Gastropod Community Structure in the Coastal Waters of Lalang Village Siak Regency

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Abstract

Class Gastropods is the largest class of the Phylum Mollusca. Changes influence the gastropod community structure in terms of environmental factors. This study was conducted in the coastal waters of Lalang Village, Sungai Apit District, Siak Regency, in June 2022, aiming to determine the structure of the Gastropod community, which includes species, density, diversity, uniformity, dominance, and distribution pattern, and water quality. Sampling using the line transect method was carried out at four stations. The study found eight species of gastropods; the gastropod density values obtained at each research station were 3.57-4.84 ind/m^2. The value of the gastropod diversity index (H') was categorized as medium, the gastropod uniformity index (E) was classified as high, and the dominance index value (C) indicated that there were no dominant species in the waters. The distribution pattern of gastropods between observation stations is clustered.

1. Introduction

Mangroves The beach is the area at the water's edge that is influenced by the highest and lowest tides. The beach is the boundary between the land area and the ocean area. This area has a diversity and abundance of organisms, one of which is gastropods, where the existence of gastropods is vital to maintaining the ecological balance of the coastal regions.

Gastropods are animals found in various habitats such as oceans, freshwater waters, and on land, and they have important ecological roles. The environmental function of gastropods is to balance the environment. Researchers in various countries use various methods to understand Gastropods, one of which is morphometric studies. Morphometric studies can describe changes in Gastropod physiology, which can then be used to determine the influence of the environment on Gastropod growth and development (Echem, 2017).

Environmental factors in an ecosystem will affect the density, diversity, and distribution of fauna living in it related to the structure of the gastropod community has an economic role that provides benefits for human life, including as a food source of animal protein such as *Bellamnya sumatraensis*, industrial materials for jewelry crafts and mixed ingredients for poultry food such as *Pomacea canacilita* In addition, Gastropods are organisms that can be used as aquatic bioindicators because they are sessile, which is a group of organisms that do not move much (Ansary, 2014).

According to Silaen et al. (2013), the density and distribution of gastropods are influenced by their habitat environment, food availability, predation, and competition. Ecological pressures and environmental changes, such as vegetation, can affect the density of these organisms.

Activities carried out in this zone threaten biota, especially gastropods, whose existence is significant in maintaining the ecological balance of coastal areas. Gastropods are one of the aquatic organisms that have an essential component in the marine ecosystem with high species diversity and spread widely in various marine habitats and ecosystems such as seagrass ecosystems, coral ecosystems, mangrove

ecosystems and sandy or muddy substrates (Rizkya et al., 2012) and are one of the biological aspects that play an important role in assessing the quality of a water body (Ridwan et al., 2016).

Around the waters of Lalang Village, various activities can cause pollutants, such as household and port pollution. These activities can interfere with the existence of organisms, especially gastropods, in the coastal waters of Lalang Village, which reduces and disrupts the ecological balance of coastal areas. In addition, various activities contribute to pollution in these waters, damaging the structure of the gastropod community and causing a decrease in water quality.

Research on the structure of the gastropod community in the waters of various regions has been carried out, including Marnis (2019) on Kasiak Island Beach, North Pariaman, West Sumatra, Sulastri (2018) in the Mangrove Ecosystem in Mengkapan Village, Sungai Apit District, Siak Regency, Riau Province. With limited information and data on the presence of gastropods in the monitored waters of Lalang Village, the authors are interested in researching the structure of the gastropod community in the coastal waters of Lalang Village, Siak Regency.

2. Methodology

2.1. Time, Place, and Materials

This research was conducted in June 2022. The research location was in the coastal waters of Lalang Village, Siak Regency (Figure 1). Gastropod identification and counting activities and sediment sample analysis were conducted at the Marine Biology Laboratory, Department of Marine Science, Faculty of Fisheries and Marine Sciences, Universitas Riau.

2.2. Method

The method used in this study is a survey method, namely direct observation of the research area and sampling and measurement of water quality parameters in the field. Parameters to be measured include gastropod species, abundance, diversity, uniformity, dominance, distribution patterns, water temperature, salinity, acidity, total organic matter and sediment type. Furthermore, the samples were identified and analyzed at the Marine Biology Laboratory of the Department of Marine Science, Faculty of Fisheries and Marine Sciences, Universitas Riau.

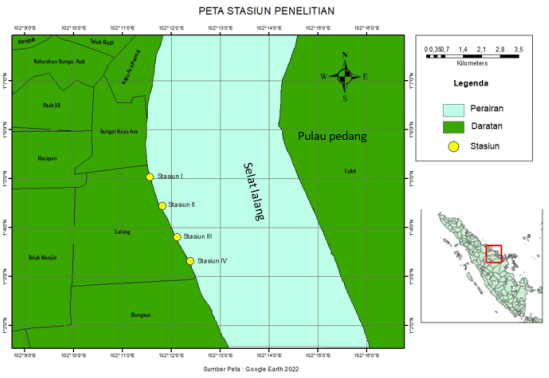

Figure 1. Research Location

2.3. Procedure

Gastropod Sampling

Gastropod samples brought to the laboratory were washed with fresh water, then gastropods were identified and grouped into trays labelled according to the station point. Samples were determined based on the shape obtained using the identification book of Carpenter & Niem (1998). Furthermore, the number of species obtained was calculated.

Gastropod abundance

According to Brower & Zar (1990), density was calculated using the following formula:

$$Di = ni / A$$

Description:

Di = The abundance of the i-th individual species (ind/m^2)

ni = Number of individuals of the i-th species obtained

A = Plot area of the i-th species found (m^2)

Gastropod Diversity Index

The gastropod species diversity index is based on the Shannon Wienner formula (Kasry et al., 2012) with the following formula:

$$H' = - \sum_{i-1}^{s} pi \, (\ln pi)$$

Description:

H' = Species diversity index

Pi = ni/N

ni = Number of individuals in the i-th

N = Total number of individuals

s = Number of species captured

Gastropod Diversity Index

The species uniformity index is calculated by the Shannon-Wiener formula (Krebs (1989) *in* Fajri, 2013), namely:

$$E = \frac{H'}{H'max} = \frac{H'}{\ln(s)}$$

Description:
E = Uniformity index
H' = Shannon-Wiener diversity index
s = Number of species

Dominance Index of Gastropods

The dominance index is used to determine the type of gastropod that dominates in an area, calculated using Simpson's formula (Kasry et al., 2012), namely:

$$C = \sum_{i=1}^{s} (ni/N)^2$$

Description:
C = Dominance index
ni = Number of individuals of each species
N = Total number of individuals of all species
s = Number of individuals captured

Distribution Pattern of Gastropods

Gastropod distribution patterns were calculated using the Morisita index formula (Krebs *in* Adi, 2013) as follows:

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

Description:
Id = Morisita distribution index
N = Number of sampling plots
Σx = Number of individuals per plot
$\Sigma x2$ = The sum of squares of individual plots

Fraction of Sediment and Total Organic Matter

Two methods were used to analyze the sediment fraction: the wet sieving method and the pipette method. The graded sieve method was used to obtain Ø-1 - Ø4, while for the pipette method, a volumetric pipette was used to obtain Ø5 - Ø7. Rifardi (2008) was used to analyze the sediment fraction type.

The concentration of total organic matter in the sediment was carried out with a formula that refers to Heiri *in* Prasetia (2019), as follows:

$$BOT = \frac{(Wt-C)-(Wa-C)}{Wt-C} \times 100\%$$

Description:
Wt = the total weight (crucible + sample) before burning,
Wa = the total weight (crucible + sample) after burning, and
C = weight of the empty crucible

3. Result and Discussion

Water Quality Parameters

The results of measurements of the aquatic environment of the physical and chemical parameters of the waters at the research site have salinity values ranging from 22-25‰ and pH ranging from 7 to 9.8. and temperature between 29-31 °C. The results of measuring the aquatic environment can be seen in Table 1.

Table 1. Water Quality Measurements in the Coastal Waters of Desa Lalang

Stasiun	pH	Temperature (^{O}C)	Salinity (‰)	Organic Matter (%)
I	7	29	22	8,21
II	8	30	24	9,08
III	9,8	31	25	7,40
IV	9	30	25	6,66

The pH value dramatically affects the water's biochemical processes and the diversity of aquatic biological communities. The pH value of the waters at each observation station is in the range of 6.5 - 6.6. According to Satria (2014), gastropods generally require water pH between 6.5 and 8.5 for survival and reproduction, so it can be concluded that the pH value at the three research stations is still tolerable for gastropod life.

Temperature is a significant factor in regulating the life of aquatic organisms. Dewiyanti (2004) stated that the existence of a species and the state of a community's entire life tends to vary with changes in temperature. From the measurement results, the temperature value ranged from 28.4-31.36 ^{0}C. This range of average temperature values is still relatively good for the life of Gastropods; this relates to what Odum *in* Satria (2014), that the range of temperatures suitable for the growth and

reproduction of Gastropods in general is 25-32 ^{0}C. Temperature also influences the diversity of gastropods. Temperature also influences the diversity, uniformity, and dominance of gastropods.

The salinity obtained at the research location is 22-25 ‰; this is suspected because the research location is in the strait area, so it has a small salinity. Salinity does not significantly influence gastropods because gastropods have a wide tolerance to salinity (Heryanto, 2006).

Sediment Types

The type of sediment that dominates in the coastal waters of Lalang Village is mud. The highest percentage is found at station I, 88.4% and the lowest at station II sampling point, 78.63%. The calculation of each percentage of fraction weight and sediment type at each station can be seen in Table 2.

Table 2. Percentage of Sediment Fraction (%) and Sediment Type

Station	Sediment Faction (%)			Sediment type
	Gravel	sand	Mud	
I	0,31	11,21	88,48	Mud
II	0,33	21,04	78,63	Mud
III	0,51	12,81	86,69	Mud
IV	1,99	19,11	78,91	Mud

Total organic matter in sediment (%)

The sediment organic matter content at each research station has a different percentage. The highest organic matter content is found at station I, with a rate of 8.21%, while the lowest is at station IV, with a rate of 6.66% (Table 2). Sitorus (2008) states that the criteria for high and low sediment organic content based on the rate as follows: <1% = very low; 1-2% = low; 2-3% = medium; 3-5% = high; >5% = very high.

According to Riniatsih & Widianingsih (2007), the high and low abundance values are supported by the percentage of organic matter content in the waters. This is thought to be caused by organic matter playing an important role in providing food sources for gastropod organisms.

Types and Abundance of Gastropods in the Coastal Waters of Lalang Village, Siak Regency

The gastropods consisted of six families, seven genera, and eight species. The gastropod families at all research stations consisted of Neritidae, Melongenidae, Littorinidae, Potamididae, Naticidae, and Muricidae. The most common species found was *Nerita undata* from the Neritidae family (Table 3).

The abundance of gastropods between stations in the coastal waters of Lalang Village was 2.56 - 4.67 ind/m^2. The highest abundance was found at station I, with 4.67 ind/m^2, while the lowest was at station IV, with 2.56 ind/m^2 (Table 3). Abundance is a relationship between space and the number of individuals. Abundance is expressed as the amount of biomass per sample unit, unit area/volume, or unit of capture (Maknun, 2017).

Table 3. Types of Gastropods Found

No.	Famili	Genus	Spesies
1.	Neritidae	Nerita	*Nerita undata*
2.	Neritidae	Nerita	*Nerita costata*
3.	Melongenidae	Volema	*Volema myristicai*
4.	Littorinidae	Littoraria	*Littoraria melanostoma*
5.	Naticidae	Natica	*Natica tigrina*
6.	Muricidae	Chicoreus	*Chicoreus capucinus*
7.	Potamididae	Cerithidea	*Cerithidea cingulata*
8.	Potamididae	Telescopium	*Telescopium telescopium*

Based on the results of the calculation analysis, the abundance of gastropods between stations in the coastal waters of Lalang village, Siak District, obtained the results of 2.56-4.67 ind/m^2. The highest abundance was found at station I, 4.67 ind/m^2. This is caused by mangrove vegetation that gastropods can use as a shelter from the waves. In addition, environmental factors that are still classified as good, unpolluted, and far from local community activities are among the factors that contribute to the high abundance at the station.

According to Fachrul (2007), environmental factors greatly influence the community and abundance of gastropods. Habitat conditions and the high level of human activity in the habitat strongly influence the existence of benthos (gastropods and bivalves). In addition, the abundance and distribution of gastropods are influenced by food availability, predation and competition. Biotic and abiotic environmental conditions strongly influence the

presence of gastropods in a water body. Environmental factors that can affect the presence of gastropods are temperature, salinity, pH, substrate, dissolved oxygen and brightness.

Table 4. Abundance of Gastropods

Station	Mean
I	4,67 ± 0,543
II	3,00 ± 0,318
III	2,67 ± 0,324
IV	2,56 ± 0,576
	3,22 ± 0,440

The abundance of gastropods between subzones in the waters of Lalang Village was also calculated, where the results obtained were 1.88-2.88 ind/m^2. The highest abundance was found in the Upper Intertidal Zone (ZIA) at 2.88 ind/m^2, while the lowest abundance was found in the Lower Intertidal Zone (ZIB) at 1.88 ind/m^2 (Table 4).

This is because the upper intertidal zone (ZIA) has sufficient food availability from organic matter that settles in this upper subzone, has a suitable substrate and a good habitat for gastropod protection from various threats in these waters. There are other environmental factors, so it is ideal for the survival of gastropod life.

Table 5. Abundance of Gastropods

Sub Zona	mean
Upper Intertidal Zone (ZIA)	2,88 ± 0,216
Mid Intertidal Zone (ZIT)	2,50 ± 0,176
Lower Intertidal Zone (ZIB)	1,88 ± 0,163
Average	2,42 ± 0,182

Gastropod Diversity, Uniformity, and Dominance Indices

The diversity index value (H') of gastropods between stations in the coastal waters of Lalang Village was found to be 0.89-1.45, with the highest diversity index value found at station I, namely 1.45 and the lowest diversity index value found at station IV, namely 0.89.

The uniformity index (E) between stations is 0.37-0.74, with the highest uniformity index value at station I, 0.74, and the lowest at station I, 0.37. The dominance index value (C) between stations is 0.27-0.45, with the highest dominance index value at station IV at 0.45 and the lowest at Station I at 0.27. Based on the data analysis obtained, calculations of diversity, uniformity, and dominance between stations in the coastal waters of Lalang Village can be seen in Table 6.

Table 6. Index of Diversity, Uniformity, and Dominance of Gastropods

Observation Stations	(H')	(E)	(C)
I	1,45	0,74	0,27
II	1,29	0,67	0,29
III	1,28	0,53	0,31
IV	0,89	0,37	0,45

Community structure parameters can be analyzed by looking at biological indices, namely diversity indices, uniformity and dominance of species (Leatemia et al., 2006). According to Saleky (2019), ecosystem environmental conditions are good if a high diversity and uniformity index and a low dominance index value are obtained. Yuniarti (2012) showed that the condition of the aquatic environment also affects the diversity, uniformity and abundance of gastropods.

The diversity index (H') of gastropods in the coastal waters of Lalang Village, Siak Regency, at each station obtained values ranging from 0.89 - 1.45. Station I has a diversity index value of 1.45, station II has a diversity index value of 1.29, station III has a diversity index value of 1.28, and Station IV has a diversity index value of 0.89. The diversity index, according to Fachrul (2007), is a vegetation parameter that is very useful for comparing various communities, especially to study the influence of environmental or abiotic factors on a community or to determine the succession and stability of the community. Following the gastropod species diversity index, which states $1.0 \leq H' < 3.0$, shows that the diversity criteria at Station I, station II and Station III are included in the category of moderate distribution of the number of individuals, sufficient productivity, ecosystem conditions are quite balanced, moderate ecological pressure and water stability has been moderately polluted. However, station IV is in the low diversity category because the ecosystem is under pressure or its condition decreases due to natural disturbances and human activities.

A community is said to have high species diversity if the community is composed of many species with relatively the same or almost the same abundance (Ernanto et al., 2010). Meanwhile, according to Rafsanjani (2013), a

community has high species diversity if it is composed of many species with the same abundance.

Conversely, if the community is composed of a few species and only a few species are dominant, then the species diversity is low. In a community with high diversity, species interactions will involve energy transfer (food webs), predation, competition, and the division of niches that are theoretically more complex. One of the causes of the moderate gastropod diversity index at the research site is that it has been captured by visiting tourists and some resident activities that reduce the quality of the number and types of gastropods.

The uniformity index (E) of gastropods in the coastal waters of Lalang Village for each station obtained values ranging from 0.37 -0.74. Station I has a uniformity index value of 0.74, station II has a uniformity index value of 0.67, station III has a uniformity index value of 0.53, and station IV has a uniformity index value of 0.37. Following the type uniformity index, which states $0.6 \leq E \leq 1.0$, it can be concluded that the uniformity at Station I, station II, station III and Station IV is in the high uniformity category.

According to Sirante (2011), if the uniformity index is close to one, then the organisms in the community show uniformity. Otherwise, if the uniformity index is close to zero, then the microorganisms in the community are not uniform. Meanwhile, according to Hendri (2014), if the value of E is close to 1 (> 0.5), it means that the uniformity of organisms in a water body is in balance. There is no competition for both place and food. The diversity and uniformity index value of biota in a body of water highly depends on the number of species in the community. The more species found, the greater the diversity and uniformity, although this value highly depends on the number of individuals of each species and vice versa.

The dominance index (C) of gastropods in the coastal waters of Lalang Village at each station obtained values ranging from 0.27 - 0.45. Station I has a dominance index value of 0.27, station II has a dominance index value of 0.29, station III has a dominance index value of 0.31, and Station IV has a dominance index value of 0.45, it can be concluded that there is no dominating species at the research location. The dominance index describes a species' dominance pattern over other species in an ecosystem community (Mawazin, 2013).

The higher the dominance index value of a species illustrates the pattern of control centred on certain species only or the community is more suitable for certain species. On the other hand, if the dominance index value is lower, it will illustrate that the pattern of control of species in the community is relatively spread among each species (Olivia, 2019). In addition, the low dominance of species indicates no dominating species, which means there is no significant competition for space, food, or living space for these organisms (Hermanses, 2018).

Distribution Pattern of Gastropods

The distribution pattern between observation stations obtained the results of 2.25 - 3.42, where Id> 1 means the distribution pattern is clustered. The calculation of gastropod distribution patterns between stations can be seen in Table 7.

Table 7. Gastropod Distribution Patterns.

Observation Station	Id	Distribution Patterns
I	2,25	Grouping
II	2,41	Grouping
III	2,64	Grouping
IV	3,42	Grouping

Several factors, including environmental conditions, substrate type, eating habits and production methods, affect the nature of this group. In addition, the way of life of biota in groups shows a strong tendency to compete with other biota, especially in terms of eating (Mardatila, 2016). According to Bahri (2006), the distribution pattern of biota is influenced by the type of habitat that includes physicochemical factors of water as well as food and adaptability of biota in an ecosystem. Distribution occurs in groups because it is influenced by habitats that provide sufficient food sources, so there is no competition and abundant numbers even though the food sources are the same. In addition, environmental factors such as temperature, pH, salinity and substrate are also in the optimal range to support the life and distribution of gastropods (Idrus et al., 2021).

Clustered distribution patterns are caused by limiting factors to the existence of a population. The grouping of a species is due to the tendency to defend itself from predators and other unfavourable factors. Distribution patterns

are very typical for each species and habitat type. The cause of the distribution pattern is due to differences in response to habitat. Clustering dispersal patterns with varying degrees of clustering are the most common form of dispersal because individuals in populations tend to form groups of various sizes.

4. Conclusion

The results showed that there were 8 (eight) species. Gastropod species found at all research stations consisted of *N. undata, N. costata,* V. *myristicai, L. melanostoma, C. cingulata, N. tigrina, C. capucinus, T. telescopium*.The abundance of gastropods between stations in the coastal waters of Lalang Village was 2.56-4.67 ind/m^2. The diversity index value (H') of gastropods was categorized as medium, the uniformity index value (E) of gastropods was classified as high, and the dominance index value (C) showed no dominating species in the waters. The distribution pattern of gastropods between observation stations is clustered.

References

Ansary, B.M. (2014). *Keanekaragaman Makrozoobenthos di Ekosistem Magrove Silvofishery dan Mangrove Alami Kawasan Ekowisata Pantai Bkoe Kecamatan Galesong Kabupaten Takalar.* Universitas Hasanuddin. Makassar.

Brower, J.E., & Zar, J.H. (1990). *Field and Laboratory Methods for General Ecology.* Brown Co-Publisher. Lowa.

Ernanto, R., Agustriani, F., & Aryawati, R. (2010). Struktur Komunitas Gastropoda pada Ekosistem Mangrove di Muara Sungai Batang Ogan Komering Ilir. *Maspari Journal*, 1(2): 73-78.

Fajri, N. (2013). Struktur Komunitas Makrozoobenthos di Perairan Pantai Kuwang Wae Kabupaten Lombok Timur. *Jurnal Educatio*, 8(2): 81-100.

Fachrul, M.F. (2007). *Metode Sampling Bioekologi.* Bumi Aksara : Jakarta.

Hendri, F. (2014). *Hubungan Kerapatan Mangrove dengan Kelimpahan Gastropoda Desa Sungai Alam Kecamatan Bengkalis Kabupaten bengkalis Provinsi Riau.* Fakultas Perikanan dan Ilmu Kelautan Universitas Riau. Pekanbaru.

Hermanses, E. (2018). Komunitas Gastropoda di Daerah Intertidal Pantai Likupang Kampung Ambong Kecamatan Likupang Timur Kabupaten Minahasa Utara. *Jurnal Ilmiah Platax,* 6(2):58-65.

Idrus, S., Alwi, D., Nurafni, N., & Kadafi, M. (2021). Keanekaragaman dan Pola Sebaran Gastropoda Ekosistem Lamun di Perairan Desa Pandanga Kabupaten Pulau Morotai Provinsi Maluku Utara. *Jurnal Laut Ilmu Kelautan*, 3(2): 80-89.

Kasry, A., Elfajri, N., & Agustina, R. (2012). *Penuntun Praktikum Ekologi Perairan*. Fakultas Perikanan dan Ilmu Kelautan Universitas Riau. Pekanbaru.

Kinasih, A.G. (2018). Studi Hubungan Struktur Komunitas Makrobenthos dengan Kualitas Perairan di Rumah Mangrove Wonorejo. Seminar Nasional Kelautan dan Perikanan. Tunjungan-Surabaya.

Mardatila, S. (2016). Kepadatan, Keanekaragaman dan Pola Distribusi Gastropoda di Danau Diatas, Kabupaten Solok, Provinsi sumatera Barat. *Jurnal Biocelebes,* 10(2):25-31.

Marnis, A. (2019). *Struktur Komunitas Gastropoda pada Zona Intertidal di Pantai Pulau Kasiak Pariaman Utara Provinsi Sumatera Barat.* Fakultas Perikanan dan Kelautan. Universitas Riau. Pekanbaru.

Mawazin, M. (2013). Species Diversity and Composition of Logged Over Peat Swamp Forest in Riau. *Indonesian Forest Rehabilitation Journal*, 1(1): 59 - 73.

Satria, M. (2014). *Keanekaragaman dan Distribusi Gastropoda di Perairan Desa Berakit Kabupaten Bintan.* Fakultas Kelautan dan Perikanan. Universitas Maritim Raja Ali Haji. Tanjungpinang.

Sulastri, D. (2018). *Struktur Komunitas Gastropoda pada Ekosistem Mangrove di Desa Mengkapan Kecamatan Sungai Apit Kabupaten Siak Provinsi Riau*. Fakultas Perikanan dan Kelautan. Universitas Riau. Pekanbaru.

Tyas, M.W. (2015). Identifikasi Gastropoda di Sub Das Anak Sungai Gandong Desa Kerik Takeran. *Jurnal Florea,* 2(2): 52-57