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POPULATION STRUCTURE OF LOKAN (*Polymesoda expansa*) IN THE REHABILITATION MANGROVE ECOSYSTEM OF ANAK SETATAH VILLAGE, MERANTI ISLANDS REGENCY

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ABSTRACT

Polymesoda expanse belongs to the class of Bivalves found in mangrove forests; their habitat is between mangrove roots on muddy substrates, sandy mud and mangrove litter. This study aims to determine the abundance of *P. expansa* in Anak Setatah Village, Kepulauan Meranti Regency, examine the size-frequency distribution, and investigate the distribution pattern in the area. The study was conducted in October 2024 by using a survey method. The sites were located in the coastal waters of Anak Setatah Village. Station I is near residential areas, Station II is near fishing ports, and Station III is near agricultural areas. A one-way ANOVA was used to analyse differences in abundance between stations and zones. The results revealed significant differences in abundance, with Station II (near fishing ports) exhibiting the highest abundance and Station I (near residential areas) showing the lowest. The middle zone had the highest abundance among the zones. Furthermore, based on the results of the ANOVA test ($p < 0.05$), there is a significant difference in abundance between stations. The LSD test revealed a substantial difference in abundance between stations I and II, and stations I and III. However, no significant difference was found from the ANOVA test, with a p-value of $0.125 > 0.05$, indicating that there was no significant difference in abundance between zones. The size frequency of *P. expansa* ranged from 17.6-64.8 mm, and the distribution pattern was clustered.

Keywords: Anak Setatah, Distribution Pattern, Population Structure

1. INTRODUCTION

The intertidal zone is a region that contains mangrove ecosystems, consisting of organisms (plants and animals) that interact with environmental factors within a mangrove habitat. There is a close interaction between marine, river and terrestrial waters. This close interaction enables the mangrove ecosystem to have a high diversity of flora and fauna. [1] The uniqueness and complexity of mangrove ecosystems play an essential role in the surrounding community and support ecosystem services along the coastline in tropical regions[2]. Mangrove ecosystems are critical coastal ecosystems and have a vital role in maintaining the balance of the aquatic environment.

Mangrove forests are found in almost all of Indonesia's islands, primarily in Papua, East Kalimantan, South Kalimantan, Riau, and South Sumatra[3]. Mangrove is one of the dicotyledonous plants that live in coastal areas, tropical climates, on muddy substrates, and in areas with varying salinity levels[4]. The ecological functions of mangrove ecosystems include coastal protection from wind, currents, and waves from the sea, as well as providing habitat, foraging grounds, nursery and rearing grounds, and spawning grounds for aquatic biota[5]. Mangroves greatly affect the diversity of macrofauna associated with

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them; crabs and molluscs are the most dominant macrofauna[6]. One of the macrofauna included in the Mollusc Phylum is bivalves, which have high adaptability to place and weather, influencing their presence in an area[7].

Mangroves are one of the breeding ecosystems for marine life, including bivalves. Bivalves are one of the constituents of the invertebrate community in the intertidal area. Two symmetrical shells characterize bivalves (Lokan). The two shells are joined by an elastic joint called a ligament on the dorsal surface. In ecological terms, bivalves are a vital component of aquatic ecosystems, as they mitigate the risk of environmental degradation and serve as a food source for various other species in the food chain. Bivalves can be found in multiple types of water, especially in shallow water ecosystems such as the Intertidal Zone of

Anak Setatah Village. *P. expansa* belongs to the Bivalve class, which is found in mangrove forests; its habitat is between mangrove roots on muddy substrates, sandy mud and mangrove litter[8]. This lokan is a ciliary feeder (as a deposit or filter feeder) as a filter. Feeder: The Lokan filters food using gills; the main food of the Lokan is plankton and detritus[9]. Lokan can accumulate heavy metals that can be utilized as an indicator of pollution[10]. Lokan is one type of Lokan that inhabits mud in estuarine areas, brackish water mangrove forests, and large rivers. This mussel is distributed in the western Indo-Pacific region from India to Vanuatu, north to south of the Japanese archipelago. In Indonesia, apart from West Kalimantan, it is also found in the Segara Anakan islands and Irian Jaya.

Anak Setatah Village is situated directly adjacent to the Malacca Strait and the East Coast of Sumatra, characterised by large waves and muddy beach contours. This muddy beach condition suits the Bivalve habitat, especially *P. expansa*. The existence of Bivalves in the coastal area of Anak Setatah Village is influenced by many ecological factors, including temperature, waves, and salinity. The existence of the Bivalve community plays a vital role in the mangrove ecosystem's food chain, serving as a life support system for other biota at higher trophic levels. It is essential in energy transfer[11]. Anak Setatah Village has a land elevation of 3-5 meters above sea level, characterised by lowland topography. Anak Setatah Village has a high abrasion rate of approximately 12 meters per year, with an abrasion area of approximately 2.5 kilometres in length. The high productivity of mangroves creates a suitable living habitat for aquatic and terrestrial organisms, including bivalves. Food chains in mangroves become more diverse, complex, and intricate, with a greater number of relationships/connections involving more complex mangrove trees as the basic species in an ecosystem[12].

The purpose of this study was to determine the abundance of *P. expansa* found in Anak Setatah Village, Meranti Islands Regency, to determine the size-frequency distribution of *P. expansa*, and to determine the distribution pattern of *P. expansa* in Anak Setatah Village, Meranti Islands Regency.

2. RESEARCH METHOD

Time and Place

This research was conducted from September to October 2024 in Anak Setatah Village, West Rangsang District, Meranti Islands Regency, followed by sample analysis at the Marine Biology Laboratory and Marine Chemistry Laboratory, Marine Science Department, Faculty of Fisheries and Marine Sciences, Universitas Riau.

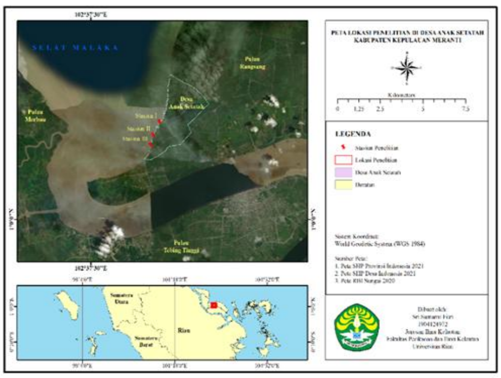

Figure 1. Map of research location

Method

The method used in this study is a survey method involving observing the research area and sampling *P. expansa,* which includes abundance, distribution patterns, and size frequency, and measuring water quality parameters, including temperature, salinity, and acidity (pH). Then, the samples were analyzed at the Marine Biology and Marine Chemistry Laboratory, Department of Marine Science, Faculty of Fisheries and Marine Sciences, Universitas Riau.

Procedures

Determining Research Locations

Research sampling points were determined using a purposive sampling method. According to Fachrul[13], purposive sampling is a sampling technique used when the sample to be taken has specific considerations, in this case, the determination of the sampling location based on habitat considerations and the distribution of Bivalve life almost evenly, where the determination of the research station can represent the intertidal zone of Anak Setatah Village waters as a research location.

The research location is divided into 3 (Three) stations: Station I is near the community settlement, Station II is near the local community fishing port activities, and Station III is near the community plantation area. At each station, 3 line transects were installed with a distance of 50 meters between transects. Then, each transect is installed in quadrant plots measuring 5 x 5 m² with a distance of 20 meters between zones. Each transect has three sampling points: 1. in the intertidal zone, namely in the zone of the highest tide (upper zone), 2. the zone between the highest tide and the lowest ebb (middle zone), 3. in the zone of the lowest ebb limit (lower zone).

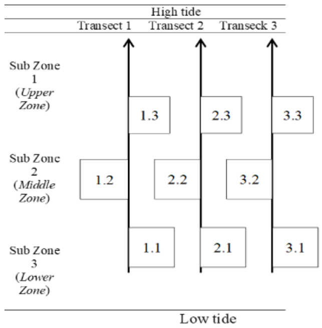

Figure 2. Transect and plot placement scheme at each research station

Measurement of Water Quality Parameters

Water quality measurements were taken at each sampling point in the waters of Anak Setatah Village. Data obtained from water quality measurements have a significant Influence on the population structure of *P. expansa.* Water quality measurements include temperature, salinity, and acidity (pH) to provide an overview of the water's condition at the time of the study.

The abundance of *P. expansa*

Samples of *P. expansa* that are obtained are then observed and counted to determine how many individuals are present; the abundance of *P. expansa* can be calculated using the formula[14]:

$$K = \frac{N}{A}$$

Description:
K = Species abundance (ind/m^2)
N = Number of individuals of a species
A = Plot area (Ha)

Distribution Patterns of *P. Expansa*

Bivalve distribution patterns tend to cluster with low species diversity but moderate species uniformity due to competition between species fighting for food and space, and differences in response between Bivalve species adapting to their environment[15]. To see the distribution pattern at each station, the Morisita Distribution Index (Id) is used, which refers to Brower et al.[16]:

$$Id = n\frac{\sum x^2 - N}{N\,(N - 1)}$$

Description:

Id	=	Species distribution index
n	=	number of sampling units (plots)
x^2	=	number of individual species in each plot
N	=	The total number of individual species from all plots

With assessment criteria based on Kamalia et al.[17].; Id = 1: Indicates a random or random distribution pattern (R); Id > 1: Indicates a clumped or grouped distribution pattern (C); Id < 1: Indicates a regular uniform distribution pattern (U)

Size Frequency

To get the size class of *P. expansa* found, the interval class is made according to Nugroho et al.[18], with the formula:

Range (J) = Maximum - Minimum value

Number of intervals (k) = 1 + 3,322 log n

Class interval width (c) = (k) / (c)

Description:

k	= number of classes
n	= number of data points
J	= Range
C	= Length of interval

Sediment Sampling

Sediment samples were taken at the exact location where *P. expansa* was sampled. Sampling was conducted at low tide using a 10 cm diameter pipe; the substrate was collected by inserting the pipe into the substrate to a depth of 5 cm. Sediment samples were taken in quantities of approximately 500 g, then placed in labelled plastic samples and stored in an ice box for transport to the laboratory for analysis. The sediment type is reinforced with a Shepard's triangle.

Sediment Organic Matter Content

According to Heiri et al.[19], the loss-on-ignition method is used to analyse the organic matter content of sediments. The following procedure analyses organic matter content using the loss-on-ignition method. The following formula calculates the organic matter content.

$$\text{Total Organic Matter} = \frac{(a\text{-}c)}{a\text{-}b} \times 100\%$$

Description:

a	=	Weight of cup and sediment sample before burning or after drying (g)
b	=	Weight of cup (g)
c	=	Weight of cup and sample after burning (g)

Data Analysis

Data obtained from sampling are presented in tables and graphs, and then discussed descriptively with the conditions of the research site. The abundance of *P. expansa* was processed using Microsoft Excel software. At the same time, statistical testing was conducted using the one-way ANOVA test to assess the difference in the abundance of *P. expansa* between stations and zones.

3. RESULT AND DISCUSSION

Abundance of *P. expansa*

The highest abundance is found at station II, which is 2,355 ind/ha, while the lowest abundance is found at station I, with an abundance of 1,111 ind/ha. This is due to the Influence of environmental factors such as the type of substrate and the availability of different organic materials at each station. Rajab et al.[20] also emphasised that the existence of bivalves is highly dependent on factors such as salinity, food availability, organic content, adaptability to environmental conditions, and ecological pressures, including predators. The high sediment organic matter content at each station is also due to the muddy substrate. Muddy substrates have a high organic matter content because they more easily accumulate organic matter.

Situmorang et al.[21] also argue that sediments containing finer fractions will collect significantly more organic matter than sediments containing coarser fractions, such as sand and gravel; some of these factors contribute to differences in the abundance of *P. expansa* at each station. More details on the difference in abundance of *P. expansa* between stations are shown in Figure 3.

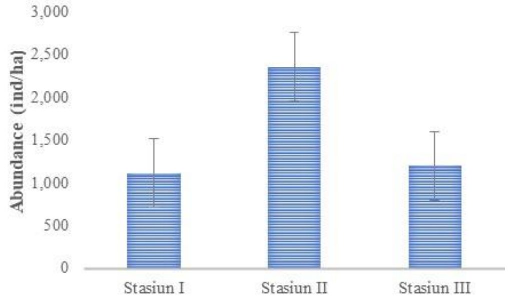

Figure 3. Average abundance of *P. expansa* (Ind/ha)

Based on the Figure 3, it can be seen that the results of the calculation of the abundance value of *P. expansa* have varying values at each station; the abundance data obtained have also been statistically tested using the One-Way ANOVA test where the sig value obtained is 0.004< 0.05, meaning that it can be concluded that there is a significant difference in abundance between stations. Meanwhile, the abundance of *P. expansa* in its zone is evident in Table 1.

Table 1. Average of *P. expansa* of each sub-zone in the mangrove ecosystem of Anak Setatah Village

Zone	Transect	Station			Average per zone ± Std. Dev
		I	II	III	
Upper	1	3	4	3	1,510 ± 0,025
	2	2	5	3	
	3	5	6	3	
Middle	1	2	6	5	1,777 ± 0,066
	2	3	7	3	
	3	3	8	3	
Lower	1	2	5	2	1,377 ± 0,250
	2	2	5	2	
	3	3	7	3	

Based on Table 1, the abundance of *P. expansa* in each sub-zone is highest in the middle zone, 1.777 ind/ha, and the lowest is in the lower zone, 1.377 ind/ha. This abundance is also due to the middle zone, where the factor of organic matter is one of the constituent components of the aquatic substrate, which is a pile of plant and animal remains; plant litter and animal carcasses on the ground surface will be decomposed by decomposing organisms into energy sources[22]. This situation is thought to increase the abundance of P. expansa in the middle zone compared to other zones.

Distribution Pattern

The distribution pattern of *P. expansa* in the Rehabilitation Mangrove Ecosystem of Anak Setatah Village is presented in Table 2.

Table 2. Distribution pattern of *P. expansa* between stations in the Rehabilitated Mangrove Ecosystem of Anak Setatah Village

Stasion	Id	Distribution Pattern
I	2,82	Clustered
II	2,95	Clustered
III	2,87	Clustered

As shown in Table 2, the calculation results for the distribution pattern between stations at the research location yield consistent findings, with Id > 1 indicating a clustered distribution pattern. Lokan's clustered distribution is due to the abundance of particular species dominating specific areas. This clustering Tendency is likely related to food acquisition strategies and low mobility, making it difficult for the species to disperse. Meanwhile, the distribution pattern across sub-zones is illustrated in Table 3.

Table 3. Distribution pattern *of P. expansa* between Sub-Zones in the Rehabilitation Mangrove Ecosystem of Anak Setatah Village

Zona	Id	Distribution Pattern
Upper	3,45	Clustered
Middle	3,38	Clustered
Lower	2,98	Clustered

According to Table 3, the calculation results for the distribution pattern across sub-zones at the research location also show consistent results, with Id > 1 indicating a clustered distribution pattern. According to Dalimunthe[23], substrate type, environmental conditions, reproduction methods, and feeding habits Influence the clustered distribution pattern. The clustered nature of an organism's behaviour demonstrates its ability to compete with other biota for food. Habitat type also significantly influences distribution patterns, including adaptability to the environment and the physicochemical components of the water body, as well as the availability of food sources.

Size Frequency of *P. expansa*

The results of measuring the size frequency of each *P. expansa* obtained ranged from 17.6 to 64.8 mm, with a total of 105 individuals and eight classes, resulting in a class interval of 5.9 mm. The frequency distribution of *P. expansa* size at each station is shown in Figure 4.

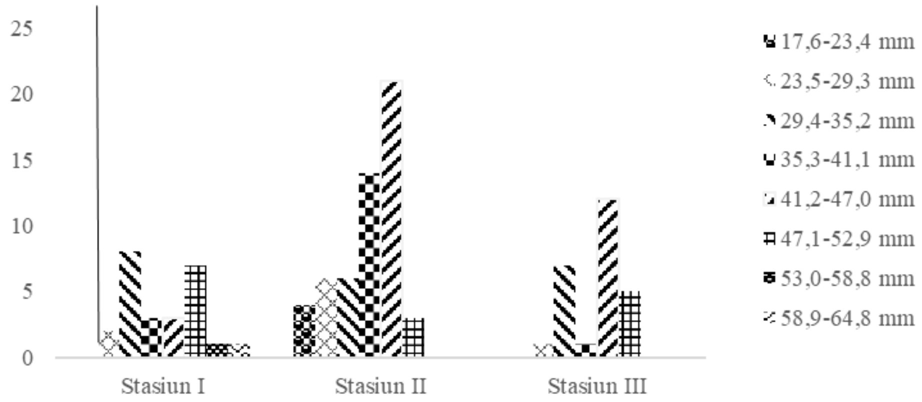

Figure 4. Frequency distribution of *P. expansa* size

Figure 4 shows that P. expansa is most commonly found at station I, specifically in individuals measuring 29.4-35.2 mm, with as many as eight individuals, while the smallest individuals measure 17.6-23.4 mm. Furthermore, for station II, a large number of individuals were found in the size range of 41.2-47.0 mm, with the least in the size group of 53.0-64.8 mm. Then, at station III, many were found to be in the size range of 41.2-47.0 mm, and the smallest was found in the same size range as at station II. Meanwhile, a comparison of the frequency distribution of *P.expansa* size across subzones is shown in Figure 5.

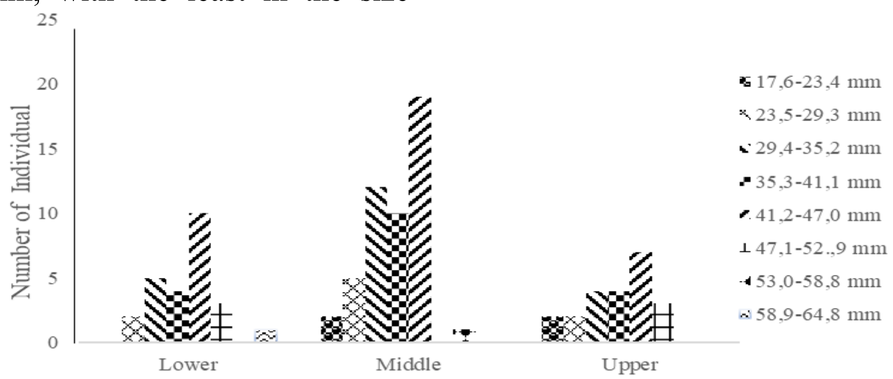

Figure 5. Frequency distribution of P. *expansa* size

The size frequency distribution obtained between zones shows differences between stations, which is known for the three zones. The most common individuals are those measuring 41.2-47.0 mm, while other sizes have different distribution ranges in each zone.

Water Quality Parameters

The measurement of water quality parameters is a significant factor influencing the metabolic activity, movement, growth, development, and spread of *P. expansa*. Temperature is an essential factor for living things, particularly in the aquatic environment, as it directly affects biota, including the rate of metabolism and reproduction[24]. Meanwhile, according to Akbar[25], temperature can affect the abundance value because if the water temperature is high, bivalves cannot live well, and vice versa. If the temperature is low, they cannot grow well either.

Bivalves are shellfish that can live well in waters with temperatures between 20 and 35^{0}C. The salinity obtained in the study was around 29-30 ppt. The salinity value obtained is still in good condition for bivalve growth; this is to the statement of Hawari[26], which states that the average salinity of 25-30 ppt is a salinity value that is suitable for shellfish habitat, the value of the salinity range of bivalves can survive, as well as the average pH value of the waters of Anak Setatah Village, which is 7, this value is still classified as suitable for lokan life. This is in response to the statement Effendi[24], which states that a pH value of 7.0-8.5 is ideal for bivalve development because a pH of less than 5 and greater than 9 creates unfavourable conditions for bivalves. The results of measuring the aquatic environment are presented in Table 4.

Table 4. Water quality measurements in the Rehabilitation Mangrove ecosystem of Anak Setatah Village

Station	pH	Temperature (^{O}C)	Salinity (‰)
I	7,3	29	30
II	7	29	30
III	7	28	29

Sediment Fraction Type

Based on the average results of sediment fraction analysis in the intertidal zone of Anak Setatah Village, it is evident that the composition of sediments varies between stations, as shown in Table 5.

Table 5. Results of sediment type analysis in the mangrove ecosystem of Anak Setatah Village

Stasion	Sampling Points	% Sediment fraction			Sediment Type
		Gravel	Sand	Mud	
I	Lower	1,54	2,11	96,35	Muddy
	Middle	1,73	1,58	96,69	Muddy
	Upper	1,59	1,25	97,16	Muddy
II	Lower	1,37	1,37	97,26	Muddy
	Middle	1,53	1,11	97,36	Muddy
	Upper	1,44	1,38	97,18	Muddy
III	Lower	1,50	1,27	95,94	Muddy
	Middle	1,65	1,21	97,15	Muddy
	Upper	1,16	2,23	96,61	Muddy

Table 5 shows that the sediment type of all stations in the intertidal zone in Anak Setatah Village is muddy. The highest percentage of mud sediment fraction is 97.36% at Middle Station II, and the lowest is 95.94% at Lower Zone Station III. Other factors that also Influence why the percentage of station II is higher are that the physical conditions of the mangrove ecosystem are still tight; sediment is an essential component that determines the life, diversity, and composition of the types of molluscs that live in it. Observations from the research show that the substrate in the intertidal zone of Anak Setatah Village is muddy. Dahuri's in Siregar[27] states that bivalves are biota commonly found in muddy substrates. Bivalves in high mud substrates can increase the abundance of bivalve organisms because bivalve organisms highly favour muddy substrate types.

Sediment Organic Matter

Based on the results of the analysis that has been carried out on all sediment samples, it can be seen that the organic matter content in sediments found at stations I, II, and III in Anak Setatah Village is shown in Table 6

Table 6. Organic matter content of sediment in the Rehabilitated Mangrove Ecosystem of Anak Setatah Village

Stasions	Sampling Point	organic matter content (mg/L)	Average organic matter content (mg/L) %
	Lower	7,12	
I	Middle	7,71	7,59
	Upper	7,95	
	Lower	8,07	
II	Middle	8,72	8,28
	Upper	8,08	
	Lower	7,24	
III	Middle	6,97	6,72
	Upper	5,95	

Based on Table 6, it can be seen that the sediment organic matter content at each research station has a diverse percentage. Each station's average organic matter content ranges from 7.59 to 8.28%; the highest organic matter is found in Station II, with a total rate of 8.28%, and the lowest organic matter content is in Station III, with a total rate of 6.72%. Organic matter is an indicator of environmental fertility both on land and at sea. The organic matter content on land reflects soil quality, while organic matter in water can be a quality factor in a body of water. Organic matter in a certain amount is beneficial for water, but if the amount that enters exceeds the carrying capacity, it can cause a decrease in water quality.

4. CONCLUSION

The results of the abundance of Lokan (*P. expansa*) in the rehabilitation mangrove ecosystem of Aanak Setatah Village reveal differences between stations and zones, with a moderate percentage of abundance compared to other studies conducted in different locations. The frequency of individual sizes found at the research site ranges from 17.6 to 64.8 mm in size; based on this size range, the frequency of individual sizes found is classified as large. The distribution pattern of *P. expansa* at each station and sub-zone has a clustering distribution pattern.

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