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Diversity and Abundance of Gastropods in the Seagrass Ecosystem in the Teluk Bakau Village, Bintan Regency, Kepulauan Riau Province

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ABSTRACT

The diversity and abundance of gastropods are related to the condition of seagrass. In Teluk Bakau Village, anthropogenic activities such as tourism and fish catching negatively affect the seagrass ecosystem. To understand the diversity and abundance of gastropods in that area, a study was conducted in January-March 2023. Sampling was carried out at three stations: in the area close to human inhabitants (S1), ecotourism area (S2), and in the area with no human activity (S3). In each station, there were three transect lines; in each line, there were five plots (1x1 m^2). Gastropod and seagrass samplings were conducted three times. Gastropods and seagrass were collected manually from each plot and then calculated and identified. Results showed eight species of gastropods and four species of seagrass. Abundance of Gastropods was 16.13 ind/m^2 in S1, 11.6 ind/m^2 in S2 and 50.53 ind/m^2 in S3. The most abundant gastropod in the study area was *Strombus canarium*, which was present in each station. The seagrass density ranged from 51-113.86 plants/$m^{2,}$ and the most common seagrass was *Enhalus acoroides*, found in each station. The results of a simple linear regression test on the relationship between seagrass density and gastropod abundance was R = 0.975 (very strong).

Keywords: Snail, *Enhalus* sp, *Strombus* sp, Ecotourism

1. INTRODUCTION

Bintan Island is a diverse area with coral reefs, seagrass beds, and mangroves. Malang Rapat Village, Teluk Bakau, Pengudang Village, and Berakit Village are seagrass diversity hotspots in the north and east areas of Bintan Regency. Teluk Bakau Village is a village in Trikora Beach area in Bintan Regency. The Trikora beach area is popular with tourists. Teluk Bakau Village has a beautiful white sand beach with beautiful rocks. The beach faces the South China Sea, and several coastal ecosystems are present, including mangroves, coral reefs, and seagrasses (Bestari, 2019).

Seagrass ecosystems play an important role in supporting sea life, serving as a food source and a habitat for marine biota. Seagrass is an essential ecosystem in coastal areas because it is a habitat for marine life, such as shrimp, small fish, and various types of sea slugs known as gastropods (Purba et al., 2018). Invertebrates that live in seagrass beds are classified as gastropods. As a result, seagrasses influence the presence of sea slugs (gastropods). Food availability, environmental conditions, and predators can influence the abundance of sea slugs (gastropods).

There is a connection between the gastropod snails that live in seagrass beds. These organisms play a role in the food chain cycle in seagrasses because gastropods are animals that eat the remains of organisms (detritus feeders). Human activities such as human settlements and tourism can disrupt seagrass ecosystems and the biota, particularly gastropods. The authors conducted research on Gastropod Diversity and Abundance in Seagrass Ecosystems in Teluk Bakau Village, Bintan Regency, Kepulauan Riau because activities in the area have the potential to disrupt seagrass ecosystems and living organisms, specifically gastropods.

2. RESEARCH METHOD

Time and Place

The study was carried out from January to March 2023 in Teluk Bakau Village, Bintan Regency, Kepulauan Riau, and the data was analyzed at the Marine Chemistry Laboratory of Raja Ali Haji Maritime University.

Method

Establishing research stations based on

activities found in seagrass areas in Teluk Bakau Village, Bintan Regency, Kepulauan Riau Province, used a purposive sampling method. The research area has been determined to be three (3) stations. Station 1 is a residential area, Station 2 is a tourist area, and Station 3 is a community activity-free zone.

Procedures

The line transect method was used to collect gastropods and seagrass samples. At low tide, sampling was repeated three times. The sampling method was hand-collected from each plot, and the quadratic plot measured 1x1 m^2.

Data Analysis

Primary data were presented in tabular or graphical form, such as species, gastropod abundance, seagrass density, diversity index, uniformity index, and dominance index. The relationship between seagrass density and gastropod abundance was tested using simple linear regression in SPSS version 23.0, and the data was then analyzed descriptively with the literature.

3. RESULT AND DISCUSSION

General Conditions of the Research Area

Waters at Teluk Bakau Village are geographically located in Bintan Regency, Kepulauan Riau Province. The water of Teluk Bakau Village is located at 1º31'30" LU 104º38'30" LS. It is bounded to the north by the village of Malang Prestasi, to the south by the village of Gunung Kijang District, to the west by the village of North Toapaya, and to the east by the South China Sea. Teluk Bakau Village covers an area of 11,200 ha.

Teluk Bakau is a coastal area with abundant land and ocean fishery potential. The coastal area is designated as a seagrass conservation area. Because seagrass serves as a nursery for marine biota, people rely on the capture fisheries sector for a living. Several types of biotas can be found in the seagrass ecosystem, including a type of sea snail (gastropod).

Type of Gastropod

The research in Teluk Bakau Village found eight different types of gastropods. *Strombus canarium, Canarium urceus, Naria eburnean, Turbo marmoratus, Polinices tumidus, Rhinoclavis aspera, Volegalea cochlidium,* and *Urosalpinx cinerea* were among the gastropods discovered.

Abundance of Gastropod

In the Teluk Bakau area, the abundance of sea slugs (Gastropods) ranges from 11.6 to 50.53 ind/m^2. The highest abundance of gastropods was found at station III (50.53 ind/m^2), while the lowest was at station II (11.6 ind/m^2) (Table 1).

Table 1. Abundance of Gastropods in Teluk Bakau Village, Bintan Regency

No	Type of Gastropod	Station		
		I	II	III
		(ind/m^2)		
1	*Strombus canarium*	27	18	219
2	*Naria eburnean*	0	13	97
3	*Turbo marmoratus*	53	91	129
4	*Polinices tumidus*	22	27	0
5	*Rhinoclavis aspera*	13	0	95
6	*Volegalea cochlidium*	20	25	0
7	*Canarium urceus*	14	0	83
8	*Urosalpinx cinerea*	93	0	135
	Total	16.13	11.6	50.53

Station III's high abundance of gastropods was because the waters were still relatively natural and were seagrass conservation areas with high seagrass densities. The dense growth of seagrass protects from predators, avoids direct sunlight, and produces organic matter that was used as a source of nutrition for gastropods. According to Pogoreutz et al. (2012), the high density of seagrasses allows gastropods to find shelter and food. Because of the density of rare seagrasses, gastropods are unprotected from predators and sunlight and do not provide food.

The low abundance of gastropods at Station II was suspected to result from tourism

and other human activities. The activity that entered these waters disrupts water quality, resulting in a low density of seagrasses, which provided no shelter from danger and food sources for gastropods. According to Nurjanah (2013), increased human activity will degrade water quality and significantly impact ecosystems, particularly types of sea slugs (gastropods) and seagrasses.

Type of Seagrass

Seagrass species found in the Teluk Bakau area included *Enhalus acoroides, Thalassia hemprichii, Syringodium isoetifolium,* and *Cymodocea rotundata*. Station I found two types of seagrass, *Enhalus acoroides* and *Thalassia hempariciissia hemparici*, while in Station II found three specieses, namely *Enhalus acoroides, Thalassia hempariciissia hemparici,* and *Cymodocea rotundata*. In Station III, the researcher found *Enhalus acoroides, Thalassia hempariciissia hemparici, Syringodium isoetifolium,* and *Cymodocea rotundata*.

Density of Seagrass

Teluk Bakau Village had four types of seagrasses with densities ranging from 51 to 113.87 ind/m^2 for 218 ind/m^2. Station 3 had the highest seagrass density, measuring 113.87 ind/m^2. Station II had the lowest density, measuring 51 ind/m^2 (Table 2).

Table 2. Seagrass density in Teluk Bakau Village, Bintan Regency

No	Type of Seagrass	Station			Seagrass Density
		I	II	III	
		ind/m^2			
1	*Enhalus acoroides*	23,6	25,53	30,73	79,86
2	*Thalassia hemparicii*	29,9	0	26,8	56,66
3	*Syringodium isoetifolium*	0	10,6	27,2	37,8
4	*Cymodocea rotundata*	0	14,6	29,13	43,73
Total		53,5	51	113,86	218

Diversity Index (H'), Uniformity Index (E), Dominance Index (C)

According to the findings, the gastropod diversity index values in Teluk Bakau waters ranged from 1.93 to 2.50. Station III had the highest number index of 2.50, while Station II had the lowest number index of 1.93. Figure 1 shows the value of the diversity index.

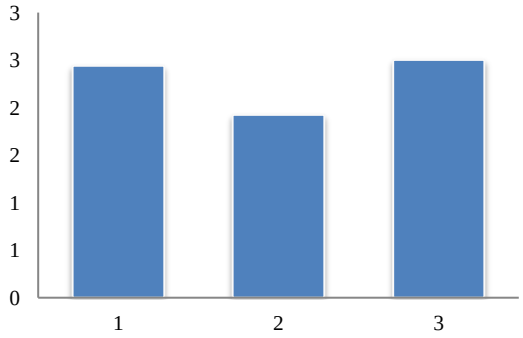

Figure 1. Value of diversity index (H')

The high diversity index value at Station III is thought to be due to the high organic matter (5.715%) and seagrass density (113.87 ind/m^2). Dewi et al. (2014) confirmed that the amount of organic matter in the sediment strongly influences the population of bottom organisms. The abundance and diversity of organisms supports organic matter-rich sediments.

Meanwhile, tourism and some community activities contributed to low diversity at station II. The pressure on these waters caused gastropods to find a safe place. According to Gea et al. (2020), the cause of the low species diversity index of sea snails (gastropods) is due to community activities in collecting gastropods for consumption or commercial purposes, reducing the quality, number, and types of sea snails (gastropods). The gastropod diversity index ranged from 0.72 to 0.97. The highest uniformity index was 0.97 at station III, and the lowest was 0.72 at station II.

Figure 2 shows the uniformity index values at the three high-ranking stations. This was concluded because the obtained uniformity index values ranged from category e > 6, indicating high species uniformity. Saptarini (2010) states that if the homogeneity value is close to one, it suggests that each member of the species present in the community is in reasonably good condition. This shows that the distribution of each species was relatively high, even though some types of gastropods were

found in more significant numbers than others.

Odum (1993) supports this by stating that a high category uniformity value indicates a high degree of species similarity, corresponding to a lower abundance of each species. This showed an interaction between biotic and abiotic components at the study site, which influenced the index of gastropod uniformity.

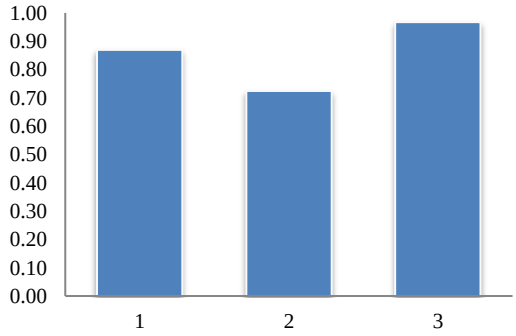

Figure 2. Value of uniformity index (E)

The domination index of gastropods in Teluk Bakau Village waters ranged from 0.19 to 0.33. As shown in Figure 3, station III has the lowest advantage index of 0.19, while station II has the highest dominance index of 0.33

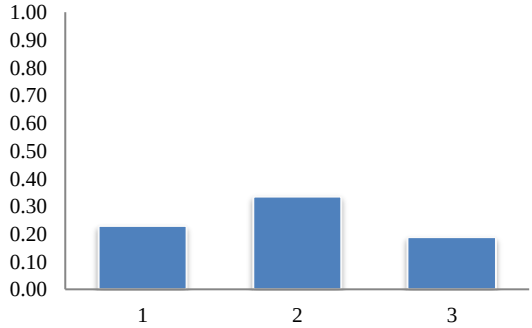

Figure 3. Value of dominance index (C)

Figure 3 shows the dominance index value for sea snail (gastropod) species in Teluk Bakau Village waters, which is less than or close to 0. According to Simpson in Sipahutar (2016), neither species dominates when the dominance index value is close to 0 (0.5). This is shown by the fact that no single type of gastropod dominates, despite numerous species such as *Strombus canarium* and *Turbo marmoratus*.

Saripantung (2013) states that the presence or absence of dominance if the environment is supportive provides plenty of food and favourable physical conditions to support the growth of specific species. The degree to which different species adapt to their environments also contributes to dominance.

Water Quality

Temperature measurements in Teluk Bakau waters ranged from 29 to 30°C. The highest water temperature was found at stations I and III, 31°C, and the lowest at stations II, 29°C. According to Ayunda (2011), the temperature range that gastropods still accept is 25-32°C. This shows that the temperature range in the study site is suitable for the survival of gastropods and the growth of seagrasses.

The result of measuring the degree of acidity in Teluk Bakau waters was 7. According to Persulessy & Arini (2018), the optimum pH for sea snail (gastropod) survival ranged from 6.5 to 8.5. This shows that the acidity (pH) level in Teluk Bakau Village waters was considered suitable for the survival of gastropods and seagrasses.

Salinity measurements showed that the salinity value in Teluk Bakau waters was, on average, 32-35‰. The salinity at stations I and III was 33‰. Another example of salinity at station II was 32‰. The low salinity at Station II was due to residential areas, which caused water flow from upstream during low tide, allowing more wastewater to enter the waters.

According to measurements, dissolved oxygen levels in Teluk Bakau waters range between 6.4 and 7.9 mg/L. According to the Minister of Environment Decree No. 51 of 2004, the standard for the quality of dissolved oxygen required for the survival of marine biota was more significant than 5 mg/L. As a result, a conclusion can be made as to whether the dissolved oxygen value at the three stations in the Teluk Bakau Village waters met the good criteria.

Station I contained mud (14.75%), gravel (9.99%), and sand (75.26%), station II contained mud (15.19%), gravel (11.97%), and sand (72.84%), and station III contained mud (12.71%), gravel (5.15%), and sand (82.14%). According to the measurement results, the waters of Teluk Bakau Village had a higher percentage of sand-type substrates. Overall, the environment in which gastropods live was suitable because it generally consisted of a substrate of sand and sand mixed with silt, which contained many natural sources of ingredients that can be used for food. In a study by Dewi et al. (2014), the state of the seabed influenced the growth of the mollusc community. Gastropods preferred a slightly silty substrate.

Meanwhile, the total organic material of the Teluk Bakau seagrass ecosystem ranged

from 4.962 to 5.715%. Station III had the highest organic material, 5.715, while Station II had the lowest organic matter, 4.962%. The total organic material is presented in Table 3 below based on the analysis results.

Table 3. Total of Organic Materials in Teluk Bakau Waters

Station	Total of Organic Materials (%)
I	5,501
II	4,962
III	5,715

According to Table 3, station III has the highest organic matter content. The high organic material content at the station was most likely due to seagrass litter settling to the bottom of the water over time. The litter then decomposed, releasing nutrients required for seagrass growth. With activities that generated natural materials for gastropods to use as food. The complexity of seagrass ecosystems, as well as the numerous sources of food from organic deposits originating from rotted seagrass litter and broken stems and leaves, were essential factors (Istiqlal, 2012).

The Relationship between the Seagrass Density and the Gastropods Abundance

Simple linear regression analysis yielded a simple linear regression equation, y = -5.305 + 0.578x (Figure 4). Figure 4 shows a correlation between the seagrass density and the gastropod abundance in the Teluk Bakau waters. R = 0.975 (the relationship strength was classified as very strong). In a sense, if the condition for the value of x (seagrass density) declines, so will the value of y (gastropod abundance).

The determination of $R^2 = 0.95$ value then stated that only 95% of seagrass density affects gastropod abundance, and the remaining 5% was influenced by other visible factors such as human activities such as tourism and seagrass conservation, which could disrupt seagrass and gastropod ecosystems. There were also activities from settlements that caused waste to enter the waters, causing changes in water quality and affecting the growth of seagrass and the survival of gastropods.

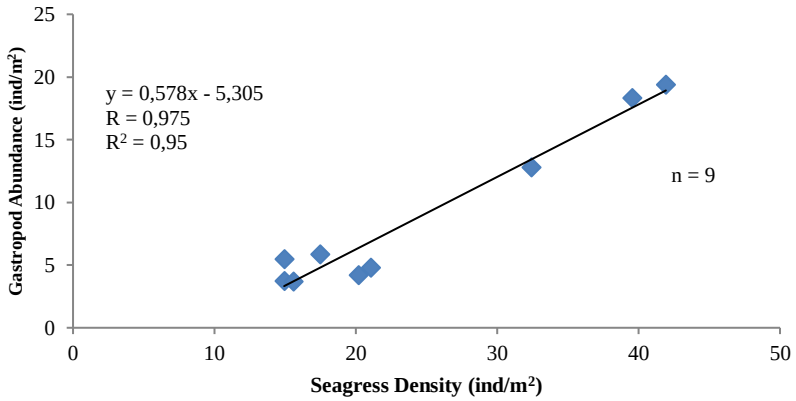

Figure 4. Relationship between seagrass density and gastropod abundance

4. CONCLUSION

The study concludes that eight types of gastropods were found in the seagrass ecosystem of Teluk Bakau waters, namely *S.canarium*, *N.eburnean*, *T.marmoratus*, *P. tumidus*, *R.aspera*, *V.cochlidium*, *C.urceus*, and *U.cinerea*, with an average abundance ranging from 15.8 to 62 individual/m^2. Gastropods in Teluk Bakau had a moderate species diversity that was evenly distributed, with no single species dominating. *E.acoroides*, *T.hempariciissia*, *S.isoetifolium*, and *C.serrulata*, were the four types of seagrasses, with densities ranging from 56.4 to 113.87 ind/m^2. The simple regression test results showed a strong relationship between seagrass density and gastropod abundance.

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