Study of bivalvia habitat in the mangrove area of Aceh Jaya District, Aceh Province

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Abstract. One of the biota that utilizes the mangrove ecosystem as its habitat is a group of Bivalvia belonging to the Phylum Mollusca Class Pelecypoda (Bivalvia). Shellfish have relatively high economic and nutritional value, so that the collection of shellfish in Aceh Jaya District continues. The research was conducted to study the biological components, analyze the habitat preferences, and management patterns of shellfish in the mangrove area of Aceh Jaya Regency. The research was conducted by using purposive sampling method, by determining 12 stations in 6 districts. Shellfish samples were taken three times with an interval of 15 days. The results found 5 species of shellfish with a dominance index of 0.002 to 0.255 with a low dominance level. The frequency of the presence of shellfish species is very rare (accidental) to rare (constant). The lowest presence level was Centrocardita rosulenta with a value of 8.33% and the highest was Sinanodonta woodiana with a value of 58.33. Habitat preference Sinanodonta woodiana has a salinity range between 3-7 ppt and clay soil texture class, while Geloina habitat preference likes salinity with a range of 12 to 25 ppt with sand, loamy sand and sandy loam soil texture classes.

1. Introduction
The typical vegetation in tropical and subtropical coastal areas is mangrove forests, this vegetation generally thrives in coastal areas close to the coast and is protected from the waves of the sea. Habitat characteristics that stand out in mangrove forests include muddy, loam or sandy soils, receiving an adequate supply of fresh water from land, especially from rivers, springs, and groundwater, with salinity of 2-22 ppt [1]. However, mangrove forests will be able to live with a salinity of 90 ppt [2].

Mangroves are a place for biota to find food, a place to spawn, and a place to protect from predators. One of the biotas that utilizes the mangrove ecosystem as its habitat is a group of members of the Phylum Mollusca Class Pelecypoda (Bivalvia). Mangrove shells from Phylum Molluscs are in the class of Bivalvia, which have a pair of shells to protect their soft bodies [3].

If the mangrove ecosystem experiences degradation or damage, of course it will affect the structure and composition of mangrove shells [4]. The components of the aquatic environment where shells live, can affect the survival of shells in a water body. Salinity, pH, bottom water substrate, and availability of food in the bottom waters can affect the presence of shellfish in their habitat [5].
Dwiono (2003) in [6] states that organic carbon has a relationship with the presence of shellfish, organic and inorganic materials at the bottom of the waters can be food ingredients for shellfish. The habitat conditions in the mangrove ecosystem of Aceh Jaya Regency have different characteristics, including having a salinity of between 5-30 ‰ with a sand and mud substrate, water temperature between 27 to 33°C, soil pH ranging from 5-6 (Survey results, 2019).

Therefore, it is necessary to conduct research on habitat and management patterns of shells in the mangrove area of Aceh Jaya Regency, Aceh Province. The purpose of this research is to study the components of shellfish biology including dominance index, frequency of presence, level of similarity of shellfish and basic biota of mangrove ecosystem waters and to analyse the preferences of shellfish habitat in the mangrove area of Aceh Jaya Regency, Aceh Province.

2. Method

2.1. Study area
The research was carried out in Aceh Jaya District, the mangrove ecosystem area in Indra Jaya District, Sampoiniet District, Setia Bakti District, Krueng Sabee District, Panga District, and in the mangrove ecosystem in Teunom District (Figure 1). Identification of shellfish species and aquatic biota was carried out at the Biology Education Laboratory of FKIP Unsyiah. Identification was carried out only looking at the morphological part, while soil texture analysis was carried out at the Aceh Agricultural Technology Assessment Laboratory. The shellfish data collection was carried out from February to April 2020.

![Figure 1. Map of research location in six sub-district](image)

This study used a purposive sampling method and samples were taken according to the existence of the research object, namely shellfish and aquatic biota. Sampling was carried out three times, with an interval of 15 days. The individual samples of shellfish and another aquatic biota found in the plot were counted and put into the specimen bag, then preserved using 76% alcohol. For the identification of these biota species using the book Recent & Fossil Indonesian Shells, referring to the Molluska Base (www.molluscabase.org) and the World Register of Marine Species (www.marinespecies.org) with a look at morphological characteristics.

Sampling of the soil texture of shellfish habitat was carried out at each station with a depth of 25 cm using a 2.5-inch pipe. Texture samples were put in a plastic bag for analysis at the Laboratory of the Aceh Agricultural Technology Research Institute (BPTP). Observation of physico-chemical factors was carried out in-situ, and measurements were carried out directly at the research location.
2.2. Data analysis

2.2.1. Biological component

The dominance level (C) is used to determine the clams and biota groups that dominate shellfish and other biota groups. This dominance is analyzed using the Dominance Index formula (Odum, 1993) as follows:

\[ C = \sum_{i=1}^{n} P_i = \sum_{i=1}^{n} \left( \frac{n_i}{N} \right)^2 \]

where:

- C: Dominance Index
- \( n_i \): The number of the ith individual
- N: The total number of individuals
- If C = 0 - 0.5 low dominance; C = 0.5 - 0.75 moderate dominance; and C = 0.75 - 1 high dominance

The presence frequency is a value that states the number of presences of a species in a habitat. To calculate the frequency of attendance, used the following formula [7].

\[ FK = \frac{\text{number of plots species catch}}{\text{Total plots species}} \times 100\% \]

with the criteria of > 90% is Very high similarity, ≤90% is High degree of similarity, ≤60% is Medium similarity level, ≤30% is Low similarity level

2.2.2. Chemical physics factors

The physical and chemical factors measured in this study were temperature, salinity, water pH, and brightness, while soil pH was analyzed at the Aceh Agricultural Technology Research Institute (BPTP) Laboratory using the 1: 5 method in H2O. This data will be presented in tabulations and analyzed descriptively.

2.2.3. Soil texture

Soil texture analysis was analyzed based on the hydrometer method. After knowing the percentage of sand, clay and dust, the soil will be grouped by soil texture class with the Texture Triangle.

2.2.4. Shellfish habitat preference

Analysis of shellfish habitat preferences used a Correspondence Factorial (Correspondence Analysis or CA). This analysis aims to determine the type of habitat that shellfish prefer. This analysis uses the MultiVariate Statistical Package (MVSP) software.

3. Result and Discussion

3.1. The dominant index

The dominance index for shellfish ranges from 0.002 to 0.255, with a low dominance level. The species Centrocardita rosulenta has a low dominance index value (0.002), while the highest Sinanodonta woodiana with a dominance index value of 0.255 can be seen in Figure 2.

Based on Figure 2, it explains the dominance of shellfish species in the mangrove area of Aceh Jaya Regency which has a low index category with an index value of 0.002 to 0.234. The highest dominance index value was by Sinanodonta woodiana, followed by Geloina bangalensis, Geloina expansa, Geloina erosa and Centrocardita rosulenta. [7] states that if the dominance index value is below 0.5, it indicates low dominance, which indicates that there are no shells that dominate the mangrove area of Aceh Jaya Regency. Furthermore, [8] stated that if the dominance index value is close to zero, then the species does not dominate other species.
The dominance index of shellfish species at each station is different. This is because each shellfish species has a different habitat type and the habitat conditions at all stations are different. Differences in habitat conditions for each station can affect the composition of the biota therein. The results of research by Bay [9] in general, none of the shells in the mangrove ecosystem of Setia Bakti District dominate. [10] states that if there is a density of an animal genus in an area of abundant waters, then the abiotic components owned by the bottom of the waters strongly

3.2. Appearance frequency

The frequency of presence (AP) of shellfish species is very rare (accidental) to rare (constant). The minimum presence rate was 8.33% for Centrocardita rosulenta and the highest was 58.33% for Sinanodonta woodiana. Geloina erosa with presence values reaching 44.44% while Geloina bangalensis and Geloina expansa have presence values of 50% each, can be seen in Figure 3.

Based on Figure 3, the frequency of accidental presence (very rare) has an attendance frequency value of 8.33% in Centrocardita rosulenta. Geloina erosa has a frequency of presence of accessories (rare), this species is found in 16 plots of all plots with a presence frequency value of 44.44%. Geloina bangalensis and Geloina expansa were found in 18 plots of all plots, having a presence frequency value of 50% (constant). Meanwhile, Sinanodonta woodiana, the frequency of its presence was 58.33% (constant), this species was found in 21 of the 36 plots.

The presence of clam species can be influenced by the habitat conditions occupied by these clam species. Several factors that limit the distribution and density of bivalves in nature can be categorized into two factors, namely natural factors in the form of genetic traits and behavior or the tendency of a biota to choose a preferred habitat type and external factors, namely everything related to the interaction of the biota with its environment. Therefore, the distribution and density of bivalves in
nature can be used as an indication of whether a habitat is suitable for certain biota Doddy, 1998 in [11]. *Sinanodonta woodiana* was only found in Indra Jaya Station 1 District, Krueng Sabee District, Panga District and Teunom District. [7] states that "even distribution can occur if competition between individuals is very strong which encourages almost equal division of space".

*Centrocardita rosulenta* has a smaller frequency of presence compared to other species. This species was only found in 3 plots of all observation plots. The frequency of the presence of species is possible, much of which is unsuitable for the habitat conditions for *C. rosulenta*. The species of *Centrocardita* can only be found in coastal areas, reefs, shallow subtidal, subtidal seas and transition zone [12].

3.3. Environmental factor

Environmental factors at the location have differences at each station. Salinity at the study site has a range of 3-35 ppt, temperature 27-31°C, water pH 7.5-8.1, soil pH 3.54-6.16, while the C-organic content is 0.1-2.83%, each environmental factor can be seen in Figure 4.

![Figure 4. Environmental factors of shellfish habitat in Aceh Jaya District](image)

Based on Figure 3, the consistency of water quality at each research station is different, the temperature range is 27-31°C, salinity of 3-35 ppt, water pH of 7.5-8.1, soil pH of 3.54-6.16. Temperature is a factor that influences the presence of aquatic biota and influences physiological processes. The temperature at the location of species *A. woodiana* was found with a range of 27 - 30°C. [13] stated that the water temperature range of 20 - 30°C is a suitable water temperature for planktonic life which is also a natural food for *A. woodiana* shellfish. At the station, *Geloina* was found to have a temperature of 29 - 30°C which is a good temperature for the life of shellfish, especially *Geloina*. The research done by [14] on the Lokan Shell Association of *Geloina erosa*, a temperature of 26 - 30°C *Geloina erosa* shellfish can still be associated with the environment. Furthermore, [15] stated that the temperature range of 25 - 36°C is the range value that macrozoobenthos can tolerate, especially in mangrove ecosystems. According [16] stated that temperatures of 35 - 41°C can cause death for macrozoobenthic organisms, where this temperature is a critical point for the organisms that inhabit it. [17] states that temperature changes can affect changes in the composition of benthic animals in a water body and affect the abundance and diversity of these biota, either slowly or quickly.

In the research location where *S. woodiana* was found, it had a salinity range of 3-15 ppt. Species from the genus *Geloina* were found in Indra Jaya Station 2, Sampoiniet District, Setia Bakti Station 2 District, and Panga District. At this station, it has habitat characteristics suitable for these species, where the water quality factor measured has a salinity range of 12-26 ppt. [18] states that bivalves are able to live in the range below 10 ppt to above 35 ppt, there is a partial tolerance for species that are able to live in the salinity range of 0.1-31 ppt. [19] states that the average salinity of 25-30 ppt is a salinity value that matches the habitat of shellfish. The results of [14] study of the Genus *Geloina* species were found in the salinity range of 14-32 ppt. Furthermore, [20] states that many bivalves are euryhaline, where each species of bivalve class can tolerate salinity conditions in their habitat.
Apart from salinity, the presence of shellfish species is also influenced by the degree of acidity (pH). The degree of acidity can affect the mortality of the biota that inhabit the waters, at the location where *S. woodiana* was found, it has a water pH value of 7.5-7.8 and a soil pH of 3.54 - 6.16 while the genus *Geloina* has a water pH range of 7.6-8.6, soil pH 3.54-5.96. [13] stated that *S. woodiana* shellfish can survive in waters with a pH between 4.8 to 9.8. The results of [21] showed that the condition of the Geloina habitat had a pH range between 7.39 to 7.51.

The content of soil organic or C-organic matter at the research station was 0.10 % to 2.83 % with the very low to moderate category. Organic C content <1% is very low, 1-2% is low, 2 - 3% is moderate, > 3% is high [22]. The research station where *S. woodiana* was found to have organic C content of 1.10 - 2.83 % [23]. The value of organic matter ranged from 0.21 to 5.43% found *S. woodiana* with a density of 0.49 - 1.56 ind/m2. Whereas in the species of the genus *Geloina* and species of *Centrocardita rosulenta* the content of C-organic was 0.10 - 2.83% with very low to moderate categories. At station two, Panga District, the content of C-organic is higher than other stations, this could be because the waters are calm and close to oil palm plantations which are often given fertilizer belonging to local residents. [24] stated, in fine sediments the percentage of organic matter is higher than coarse sediment, this is also influenced by environmental conditions, where the calm environment allows siltation followed by the accumulation of organic matter to the bottom of the water, whereas in coarse sediments, the material content the organic matter is low because the finer particles do not settle.

### 3.4. Shellfish habitat preference

Correspondent Factorial Analysis (CA) was carried out on the research habitat with environmental parameters to see the frequency of the Shells Habitat. The results of the analysis show that information is centered on the Axis 1 and Axis 2 axes. Each axis has a variable contribution of 88.74% (Eigen value 0.13) and 6.68% (Eigenvalues 0.01), with a total variance of 95.43%, can be seen in Figure 5.

![Figure 5. Distribution of Environmental Parameters to Shell Habitat](image)

Based on Figure 4 shows that the preferences of each species of shellfish have different habitat characteristics. At locations ID1, TM1, TM2, KS1 and KS2, have similar characteristics, where these locations have a negative correlation with salinity and sand. At locations ID2, SP1, SP2, SB2, PG1 and PG2 negatively correlated with clay and dust but positively correlated with salinity. Whereas at the SB1 location, it has a positive correlation with salinity. It can be concluded that the *Sinanodonta woodiana* species likes habitats that have a salinity range of 3-7 ppt, with a loamy soil texture.

The species of genus *Geloina* have characteristics of preferred habitat with a salinity range of 15-26 ppt, from sand to sandy loam substrates. The results of [1], [14] that *Geloina* shellfish were more dominant in low salinity levels. Meanwhile, the species *Centrocardita rosulenta* likes areas with a salinity of 35 ppt with clay substrate. [25] species C rosulenta can be found in habitats with temperature conditions between 10-30, with a salinity range of 30-35 ppt at a depth of 0-300 M.
4. Conclusion

The dominance of clams in the mangrove area of Aceh Jaya Regency has an index of 0.002 - 0.255 with a low dominance level, while the frequency of the presence of clams is 8.33 - 58.33% with an accidental to constant category. Preference habitat for shellfish Sinanodonta woodiana is characterized by a salinity range of 3 - 7 ppt, genus Geloina species has the characteristics of a habitat for salinity ranging from 15-26 ppt, while the species Centrocardita rosulenta likes habitats with salinity loam and soil texture.

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