequal distribution of individual species and the tendency of a species to dominate the population. According to Ernanto et al. [12] and Haryoardyantoro et al. [22], a community is said to have high species diversity if the community is composed by many types with an abundance of the same or almost the same type. Conversely, if the community is composed of very few species and if only a few types are dominant, the species diversity is low.

The Evenness index calculation as shown in table 2 shows the results of station 1 with a value of 0.14, station 2 with a value of 0.37 and station 3 with a value of 0.27. The criteria for Evenness of station 1, station 2 and station 3 fall into the low category, indicating that in each station there are species that dominate. According to Hitalessy et al. [23] high species diversity is caused by the absence of dominance of certain species in the community. In addition, the lower the dominance of species, the higher the diversity of species.

The dominance index value in all stations varies, ranging from 0.32 - 0.83. The highest dominance index value is found at station 1, which is 0.83, which is dominated by *Faunus ater*. According to Romdhani et al. [24], the higher the dominance index value of a species illustrates the pattern of centralized control on certain species or the community is more controlled by certain species, on the contrary if the dominance index value gets lower it will illustrate the pattern of mastery of species in the community it is relatively diffuse in each species. This reflects the community structure in an unstable condition, ecological stress occurs. The *F. ater* was also a dominant species in the estuary of Rawa Singkil peat swamp of Nagan Raya [25].

### 3.3. Similarity Index (IS)

Diversity index value (H’) gastropods from the three observation stations in the mangrove ecosystem of Pulo Sarok village, Singkil District, Aceh Singkil District, can be seen in Table 3. Table 3 shows that the level of similarity of at the three stations is high because vegetation is almost the same at each station. At station 2 and station 3 the similarity index value is 100%, this is because the mangrove ecosystem at both stations is a rehabilitation mangrove ecosystem. While at station 1 lies in the natural mangrove ecosystem. The similarity index value between high-value stations is also influenced by the content of sufficient nutrients found in these waters which supports the growth of gastropods between stations, so that the same species can be found. According to Barus [26] the similarity of nutrients or nutrients contained in these waters is also thought to affect the similarity of species between stations.

| Table 3. Similarity Index of gastropods in the mangrove ecosystem of Pulo Sarok Singkil Village, Singkil District, Aceh Singkil Regency. |
|---------------------------------------------------------------|
| Station 1 | Station 2 | Station 3 |
| Station 1 | - | 85,71 | 85,71 |
| Station 2 | - | - | 100 |
| Station 3 | - | - | - |

### 4. Conclusion

The results showed that in all stations there were 4 types of gastropod species obtained, namely *Faunus ater*, *Terebralia palustris*, *Neritina turrita* and *Neritina semiconica*. The value of gastropod density at station 3 is higher at 2.44 Individual/m² compared to station 1 which is 1.98 Individual/m² and station 2 which is 1.22 Individual/m². The diversity index values obtained were ranged from 0.39 - 1.85, low diversity levels were found at station 1 and moderate diversity levels were found at stations 2 and 3. The highest Evenness index value was obtained at station 2 with a value of 0.37 and index value the lowest Evenness was obtained at station 1 with a value of 0.14. The level of similarity of gastropods in all three
stations is almost high because vegetation is almost the same at each station (station 2 and station 3 is a rehabilitation mangrove ecosystem).

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