

Community structure of crustacean in mangrove ecosystem rehabilitation in Banda Aceh and Aceh Besar district, Indonesia

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Abstract. The abundance and biological indices of crustacean macrofauna were studied in the mangrove ecosystem along the coastal area in Aceh Besar and Banda Aceh. One of the macrofaunas that have high ecologic and economic value is the crustacean. The present study was conducted in the mangrove rehabilitation on November to December 2016. The objective of the study was to obtain the community structure of crustacean in mangrove rehabilitation including abundance, diversity, evenness and dominance indices. Sampling was carried out in five observation stations with purposive sampling method, and the obtainment of macrofauna was done by using square transect (2x2 m²). We recorded five families of crustacean and the highest composition was Ocypodidae (60%), whereas Portunidae, Sesarmidae, Penaeidae, Palaemonidae were 10%, respectively. The highest abundance of crustacean was Sesarma sp. (6 individuals/4m²), and this species almost found in all sampling plot. The diversity index ranged from 1.19 to 2.93 indicating a moderate category, while evenness index was in the moderate and high category ranged from 0.58 to 0.98. In addition, the dominance index (D) ranged from 0.14 to 0.51. Evenness and Dominance indices implied that the total number of individuals in the species were almost the same and there was no domination of certain species at field study.

1. Introduction

Mangrove ecosystem in Aceh Province can be found along the coast of Aceh Province, especially in the area of Aceh Besar District. As a result of the tsunami, wetlands in Aceh Province had been changed in shape, extent, and quality of water and substrate [1]. There was a lot of mangrove rehabilitation in the Aceh Province, but the results obtained are still as far as expected. This is because inappropriate in choosing the type of plant, lack in maintenance of plants, and an unsuitable substrate. The ecological impacts that result from reduced and damaged mangrove ecosystems, especially for biota species associated with the ecosystem. The negative impact of damaged mangrove ecosystems in the long term will disrupt the balance of mangrove ecosystems and associated fauna [2, 3, 4].

There are types of biota whose lives depend on mangrove ecosystems such as macrozoobenthos crustaceans. The amount of crustacean diversity is influenced by environmental factors that surrounding their habitat, food availability, predators and competition. Diversity from the population of crustacean's species can experience an increase or decrease in the number caused by environmental factors such as tides, changes in salinity, temperature, dissolved oxygen, and pH.

The United Nations Environment Program [5] states that around 30% of marine fisheries production depends on the existence of mangrove forests, because mangrove areas become nursery ground areas for feeding ground, spawning ground various marine biota including some types of fish



and macrozoobenthos i.e. crustaceans. Based on the benefits of mangroves for aquatic biota associated within, especially crustaceans, it is necessary to study the community structure of crustaceans associated with mangrove ecosystems. Therefore, The objective of the study was to obtain the community structure of crustacean in mangrove rehabilitation including abundance, diversity, evenness and dominance indices.

2. Research Methods

2.1 Study area

The present study was carried out in the mangrove rehabilitation area in the Syiah Kuala Subdistrict, Baitussalam Subdistrict (Banda Aceh), and Mesjid Raya Subdistrict (Aceh Besar). The study was done from November to December 2016. Identification of crustaceans was carried out at the Marine Biology Laboratory of Marine and Fisheries Faculty, Syiah Kuala University. Map of the research location is presented in Figure 1. Sampling was conducted in five observation sites, namely mangrove areas in Ladong Village (Site 1), Ruyung Village (Site 2), Krueng Cut Village (Site 3), Lamdingin Village (Site 4), and Deah Raya Village (Site 5).

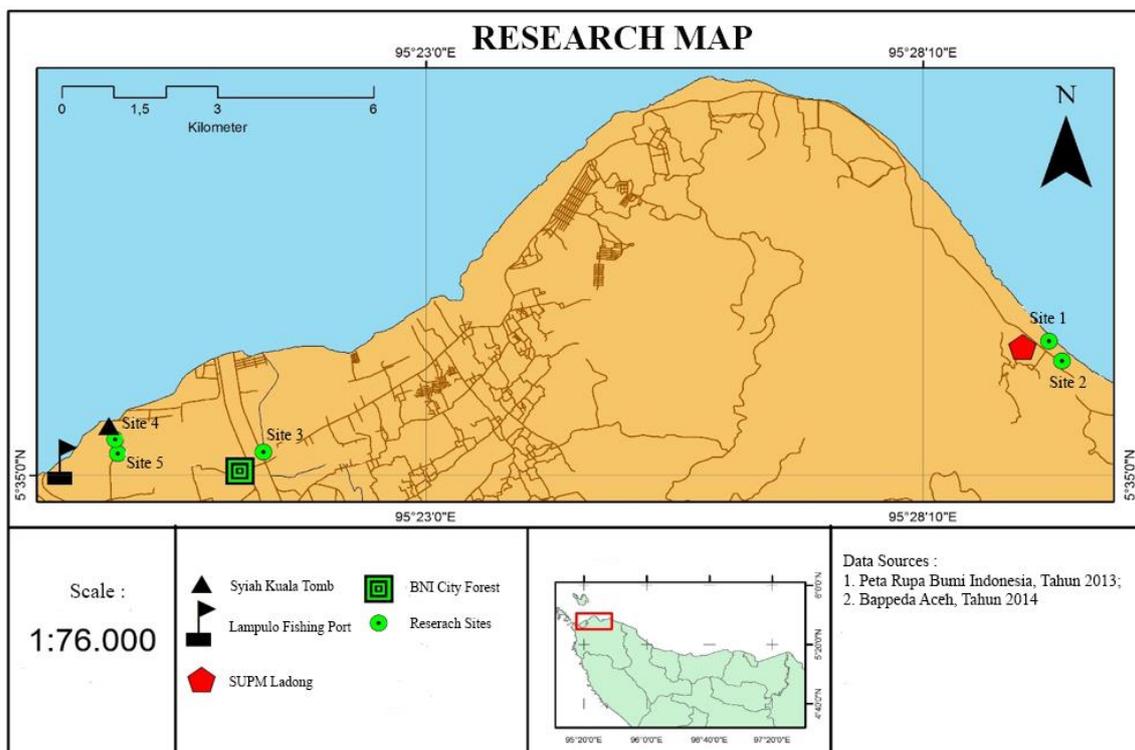


Figure 1. The map of study sites located at Banda Aceh and Aceh Besar districts.

2.2 Sampling procedures

The mangrove vegetation in the study areas is the newly formed vegetation post mangrove rehabilitation program. Five sites as sampling location (10 m x 10 m) were selected by purposive sampling method based on different criteria i.e. age of vegetation, number of individual and substrate. Sampling data collection used quadratic transect by making 2 m x 2 m as a plot along the coastal area with a distance of 15 meters between plots. There were three plots each site for repetition procedure. Macrozoobenthos (crustaceans) included not only those as infauna but also epifauna. Infauna crustaceans were excavated to depths of 5-25 cm, and epifauna crustaceans sampling was carried out by collecting crustaceans directly. Crustacean sampling was limited to the only macrofauna which has

> 0.5 mm in size [6]. Crustacean's samples were sorted and preserved in bottle sample containing 70% alcohol. Furthermore, the samples transported to the laboratory and identified based on [7].

2.3 Data analysis

Abundance of Crustaceans was calculated using the formula as follows [8]:

$$Di = \frac{ni}{A}$$

Where, Di is abundance of Crustaceans (individuals/m²); ni is the number of individual each species (ind), A is sampling area (m²).

The Shannon index of diversity (H') is a measure of species weighed by the relative abundance. Shannon index of diversity (H') was calculated using the formula:

$$H' = - \sum_{i=1}^S Pi \log_2 Pi$$

Where, H' is diversity index, Pi is the proportion of individuals in the- ith species. Shannon index was used to indicate diversity of fauna at different sampling sites.

Evenness index was calculated by using the formula as follows [9]:

$$(E) = \frac{H'}{\log_2 S}$$

Where E is Evenness index, H' is diversity index, $\log_2 = 3.32193$, and S is the number of species.

3. Results and Discussions

3.1 Species composition and abundance of crustaceans

The results showed that the composition of crustacean consisted of five families, namely Portunidae, Ocypodidae, Sesarmidae, Penaeidae, and Palaemonidae. The highest species composition from Ocypodidae which was 60%, followed by Portunidae, Sesarmidae, Penaeidae, and Palaemonidae had a composition of 10%, respectively (Figure 2). The high composition of Ocypodidae assumed because they are animals whose lives depend on mangrove areas by utilizing detritus and bacteria as decomposers to obtain food derived from the bark skin, leaves and fruits of mangrove vegetation. According to Fetemeh *et al.* [10] crabs found on the substrate are crabs that playing and searching for food. At the present study the Ocypodidae crabs which had high species composition were not found in the substrate hole but they were taken on the surface of the substrate.

The rest family found only one species each, it was because uneven spread that can be caused by several factors such as inactivated behavior, food, space and the possible influence of the environmental condition during sampling time [11]. Familia Penaeidae and Palaemonidae were such kind of shrimps that lives in brackish water i.e. in mangrove forests. Peneidae live on the bottom of the water, unlike bright light (phototaxis negative) and hide in the mud during the day [12].

The research of observation showed that the highest abundance was *Sesarma* sp. (Sesarmidae) which was 6 individuals/4m², probably due to their mobile characteristics. *Sesarma* sp. is one of crabs that lives in sandy mud. *Sesarma* sp. commonly found in mangrove ecosystem, they often build holes in the surrounding mangrove ecosystem and they can be ascertained suitable by the mangrove substrate condition whereas substrate in the study area categorized as sandy mud substrate. Naturally, *Sesarma* sp. is part of the food chain in the mangrove ecosystem as litter degradation, especially the initial fragmentation of litter [13; 14]. The species abundance of crustaceans was presented in Table 1.

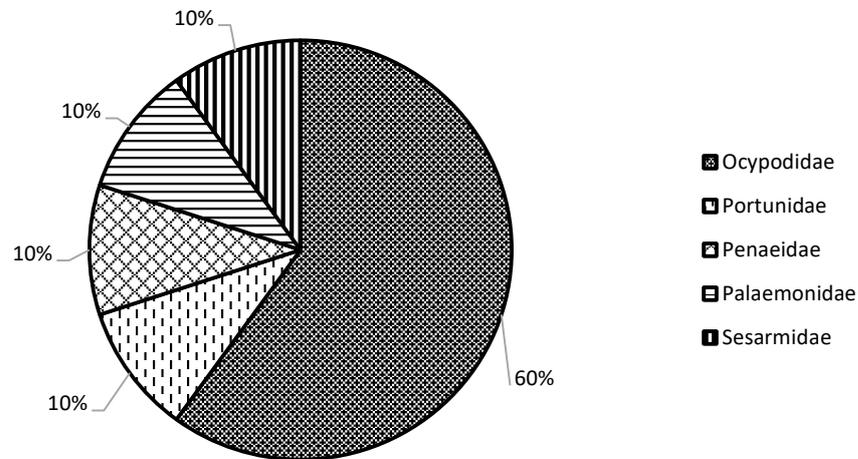


Figure 2. Crustacean Species Composition According to Family

Table 1. The Species Abundance (Ni) of Crustaceans Found at the Sampling Location

No	Species	Species Abundance (Ni) of Crustaceans (individuals/4m ²)					Total
		Site 1	Site 2	Site 3	Site 4	Site 5	
		Ni	Ni	Ni	Ni	Ni	
A Ocypodidae							
1	<i>Ocypode ceratophthalma</i>	0	0	0	0.7	1.3	2
2	<i>Uca</i> sp.	0.3	0.7	0.3	0.3	0	1.6
3	<i>Uca tetragonon</i>	0	0	0.7	0.3	0	1
4	<i>Uca dussumieri</i>	0	0.7	0	0	1.3	2
5	<i>Uca perplexa</i>	1	0	0	0	0	1
6	<i>Uca coarcata</i>	0	0	0	0.7	0	0.7
B Portunidae							
7	<i>Charybdis monodon</i>	0	0	0	0.7	0	0.7
C Penaeidae							
8	<i>Penaeus monodon</i>	0	0.3	0	0.7	0.7	1.7
D Palaemonidae							
<i>Macrobrachium</i>							
9	<i>latidactylus</i>	0	0	0	0.3	0	0.3
E Sesarmidae							
10	<i>Sesarma</i> sp.	2.7	0	0.3	0.7	2.3	6
Total		4	1.7	1.3	4.4	5.6	17

The abundance of crustaceans was ranged from 0.3 to 6 individuals/4m². The highest abundance was obtained at stations 4 and 5 due to the influence on the different age of mangrove vegetation. The older age of the mangrove vegetation, the more they survived to support biota life who depend on the mangrove ecosystem. In addition, Site 4 and 5 were rehabilitation areas formed with rehabilitation ages of 10 to 11 years old. The age of mangroves can also affect the density of crustaceans, as the

results of previous research that the highest crustaceans' abundance was obtained at Station 5 (27 years old) compared to other stations i.e. 1 year, 5 years, and 10 years old of vegetation [15]. The high density of crustaceans was thought to be related to the ecological conditions at site 5, ecological conditions support the abundance of certain crustacean, such as mud substrates that contain lots of organic material as a food source for the deposit feeder (macrozoobenthos) and the suitable water physical-chemical environmental factors in the habitat. We recorded that the salinity at site 4 and 5 was higher than other sites. Crustaceans in mangrove ecosystems prefer brackish to high salinity, this can be seen in those sites that the salinity ranged from 17 ppt to 20 ppt. The previous study done by Farah [16] which took place in the protected forest area of Angke Kapuk with salinity was ranged from 7.55 ppt to 20.11 ppt found that the crustaceans abundance was high. Furthermore, Farah [16] mentioned that the high salinity will affect the abundance of crustaceans at the study site.

3.2 Biological indices

Ecologically, crustaceans are organisms who's live related to mangrove ecosystems and their community structure can be characterized by the level of diversity, evenness and dominance index. Biological indices are often used to estimate the condition of an environment and the stability of a community (table 2).

Table 2. Biological Indices (Diversity (H'), Evenness (E), and Dominance (D) in Study Sites

Biological indices	Site 1	Category	Site 2	Category	Site 3	Category	Site 4	Category	Site 5	Category
(H')	1.19	Moderate	1.52	Moderate	1.50	Moderate	2.93	Moderate	1.87	Moderate
(E)	0.75	Moderate	0.96	High	0.95	High	0.98	High	0.94	High
(D)	0.51	Moderate	0.36	Low	0.37	Low	0.14	Low	0.29	Low

Average of diversity index was categorized in the moderate category, meaning the crustaceans community in the study site was in moderate condition. The moderate community condition can be caused by ecological pressures and food availability. Totally, 10 species of crustacean was collected, and the number of species has a correlation with diversity index, the number of species was less compare to the result done by Rahayu, *et al* [17], he found 15 species of crustacean in mangrove Purworejo, Central Java. This was also influenced by the age of mangrove rehabilitation which was in sapling category and contributed little litter production. The older age of mangrove rehabilitation would result in the more stable condition of the community due to litter sources. Furthermore, moderate diversity of crustaceans in the study area assumed because they like substrate with has high organic matter to support their life. We recorded that in the present study the C-Organic content of the substrate was ranged from 0.8 % to 1.0 %. Sukardjo [18] found that high quantities of C-organic matter in Tanah Grogot, East Kalimantan contributed by the high density of trees, because the fallen litter of mangrove leaves contributes significantly to the higher organic matter in the soils. Previously, research was conducted by Fitriana [19] in the mangrove forest area rehabilitation of the Ngurah Rai Forest Park was also classified as moderate diversity index ($H' < 3$). Species richness is influenced by the distribution of individuals in each species, even though there are many species in the community but if the spread is not evenly distributed will result species diversity is considered in the low category [20].

Evenness index (D) has ranged from 0.75 to 0.98. These values indicate a high value and community condition was stable. The dominance index (D) showed the degree of predominance of one or a few species in an ecological community. Legendre and Legendre [21] explained that if the dominance index values obtained are between 0.4 to 0.6 it can be categorized as moderate, above 0.6 is higher and below 0.4 is lower. The result showed that the dominance index was varied from 0.14 to 0.51, in average the dominance index was categorized as low value. High Evenness and low Dominance indices indicated that the number of individuals in the species was similar and no certain

species dominated in study sites. This is also in accordance with the results conducted by Irina [22] who found evenness values approaching 1 in the Lampung Bay which means the mangrove ecosystem was stable. Overall, we found that the moderate diversity index, the evenly distributed individuals within species, the high evenness and low dominance indices showed a stable crustacean community structure at mangrove rehabilitation in Banda Aceh and Aceh Besar District. Macintosh *et al.*, [23] explained that a high dominance of one species probably indicates a stressful environment while a higher diversity indicates stable condition of the ecosystem.

4. Conclusion

The composition of the crustacean was consisted of 5 families, and Ocypodidae family was the highest composition consisted of 6 species. Diversity index was categorized into the moderate category, with a high evenness index and there were no species dominated in study sites followed by low Dominance index in average. High Evenness and low Dominance indices indicated that the number of individuals in the species was similar and no species dominated in study sites. These values indicate that the community structure of crustaceans in mangrove rehabilitation was in moderate condition.

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