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POPULATION STRUCTURE OF *Cerithidea obtusa* (GASTROPODA) IN THE INTERTIDAL ZONE OF THE EASTERN COAST BENGKALIS ISLAND RIAU PROVINCE

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ABSTRACT

This research investigates the population dynamics of the gastropod *Cerithidea obtusa* along the eastern intertidal zones of Bengkalis Island, focusing on species abundance, spatial distribution, and size variation. Conducted over the span from December 2023 to January 2024, this investigation took place at two specific locales on the east coast of Bengkalis Island: Sekodi Village (Station I) and Teluk Lancar Village (Station II), employing a comprehensive survey methodology. The intertidal zones were segmented into upper, middle, and lower subzones, each with three transects containing one m² plot. Temperature, salinity, pH levels, substrate composition, and organic matter content were measured as indicators of the quality of the environment. The results revealed a significant difference in population density between the stations, with Station I showing the highest abundance at 240.000 ind/Ha and Station II the lowest at 33.300 ind/Ha. The middle subzone at Station I was the most populated, with 93.300 ind/ha. Shell size analysis revealed three categories: small (<3,35 mm), medium (3,35-4,05 mm), and large (≥4,05 mm), with medium-sized shells being the most prevalent. The distribution pattern of *C. obtusa* exhibited both uniform and clustered arrangements. A significant disparity in abundance was noted between Station I and Station II, with a p-value of 0,000, underscoring the considerable variation in population density between the two locations.

Keywords: Bengkalis Island, Gastropoda, Population Structure

1. INTRODUCTION

Intertidal biota tends to experience a decrease in diversity and population in some areas due to natural and human factors. A natural factor that influences this is the tides that cause changes in water quality. The length of immersion by tides in the intertidal zone caused *C. obtusa* to decline. A small number of *C. obtusa* usually occupies the upper subzone because it is the highest tide with a lower submergence rate than the middle and lower subzones, which have a longer submergence rate during the ebb tide. These gastropods are often found in the wettest places at the lowest low tide. The substrate they live on also tends to be muddy rather than sandy[1]. Human activities, particularly those carried out by companies and individuals, can significantly impact the population of *C. obtusa* and its distribution in the waters. These activities include the collection of diverse biota from the intertidal ecosystem for use as souvenirs, as well as over-catching without considering the number and size of the caught organisms. Such practices can lead to a decline in the population and abundance of *C. obtusa*.

The eastern coast of Bengkalis Island, especially Sekodi Village and Teluk Lancar Village, is a known location for *C. obtusa* gastropod populations directly facing the Malacca Strait. In this area, the capture of *C. obtusa* as a source of protein or widely consumed by the surrounding community

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can be expected to reduce the number of populations in their natural habitat.

There is limited information about the gastropod *C. obtusa* and its population structure, so this research was conducted to determine its population structure in the intertidal zone of the eastern coast of Bengkalis Island. With this information, future utilization management can be done correctly, and *C. obtusa* gastropods can be preserved.

2. RESEARCH METHOD

Time and Place

The research was conducted from December 2023 to January 2024. The sampling location was in the intertidal zone of the eastern coast of Bengkalis Island, Riau Province (Figure 1).

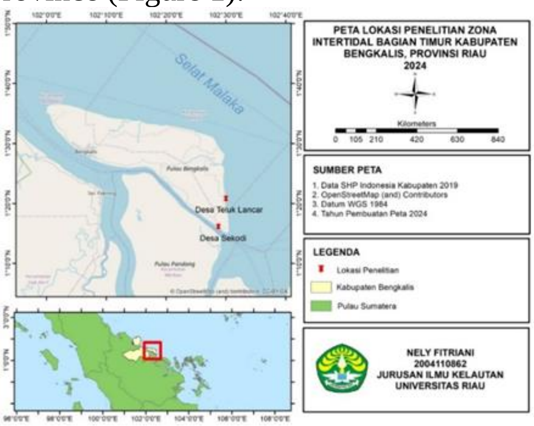

Figure 1. Map of the research location

Method

The method used in this research is the survey method, making observations and sampling directly in the field. The parameters to be measured in this study are abundance, size distribution, shell length, distribution pattern, substrate type, total organic matter content, and water quality, such as temperature, salinity, pH, and current speed.

Procedures

Determination of Sampling Locations

The research plotting technique was purposive sampling. Stations were determined based on site surveys and the area's characteristics by considering the study area's conditions and circumstances. The research was conducted in the intertidal zone of Sekodi Village (Station I) and Teluk Lancar Village (Station II) on Bengkalis Island. Both locations are known as areas where *C. obtusa* is still present. Samples were taken in the intertidal zone by dividing the intertidal zone into 3 (three) subzones, and those are: 1). upper intertidal zone, 2). middle intertidal zone, and 3). lower intertidal zone. Each research station has 3 (three) transects, each consisting of 3 (three) subzones. The width of each subzone was ±100 meters. Sampling was conducted using the 1 x 1 m^2 plot method (Figure 2).

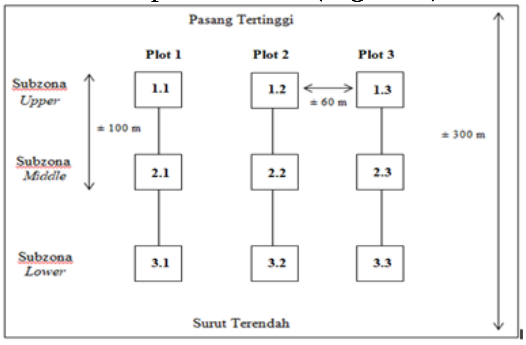

Figure 2. Schematic of plot placement in subzones

Collection and Handling of *C. obtusa* Samples

Sampling of *C. obtusa* was conducted at the lowest tide in each subzone with a plot size of 1 x 1 m^2, taken using a small shovel and then put into a benthic sieve to separate sediment and *C. obtusa*. The obtained *C. obtusa* samples were placed into plastic bags labeled based on the transects and previously determined plotsore. The tank and plot are put into an ice box filled with ice and then taken to the laboratory for analysis.

Sample Analysis of *C. obtusa*

Samples of *C. obtusa* found were taken to the biology laboratory for further identification. The procedures for sample analysis are: 1) *C. obtusa* samples obtained were grouped according to subzone and Station; 2) *C. obtusa* samples were brushed and washed using clean running water. This was done to facilitate morphological identification. 3) The washed *C. obtusa* samples were then taxonomically identified

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with WoRMS guidelines and continued with descriptive morphological identification. 4) Then, *C. obtusa* samples were measured for length.

Shell Length Measurement of *C. obtuse*

Measurements of *C. obtusa* shells were made using a micrometer or a caliper. The part to be measured is the length of the shell[2] (Figure 3).

Figure 3. Measurement scheme of *C. obtusa* shell sample

The results of the shell length measurements were then divided into three categories: small, medium, and large.

Sediment Sampling and Handling

Sediment sampling at the lowest ebb is done using a shovel. The sediment is shoveled to a depth of 10 cm, then lifted and put into a plastic sample that has been labeled. A 500g sediment sample was taken from each subzone plot and pooled to represent each subzone. The samples were put into ice boxes to be taken and analyzed further in the laboratory. Sediment samples will be used to analyze sediment type and total organic matter.

Sediment Type Analysis

Two methods were used to analyze sediment types: the stratified sieving method and the pipette method. The stratified sieving method is to obtain the Ø-1-Ø4 sediment fraction, and the pipette method uses a goiter pipette to obtain Ø5- Ø7[3].

Sediment Total Organic Matter Content Analysis

Total sediment organic matter content was analyzed using the Loss on Ignition (LOI) method[4]:

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

Description:

TOM	:	Total Organic Matter
Wt	:	Total weight before furnace after oven
Wa	:	Total weight after furnace
C	:	Weight of empty cup

Data Analysis

The data obtained were tabulated into tables, depicted in graphs, analyzed descriptively, and compared with literature studies. Size analysis of *C. obtusa* was used to determine the abundance of *C. obtusa*, distribution patterns, and size distribution patterns of *C. obtusa* in the intertidal zone on the east coast of Bengkalis Island, Riau Province.

Abundance of *C. obtusa*

Analysis of the abundance of *C. obtusa* individuals per unit area (ind/m^2) is calculated using the formula[5]:

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

Description:

K	=	Species abundance (ind/m^2)
ni	=	Number of individuals of a species (ind)
A	=	Plot area (m^2)

Data analysis of the abundance of *C. obtusa* individuals in this study will be calculated in units of hectare area (ind/ha).

Shell Length Size Distribution of *C. obtusa*

The results of measuring the length of the *C. obtusa* shell were then separated into three size groups: small, medium, and large. The division of size groups is based on samples obtained in the field using the following formula:

$$C = \frac{X_n - X_1}{3}$$

Description:

C	= class interval
X_n	= greatest value
X_1	= smallest value
3	= constant

Distribution Pattern of *C. obtusa*

The distribution pattern of *C. obtusa* can be known using the Morista Distribution Index formula[6], which is as follows:

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

Description:

Id	=	Gastropod *C. obtusa* dispersal index
N	=	Number of plots
$\sum X$	=	Total number of individuals in n plots
$\sum X^2$	=	Quadratic number of individuals per plot

With the following criteria: Id < 1 (Uniform distribution pattern); Id = 1 (Distribution pattern is random); Id>1 (clustered distribution pattern)

Test of Difference in *C. obtusa* Abundance and Shell Size

Analysis of abundance between intertidal subzones on the East Coast of Bengkalis Island, Riau Province, used the one-way ANOVA statistical test followed by the LSD (Least Significant Difference) test if there were differences in abundance between intertidal subzones and analysis of abundance between stations used the t-test statistical test on the east coast of Bengkalis Island. The study results will be presented in tabular, graphical, and descriptive form.

3. RESULT AND DISCUSSION

General Conditions of Research Locations

Geographically and astronomically, the research location of the eastern coast of Bengkalis Island is part of Bengkalis Regency with the capital city of Bengkalis, which is one of 11 regencies/cities in Riau Province. Its territory covers the eastern coastal part of Sumatra Island. Bengkalis Regency has 11 sub-districts, 19 urban villages, and 136 villages, with an area of 7.773,93 km^2[7]. Geographically, the position of the Bengkalis Regency area is at 2°30'-0°17' N and 100°52'-102°10' E. The Bengkalis Regency consists of islands and mainland and has a coastal and marine area with a 446 km coastline. Sekodi Village and Teluk Lancer Village have murky water conditions with a slightly brownish color, and there are still many mangrove trees and calm water currents. The activities carried out by the community in the area include fishing.

Water Quality Parameters

When sampling was conducted, water quality parameters were measured to see the condition of the waters at the research site on the east coast of Bengkalis Island. The results of the measurement of water quality parameters can be seen in Table 1.

Table 1. Average water quality measurements

Station	Subzone	Parameters			
		pH	Temperature (°C)	Salinity (‰)	Current speed (m/s)
I	Upper	7	28,00	28,00	0,015
	Middle	6	27,00	27,00	0,01
	Lower	7	28,00	28,00	0,01
II	Upper	7	28,00	28,00	0,01
	Middle	7	28,00	27,00	0,01
	Lower	7	27,00	27,00	0,01

Based on Table 1, the water quality measurement results of Station I and Station II were obtained with pH ranging from 6-7, temperature ranging from 27-28˚C, salinity ranging from 27-28‰, and current velocity ranging from 0,01-0,15 m/s.

Sediment Type

The results of the analysis of the percentage of sediment types using the Sheppard triangle method on the east coast of Bengkalis Island can be seen in Table 2.

Table 2. Percentage of sediment fraction and sediment type

Station	Subzone	Sediment Fraction (%)			Sediment Type
		Gravel	Sand	Mud	
I	Upper	0,77	85,97	13,24	Sand
	Middle	0,05	4,96	94,96	Mud
	Lower	0,05	2,96	96,92	Mud
II	Upper	0,14	10,38	89,40	Mud
	Middle	0,06	47,73	52,17	Sandy mud
	Lower	0,04	66,83	33,06	Silty sand

Table 3. Average sediment total organic matter

Station	Subzone	TOM (%)	Average (%)
I	Upper	20,10	15,85
	Middle	18,75	
	Lower	8,71	
II	Upper	19,29	12,08
	Middle	16,19	
	Lower	0,78	

The results of the analysis of sediment organic matter content on the east coast of Bengkalis Island can be seen in Table 3. The average total organic matter content at Station I is 15,85%, and at Station II is 12,08%. The organic matter content on the eastern coast of Bengkalis Island ranges from 0,78-20,10%.

The results of the total organic matter analysis show that the highest sediment total organic matter content is found at Station I in the Lower subzone, which is 20,10%, and the lowest in the Lower subzone is 8,71%; at Station II, the highest organic matter is found in the Upper subzone which is 19,29% and the lowest is in the Lower subzone which is 0,78%.

Abundance of *C. obtusa*

The graphic of the average abundance of *C. obtusa* between intertidal subzones of the eastern coast of Bengkalis Island can be seen in Figure 4.

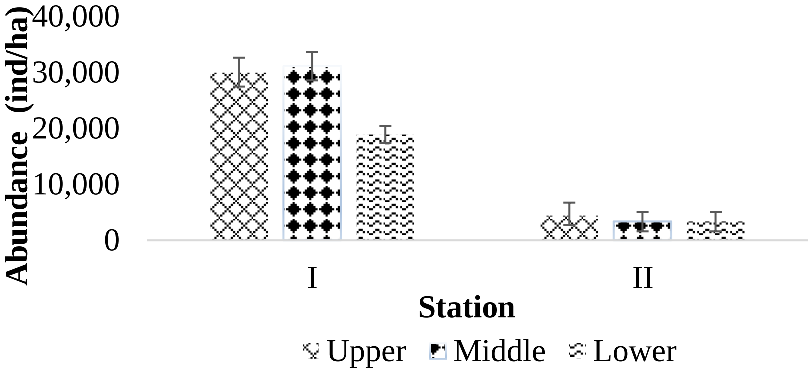

Figure 4. Abundance of *C. obtusa*

The number of individuals found in the intertidal zone of the eastern coast of Bengkalis Island was 82 ind, with an average abundance of 45.550 ind/Ha. The average abundance of *C. obtusa* Station I was higher than Station II, which amounted to 80.000 ind/ha for Station I and 11.100 ind/Ha for Station II. High and low abundance can be caused by environmental conditions, anthropogenic activities, competitors, and predators that can disrupt the survival of *C. obtusa*. The presence and abundance of gastropods are determined by several factors such as environmental conditions, food, predators, and competition[8]. The abundance value at Station I (Sekodi Village) is likely due to the favorable water conditions, slow current speeds, muddy substrates, and the presence of mangrove trees. These factors create a suitable habitat for *C. obtusa*, with minimal human settlements around the coast.

The low abundance of *C. obtusa* at Station II is likely due to the environmental conditions in that area. Station II is still covered with mangrove vegetation, which has been disturbed by the presence of a small harbor used by fishermen to anchor their ships. The low abundance of *C. obtusa* gastropods at Station II (Teluk Lancar Village) is known due to many fishing activities around the coast that can damage the environment, the presence of a small harbor, and a slightly sandy substrate that has larger pores than a muddy substrate which causes organic matter to be more easily carried away by currents and the large number of predators that inhabit the substrate so that competition occurs in nature.

The sediment type at Station I is mud; at Station II, it tends to be sandy mud. The average sediment organic matter at Station I is 15,85%, and Station II has an average organic matter of 12,08%. The abundance of *C. obtusa* can also be influenced by substrate and organic matter, which are food providers and stores for *C. obtusa*. The abundance of *C. obtusa* at Station I was significantly higher than at Station II, likely because *C. obtusa* tends to immerse itself in sediment. This preference leads to a greater favorability for muddy substrates than sandy mud substrates, as the smaller pores in mud substrates are more suitable for *C. obtusa*. Muddy substrates store many nutrients carried by currents and tides, so food availability at Station I is higher than at Station II. The Potamididae family resides in muddy substrates at the root base and is a detritus eater[9].

Sediment types that tend to be muddy have a higher organic matter content than other substrate types. Organic matter as a food source for *C. obtusa* can also indicate *C. obtusa* abundance. The higher the silt and clay content in the sediment, the higher the organic matter content will be[10]. The abundance of benthic organisms supports organic matter-rich sediments because organic matter is a food source for marine biota that live on the substrate, so their dependence on organic matter is very large.

The abundance of *C. obtusa* in the eastern intertidal subzone of Bengkalis Island was highest at Station I of the middle subzone at 93.300 ind/Ha and Station II of the upper subzone at 13.300 ind/Ha while the lowest was at Station I of the lower subzone at 56.700 ind/Ha and Station II of the middle and lower subzones at 10.000 ind/Ha. The prevalence of *C. obtusa* in the upper subzone is believed to be attributed to its substrate, which tends to be muddy, resulting in higher levels of organic matter. This subzone is located close to mangrove vegetation, which provides a significant food source.

Additionally, the upper subzone is shielded from ocean currents, allowing for the accumulation of food particles carried by these currents and those derived from mangrove plants. In contrast, the lower subzone is consistently exposed to ocean currents and experiences a limited food supply. This is primarily due to a slightly rough substrate, which facilitates the transport of nutrients by the currents. The quantity of organic matter significantly influences the distribution and abundance of gastropods in a substrate in it[11].

This difference could be due to various factors, such as differing environmental conditions between the stations, the range of the community, the presence of other dominant gastropod species, and the occurrence of prey and predators. The abundance value of *C. obtusa* in the intertidal zone of the eastern coast of Bengkalis Island, Station I, is high, with a range of 33.300-240,000 ind/ha. Based on research, the abundance of *C. obtusa* ranged from 31.600-501.600 ind/ha, research Defrianjeli[13] obtained the abundance of *C. obtusa* ranged from 750-3.400 ind/ha, and the abundance value obtained by Sirait et al.[14] in the intertidal zone of Cingnam River Village was 48.000-53.000 ind/ha. Abundance variations are believed to be influenced by various factors, including the surrounding habitat, food supply, and the presence of predators. Human activity is another factor that impacts the abundance.

The Distribution Pattern of *C. obtusa*

Based on the samples obtained in the field, the smallest shell length of *C. obtusa* is 2,65 cm, and the largest shell size is 4,75 cm. They are then grouped into three classes, namely small (<3,35), medium (3,35-4,05), and large (>4,05). The distribution of *C. obtusa* shell length between intertidal subzones of the eastern coast of Bengkalis Island is presented in Table 4.

Table 4. *C. obtusa* shell length

Size (cm)	Station I			Station II			Average		
	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
Small (<3,35)	6,00	4,00	3,00	0,00	2,00	0,00	3,00	3,00	1,00
Medium (3,35-4,05)	12,00	14,00	7,00	1,00	0,00	0,00	6,50	7,00	3,50
Large (>4,05)	9,00	10,00	7,00	3,00	1,00	3,00	6,00	5,50	6,00

Based on the findings of analyzing the size class of *C. obtusa*, it was observed that the shell length of individuals in the intertidal zone of the eastern coast of Bengkalis Island varied. At Station I, the highest number of individuals fell into the medium-size group, with 33 individuals, while the lowest number was in the small-size group, with 13 ind. The shell length at Station I varied among subzones, with the highest number of individuals in the medium-size group found in the middle subzone (14 ind) and the lowest number of individuals in the small group found in the lower subzone (3 ind).

The analysis of shell length distribution for *C. obtusa* collected at Station II reveals that the predominant shell size category is the large group encompassing 7 ind. In contrast, the group of medium size has the lowest number of specimens, with only 1 ind. Upon analyzing the shell length distribution across subzones at Station II, it becomes evident that the larger size group prevails in both the upper and lower subzones, with three specimens in each. In the upper subzone, only one specimen was discovered, representing the least represented group of medium size.

The distribution of shell length sizes in the intertidal zone of the eastern coast of Bengkalis Island reveals that the highest number of individuals is found in the medium-sized group, consisting of 34 ind. This is followed by the large-size group, which comprises 33 ind. The smallest number of individuals is observed in the small group, with only 15 ind. Within the studied subzones, it was observed that the highest shell length among individuals occurred in the medium-sized group within the Middle subzone, with 14 ind.

Conversely, the lowest shell length was found in the small size group within the Lower subzone, consisting of only 3 ind. From this explanation, it can be assumed that the relationship between shell length and the number of individuals has the same influence on the environment. The size of the shell length that dominates at Station I and Station II is classified into the adult category, which inhabits more in the intertidal zone than other sizes. The small group of *C. obtusa* is rarely found on the east coast of Bengkalis Island, and this is thought to be due to competition by predators (crabs and birds), where the smaller the size of *C. obtusa,* the greater the potential for predators to prey. Possible from supporting factors such as food, water conditions, predators, and competition, as well as external factors in the form of taking or utilization by the community as a source of food and livelihood that causes the size of *C. obtusa* in nature[15].

The eastern coastal area of Bengkalis Island, which has a type of substrate, tends to be muddy. The large amount of organic matter contained in muddy substrates can encourage the survival of *C. obtusa* in breeding. The growth rate depends on the local habitat so that C. obtusa can reach maximum length at two years, reaching gonadal maturity[15]. The eastern coast of Bengkalis Island is believed to have a suitable environment for *C. obtusa*. In addition, diet and age may also influence the size distribution of *C. obtusa* in an area. Dietary factors play a role where food affects the length and weight of an individual. Thus, a higher condition factor is obtained due to the size of the individual's weight, which is found on average to be large; factors that influence the condition of an individual are also the environment or habitat, food age, and sex of the individual. The more fertile the habitat environment is, the more significant the growth rate of an individual[16].

Distribution Pattern of *C. obtusa*

The distribution pattern of *C. obtusa* on the east coast of Bengkalis Island can be determined using the Morisita distribution index calculation. The results of the calculation of the distribution pattern of *C. obtusa* can be seen in Table 5.

Table 5. Distribution pattern of *C. obtusa*

Station	Subzone	Morisita Distribution Index (Id)	Distribution Pattern
I	Upper	0.982	Uniform
	Middle	0.976	Uniform
	Lower	0.926	Uniform
Average		0.985	Uniform
II	Upper	3	Clustering
	Middle	3	Clustering
	Lower	3	Clustering
Average		3	Clustering

From Table 5, the distribution pattern between subzones varies where the distribution pattern of *C. obtusa* at Station I Id < 1 shows a uniform or even distribution pattern and at Station II Id> 1 shows a grouped distribution pattern, so the distribution pattern of *C. obtusa* in the intertidal zone of the eastern coast of Bengkalis Island is uniform and grouped.

Based on the calculation of the Morisita index, it can be seen that the distribution pattern of *C. obtusa* in the intertidal zone of the eastern coast of Bengkalis Island is uniform and clustered. The distribution pattern of *C. obtusa* varies at each Station. This is believed to be because individuals within the population respond similarly to their habitat due to various factors, such as environmental conditions, substrate type, and reproduction methods. Excellent and stable environmental parameters, be it pH, temperature, and salinity, will cause gastropods to distribute in the water environment that best supports their survival. Gastropods that use deposit feeders or creepers filter food in the form of moss and litter attached to the rock substrate, and this can also shape the distribution pattern of the gastropod distribution itself[17].

Uniform distribution patterns are closely associated with environmental conditions, whether physical, biological, or chemical, indicating the presence of *C.*

obtusa in the study area. A uniform distribution pattern was observed at the Station. It can be inferred that the natural distribution of *C. obtusa* indicates a strong presence of competition, as the species strives to establish itself amidst the competition for food sources. The competition for food can be viewed from different perspectives. At Station I, the sediment is typically muddy with a high organic matter content and optimal water quality. These conditions make it an ideal breeding ground for *C. obtusa*, which may explain the uniform distribution pattern observed at this Station.

Uniform distribution occurs when environmental conditions are reasonably uniform throughout the area, and there is intense competition among individual members of the population for limited food and shelter. Fierce competition will encourage sharing the same space, so individuals tend to separate themselves[18]. Changes in the shape of an animal's distribution are often associated with changes in population size. Competition and high mortality rates will reduce population size and change distribution patterns. Factors that cause uniform distribution are negative individual interactions such as competition for food availability[19].

Clustered distribution patterns can be caused by several physical factors of water chemistry, as well as the availability of food so that gastropods can maintain themselves and reproduce well. The distribution is clustered due to habitats that can provide sufficient food, so there is no competition and abundant numbers despite the same food source. Besides, environmental factors such as temperature, pH, and salinity are also important for optimizing the life of gastropods. The sediment type of Station II, which tends to be sandy mud, is still included in the area favored by *C. obtusa*. The organic matter content is relatively low compared to Station I and has normal water quality. Clustering patterns occur due to differences in response to local habitat differences[20].

This condition is due to the collection of individuals in the face of weather and seasonal changes, habitat changes, and reproductive processes, thus increasing competition between individuals for food and space[8]. The way animals live in groups shows a solid tendency to compete with other animals, especially when it comes to eating. Cluster distribution patterns are closely related to environmental conditions, feeding, and reproductive habits. The distribution pattern of gastropods is clustered because the types of animals found in large numbers for each kind dominate an area[21].

4. CONCLUSION

The highest abundance of *C. obtusa* on the east coast of Bengkalis Island was found in the Upper subzone, and the lowest was in the Lower subzone. The frequency distribution of *C. obtusa* shell length was highest in the medium group and lowest in the small group of individuals. The frequency distribution of shell length between subzones is highest in the Middle subzone in the medium-size group and lowest in the Lower subzone in the small-size group. The distribution pattern of *C. obtusa* on the east coast of Bengkalis Island is uniform and clustered.

Based on the research that has been done, further research is needed on the relationship between the population structure of *C. obtusa* with community activities and competitors and predators in the aquatic environment.

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