Diversity and Distribution Patterns of Gastropoda (Mollusca) in the Mangrove Area of Tiram Beach, Padang Pariaman Regency, West Sumatra Province

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Abstract

This study was conducted in March 2023 at Tiram Beach, Padang Pariaman Regency, West Sumatra Province. This study aims to determine the diversity and distribution patterns of gastropods in the mangrove area of Tiram Beach, Padang Pariaman Regency. The method used in this study was a survey method that involved direct observation of the study area, after which samples were analyzed in the laboratory. Gastropod sampling sites in the mangrove area were determined by targeted sampling consisting of 3 (three) stations at each station with three transects with 5 square plots of 1x1 m² spaced 10 m each. The results showed that the gastropod diversity in the Tiram Beach mangrove area was included in the low and medium categories. Gastropod distribution patterns at each station are categorized as clustered. Sediment organic matter in the Tiram Beach mangrove area achieved the highest average value of 4.52-22.13%. The sediment fraction at each station is silty sand and gravelly sand.

1. Introduction

Mangroves are a type of forest found in estuaries with swampy and dense bottom structures. Mangroves are one of the significant solutions for dealing with various environmental problems, especially for dealing with environmental damage caused by habitat destruction for animals. This damage not only affects animals but also people. Mangroves are a unique ecosystem along the coast or estuaries still influenced by sea tides. Sea tides can cause fluctuations in environmental factors, especially temperature and salinity (Feka, 2015). Therefore, the types of animals that can survive and thrive in mangrove areas have a high tolerance for environmental changes, such as gastropods.

Gastropods can live on land, in freshwater, and seawater. Gastropods are associated with the mangrove ecosystem as a habitat for living, shelter, and spawning and as a food supply area supporting their growth. Ecologically, gastropods play an important role in observing the state of the coastal regions. Since coastal waters are an area vulnerable to changes in environmental factors, both from various human activities and from nature itself, these changes are believed to affect the long-term conservation of gastropod habitats. According to Maturbongs & Elviana (2016), the existence of gastropods is vital for maintaining the ecological balance of coastal and mangrove areas because Gastropods play an important role in the breakdown of mangrove leaf litter and the mineralization of organic matter, especially herbivores and a detritivore.

Diversity is a combination of species richness and evenness in a single value or as the number of species among the total number of individuals of all existing species. Species diversity is the variety of organisms that exist on Earth. A community is said to have high diversity and is composed of many species with nearly the same abundance. Diversity is synonymous with the stability of an ecosystem. That is, if the diversity of an ecosystem is

relatively high, the state of the ecosystem is usually stable. Ecosystem environments with diversity disturbance are generally moderate; in the case of polluted ecosystem environments, species diversity is typically low. Conversely, if a community consists of a few species and only a few species are dominant, then species diversity is low.

The activities strongly influence the abundance of gastropods in the mangrove ecosystem, affecting gastropod survival, as live gastropods tend to become established with limited movement. The existence of different activities in the mangrove ecosystem will change the environmental conditions in which gastropods live. Changes influence the diversity and abundance of mollusk phylum gastropods in terms of environmental factors, such as temperature, salinity, type of substrate, and organic matter content in mangrove ecosystems. Environmental factors in an ecosystem affect the density, diversity, and distribution of the fauna, which is related to the diversity and density of gastropods (Ayunda, 2011).

Tiram Beach is one of the beaches in the coastal area of Ulakan Tapakis District, Padang Pariaman Regency. Along the Tiram Coast is a pristine mangrove ecosystem with diverse and productive marine mangrove species. This beach is a growing tourist attraction frequented by many tourists such as nature and culinary tourism. The Tiram Beach and its activities highly influence gastropods in an ecosystem, affecting the survival of live gastropods because live gastropods tend to settle down with limited movement. The existence of different activities in the ecosystem will change the environmental conditions in which the gastropods themselves live.

Much research has been done on the diversity and distribution of gastropods in mangrove ecosystems, including in the Pari Island Cluster of the Thousand Islands (Ayunda, 2011), in the mangrove coastal area of Kambapi Beach, Merauke Regency (Maturbongs & Elviana 2016) and the mangrove ecosystem of Apar Village, Pariaman City (Desmarina et al., 2022). There are differences in environmental factors in previous studies, so this study aims to provide information on the importance of knowing the diversity and distribution patterns of gastropods in an aquatic environment, especially mangroves, and the lack of information on the presence of gastropods in the mangrove area of Tiram Beach, Padang Pariaman Regency, West Sumatra province. The authors are interested in researching the diversity and distribution patterns of gastropods in the mangrove area of Tiram Beach, Padang Pariaman Regency, West Sumatra Province.

2. Methodology

2.1. Time, Place, and Materials

This research was conducted in March 2023. The sampling took place in the mangrove area of Tiram Beach, Padang Pariaman Regency, West Sumatra province. Became monsters analyzed in the Marine Biology Laboratory, Department of Marine Science, Faculty of Fisheries and Marine, Universitas Riau.

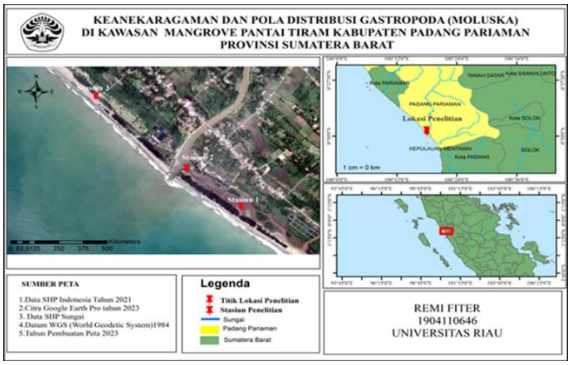

Figure 1. Research Location

2.2. Method

The method used in this study is a survey method; observations and measurements are carried out directly in the research area. Determination of research stations is done according to the method of purposive sampling, namely determining stations by selecting areas that represent observation sites based on coastal conditions and mangrove forests to see if there are differences in gastropod diversity between research stations. For this reason, 3 (three) observation stations were determined, which were considered representative of the study site considering the activities around Tiram Beach, Padang Pariaman Regency, West Sumatra Province.

2.3. Procedure

Gastropod Sampling

The gastropods' ebb sampling was performed using the line transect method, with a transect line length of ±50 m from the coast to the country. Three repetitions were performed at each station with transect line placed plots of 1x1 m² with a plot spacing of 10 m. Gastropods are gastropods attached to mangrove plants and

found on the surface of the sediment substrate. The obtained Gastropods were immediately placed in plastic bags and preserved with ice cubes. The sample is then tagged with a description of the station location, transect, plot, and sampling date and entered into an ice box to be taken to the lab for further analysis.

Overflowing Gastropods

The abundance of gastropods describes the amount of abundance in the community such that an abundance value is obtained that includes the number of individuals per unit area. Different ecological index formulas are used to determine the abundance of gastropods; namely, the abundance of a gastropod is expressed as the number of individuals/area. According to Browner & Zar (1984), the abundance formula is as follows:

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

Information:
In = occurrence of type i (ind/m^2)
ni = number of type i individuals obtained
A = Plot area of the type I found (m^2)

Relative Abundance

Relative abundance is calculated using the formula of Odum (1993), namely:

$$KR = \frac{ni}{A} \text{x} 100\ \%$$

Information:
KR = Relative Abundance
Ni = Number of individuals of the ith species
A = number of individuals of all species

Diversity

The diversity index mathematically describes the state of the gastropod population to make it easier to analyze the level of population diversity in a community. The diversity index used is the Shannon-Wiener index, which states that the Shannon-Wiener diversity index equation (Fachrul, 2007) is calculated using the following formula:

$$H' = -\sum_{i=0}^{s} pi\ Log_2\ pi$$

Description:
H' = Shannon-Wiener diversity index
pi = ni /N (proportion of i -th species)
ni = number of individuals of each type i
N = total number of individuals
S = number of species

With criteria: H`≤1 = Low species diversity; 1≤H′≤3 = Moderate species diversity; and H` ≥ 3 = High species diversity

Distribution Pattern

Follows calculated using the method of calculation with the Morisita index formula (Rani, 2003):

$$Id = N\ \frac{\sum X^2 - \sum x}{(\sum x^2)\ - \sum x}$$

Information:
Id = Morisita dispersion index
n = Total number of sampling units
ΣX = The total number of individuals in *N* plots
ΣX^2 = Square of the number of individuals per plot

With criteria: Id < 1 = Indicates a uniform distribution pattern right or even; arbitrary or arbitrary distribution pattern; clumped or clustered distribution pattern

Sediment Total Organic Substance Analysis

Sediment sampling for organic material is made with a PVC pipe with a diameter of 10 cm and a depth of 10 cm through the tube until it sinks into the sediment or substrate at stitches and the tube up again lifting.

BOT content analysis was performed using the Loss on Ignition (LOI) method. The LOI method aims to determine the total organic matter (organic carbon) content in sediments so that the deposition environment is known. The sediment occurrence process is based on the organic carbon content of sediment samples. This method is performed in the laboratory with an analysis process per 1 cm core sediment layer at a certain depth. The stages of total organic matter (organic carbon) analysis utilized the LOI method based on laboratory procedures at the University of Pittsburgh and determination (Allen *in* Sari et al., 2014) as follows:

$$\text{Li} = \frac{\text{Wo} - \text{Wt}}{\text{Wo}} \text{x}\ 100\%$$

Information:
Li = Loss on ignition
Wo = Initial weight (%)
Wt = Final weight

2.4. Data Analysis

Diversity and distribution patterns obtained in the form of calculations are presented in tables and graphs. The abundance

of gastropods is statistically analyzed using the statistical test (One-way Anova). In addition, calculations were performed using Microsoft Excel and the Statistical Program for Social Sciences (SPSS).

3. Result and Discussion

Water Quality Parameters

Water quality parameters were measured to see the state of the waters around Tiram Beach, Padang Pariaman Regency, while conducting the survey. The measurement results of the water quality parameters can be seen in Table 1.

Based on the calculations carried out, it appears that the quality of these waters can still be regarded as good for the growth and reproduction of gastropods. Environmental conditions are not always fixed and can change due to disturbances from human activities and from nature itself. Based on measurements at each station, it appears that the status of the Tiram Beach water is included in the good criteria according to PPLH number 22 years 2021.

Table 1. Measurement of Tiram Beach Water Quality Parameters

Parameter	Unit	Station I	Station II	Station III
Temperature	ºC	31	28	32
Salinity	‰_	28	24	26
pH	-	7	7	8

Sediment Total Organic Matter Content

The results of the organic matter content analysis of the sediments at Tiram Beach, Padang Pariaman Regency, West Sumatra Province, can be seen in Table 2.

Table 2. Total Organic Matter Content Sediments

Station	Intersection 1	Intersection 2	Intersection 3	Average	Std. deviation
I	27.34	17.36	21.67	22.13	±4.09
II	4.84	4.56	4.16	4.52	± 0.28
III	4.80 pm	16.92	13.47	15.73	± 1.60

Based on the analysis of the organic matter content in the sediments at the study site, it is classified as low to high fertility. The results of organic matter content measurements in the Tiram Coast mangrove area ranged from 4.52% to 22.13%. Organic matter is the material that makes up the substrate derived from the accumulation of plant and animal debris associated with falling into the substrate so that the area becomes fertile. The bottom substrate around the Tiram Beach is mixed with plant litter decomposition. According to Supriyantini et al. (2017), organic matter in water is an indicator of water quality because, scientifically, organic matter comes from the waters themselves.

The highest organic matter content was at station I. The high organic matter affected the abundance of gastropods at that station. This station has a kind of muddy sand sediment. As a result of some species of gastropods having a high abundance value to live and develop in large numbers in the mangrove area, it is suspected that this species prefers the environment around the mangrove as its habitat and can withstand competition for food and a place to live to win life compared to other species.

Sediment Type

Based on the sediment grain fraction analysis results at each station in Tiram Beach, Padang Pariaman Regency, West Sumatra Province, the substrate conditions are muddy sand and gravel sand, the preferred substrates for various gastropod species. The sediment type at each station is based on the gravel, sand, and silt proportion classified according to Sheppard's Triangle. The weight percentage of the sediment fraction and type is shown in Table 3.

Based on the measurement results of sediment types, the conditions between the stations are different, with the distribution of sand being higher than that of silt and gravel, presumably due to the different sedimentation processes. Based on the results of direct observations, the substrate conditions are muddy sand and gravelly sand, which are the preferred

substrates for various gastropod species in the mangrove ecosystem. The type of bottom sediment texture can indirectly influence gastropod life. In addition, the organic matter content of muddy sediments is higher than that of sandy sediments, which affects the abundance of gastropods (Pamuji et al., 2015).

Table 3. Percentage of Sediment Fraction

station	Intersection	Sediment fraction			Sediment type
		Gravel (%)	Sand (%)	Sludge (%)	
I	1	21.02	51.43	10.55	Mixture
	2	8.28	71.04	20.69	Muddy sand
	3	3.07	58.92	38:00	Muddy sand
II	1	0.96	88.50	10.54	muddy sand
	2	1.13	75.49	23.38	Muddy sand
	3	45.05	51.56	3.39	Pebble sand
III	1	36.64	61.72	1.64	Silica sand
	2	32.78	66.06	1.16	Pebble sand
	3	28.82	68.29	2.89	Pebble sand

Species of gastropods found in the Tiram Beach mangrove area, Padang Pariaman Regency, West Sumatra Province

Gastropoda species consisted of seven species found in all research stations, which consisted of the families Neritidae, Littorinidae, and Potamididae. The gastropod species found at the Tiram Beach research station are shown in Table 4.

Table 4. Species of Gastropods in the Mangrove Area of Tiram Beach, Padang Pariaman Regency

family	sex	Kind
Potamididae	pirenella	*Pirenella incision*
	Cerithidea	*Cerithidea stump*
Neritidae	Neritina	*Neritina turrita*
		Neritina semiconica
		Neritina auriculata
	Clithon	*Clithon corona*
Littorinidae	littorina	*Littorina scutulata*

The results of observing the species of gastropods in the Tiram Coast mangrove area during the survey yielded 7 (seven) species from three stations, namely *Pirenella incise, Cerithidea obtusa, Neritina turrita, Neritina semiconica, Neritina auriculata, Clithon corona,* and *Littorina scutulata.* Gastropods are common in different environments and are usually adapted to these environments. Some gastropods live on muddy ground or puddles, some stick to roots or stems, and some live in tidal areas.

The Potamididae family is a gastropod with a wide distribution, starting from the mud's surface to the mangroves' trunk and roots. The Potamididae family is always present in any mangrove forest zone (anterior, middle, or posterior zone), with the highest species composition in the posterior zone of the mangrove forest. The results showed several epifauna species, namely *P. incise* and *C. stump*. Gastropods *P. incise* and *C. obtusa* are native gastropods of the mangrove ecosystem, and these species prefer muddy surfaces or areas of sizeable standing water.

The abundance of gastropods in the Tiram Beach mangrove area

The results of the abundance of gastropods found at each research station differed (Table 5).

Table 5. Abundance of Gastropods

station	Abundance (ind/m^2)
I	59.67±19.75
II	6.53±2.12
III	12.33±4.00

Table 5 shows that the highest abundance is at station I. The highest abundance of

gastropods is at station I. This is believed to be caused by a type of organism that can regenerate quickly, has a long lifespan, and can produce offspring quickly. These organisms can occupy a larger space to reproduce and develop.

The results of the calculation of the gastropod density in the Tiram Beach mangrove region show that the highest gastropod abundance was at station I, i.e., 59.67 ind/m^2, and the lowest abundance was at station II, i.e., 6,53 ind/ m^2. The high abundance value at station I was influenced by the high organic matter and muddy substrate due to the optimal habitat conditions for gastropod life so that gastropods could reproduce well. The low density of gastropods at station II is suspected due to unfavorable human activities, physical environment, and water chemistry that may cause differences in abundance. According to Nurracmi & Marwan (2012), mollusks are closely related to the availability of organic matter in the primary substrate. However, if the organic matter exceeds the reasonable threshold, the position of the organic matter is considered contaminated.

The abundance of gastropods in the Tiram Beach Mangrove area, Padang Pariaman district, West Sumatra, is caused by human activities, pressures, and environmental changes that can affect the number of species and structural differences of gastropods. This agrees with Susiana's (2011) density and distribution. Mollusks in nature, both gastropods, are influenced by various abiotic and biotic factors such as environmental conditions, food availability, predator predation, and competition. Masagcha et al. (2010) also explained that a species with the highest density indicates that the organism can occupy a larger space to develop more.

Diversity index values range between 0.47- and 1.28%. The diversity index at station III is 1.28%, where this figure falls into the medium species diversity category. The diversity index of station I is 0.47%, and station II is 0.94%, which falls into the low category. The results of the calculation of the diversity of each station are simplified and tabulated in Table 6.

Table 6. Gastropod Diversity Index

station	Diversity (H')	Category
I	0.47	Low
II	0.94	Low
III	1.28	Currently

The gastropod species diversity index at Tiram Beach, Padang Pariaman Regency, West Sumatra Province, and all three stations had low to moderate diversity. Diversity index values are low, namely at stations I and II, because the index values are low from station III, so the high and low diversity index values at stations I, II, and III are caused by the condition of the waters around the Tiram Beach, including disturbed and unstable waters caused by human activities such as tourism activities, household waste, agriculture, and industrial activities so that the gastropods found in the Tiram Beach area are less diverse. According to Budi et al. (2013), the increase and decrease in the number of gastropod species in the study area was influenced by human activities such as the uncontrolled capture of gastropods for consumption and decoration of aquarium ponds, resulting in a decrease in the number of species. Moreover, according to Bahari et al. (2020), the substrate is a critical component that determines the life, diversity, and composition of the species of mollusks that live in it.

Due to the low diversity of gastropods in polluted waters, only certain species, such as *P. incisa,* can live. This type can be found at any station, from good or bad water conditions. This indicates that *P.incisa* has a high adaptability, which allows it to be classified as tolerant. *P.incisa* can be used as a bio-indicator because many of them are found in clusters in the study area, such as in station I. Based on observations, *P.incisa* is attracted to muddy areas in mangrove areas and areas affected by anthropogenic influences.

A community is said to have high species diversity if it comprises many species with the same or nearly the same species richness. Conversely, species diversity is low if the community consists of very few species and only a few are dominant. The low diversity obtained in this study was caused by the presence of certain species that dominated the community, and the numbers of each species were not evenly distributed, so the value of the diversity index obtained in this study was low (Sartika, 2012). According to Nurfitriani et al. (2017), the high and low diversity index values are caused by several factors, including the number of species and acquired species.

The diversity index reflects the stability of a community. Values falling into the low and medium categories reflect that the community is

unstable and vulnerable to environmental changes (Yuliawati et al., 2021). Diversity index values at all stations are low, indicating that the condition of the Tiram Beach, Padang Pariaman District's mangrove ecosystem is that the number of species found is unbalanced.

Distribution Pattern of Gastropods in the Mangrove Area of Tiram Beach

The results of calculating the distribution index of gastropods in the Tiram Beach Mangrove area, Padang Pariaman Regency, West Sumatra Province, ranged from 5.54 to 10.94; each station generally grouped this. Gastropod distribution patterns at each station in Tiram Beach, Padang Pariaman Regency, can be identified using the Morisita Index. The study results obtained are shown in Table 7.

Table 7. Distribution Pattern of Gastropods

station	Id	Distribution pattern
I	10.94	group
II	6.44	group
III	5.54	group

The distribution pattern is clustered based on the general analysis of the distribution pattern of gastropods at each station. The distribution pattern at stations I, II, and III is included in Id > 1 = Shows a clumped or clustered distribution pattern. The clustered distribution pattern indicates that the organism or animal can only live in specific habitats with suitable environmental conditions for the organism to survive. Clustered distribution pattern According to Sukawati et al. (2018), the clustered distribution pattern is a pattern that is common in nature and difficult to displace. This may be due to the presence of food resources in these habitats.

Sumarto & Koneri (2016) added that this distribution pattern may occur due to food resources evenly distributed in their habitat. In addition, the distribution pattern in clusters is also caused by environmental conditions and how to reproduce. Physicochemical factors, substrate types, and even distribution of mangrove species such as *Rhizopora* sp and *Nypa fruticans* also influence the distribution pattern of the dominantly clustered gastropods. Referring to Supratman & Syamsudin (2018), the clustered distribution pattern may be caused by appropriate habitat conditions such as shelter and food and the interaction of males and females to carry out the reproductive process. In addition, it also makes it easier for individuals to interact with each other for different needs; factors caused by clustered distribution patterns in the mangrove area of Tiram Beach, Padang Pariaman Regency, are believed to be caused by environmental conditions suitable for the life of these organisms, such as the availability of food.

The vertical distribution of gastropods is dominated by the family group Potamididea of the *P.incisa* type. The epifauna of the family group Potamididae of the *P.incisa* type dominates the horizontal distribution of gastropods. This species is native to mangrove snails. Hasan et al. (2020) explained that the Potamididae family is always present in any mangrove forest zone (anterior, middle, or posterior zone), with the highest species composition in the posterior zone of the mangrove forest. The distribution of the Potamididea family can be found in almost every corner of the mangrove forest, from the outer edge to the part that borders the mainland.

However, several species spread in the back of the mangrove forest, namely the Neritidea family. This is suspected because the two families have a high tolerance for the drier parts of the forest compared to the other types of families. According to Hutama et al. (2019), the uneven distribution of gastropod species in each station indicates that specific habitats are favored by this biota or the presence of native and non-native fauna.

4. Conclusion

Based Gastropods in the mangrove area of Pantai Tiram, Padang Pariaman Regency, West Sumatra Province have 7 (seven) species, namely *P.incise, C.obtusa, N.turrita, N. semiconica, N.auriculata, C.corona, L. scutulata.* The value of diversity at each station is currently in the low category. The distribution pattern of gastropods as a whole at each station is clustered.

Based on this research, it is becoming suggested that further research is needed about the structure of the gastropod community in the mangrove area, as well as research on unpleasant other habitat parameters such as the sediment fraction in the gastropod habitat in the Tiram Beach mangrove area. It's too much to hope that the community around the Tiram Beach mangrove area and the tourists who come to the Tiram Beach mangrove area shall stay maintained so that the organisms living in the region live and stay.

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