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POPULATION STRUCTURE *Nerita articulata* (GASTROPODA) IN THE INTERTIDAL ZONE OF TELUK LANCAR VILLAGE BENGKALIS DISTRICT RIAU PROVINCE

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ABSTRACT

The population structure is a collection of organisms living in a particular area at a specific time and originating from the same species. The intertidal zone is between the sea's high and low tide lines, which have extreme ecological conditions. Several groups of organisms, including gastropods, can adapt to this environment. One type of gastropod that inhabits this area is *Nerita articulata*. This research was conducted in December 2023 in the intertidal zone of Teluk Lancar Village. The study aimed to analyze the population structure of *N. articulata* in the intertidal zone of Teluk Lancar Village, including population abundance, shell size frequency distribution, and distribution patterns. The research used a survey method. The intertidal zone is divided into three subzones: upper, middle, and lower. In each subzone, three quadrat plots measuring 1x1 m are placed. Environmental parameters measured include water quality, such as temperature, salinity, pH, substrate type, and organic matter. The research results indicate that the population abundance of this species varies, ranging from high to moderate to low. The highest abundance is found in the upper subzone, while the lowest is in the lower subzone. The shell sizes of this species are grouped into 3 size classes: <18.3 mm, 18.3-24.4 mm, and >24.4 mm. The largest and smallest shell sizes are commonly found in the upper subzone. The distribution pattern is uniform with a Morisita index value (Id < 1). The abundance of *N. articulata* among subzones differs significantly ($p < 0,05$), while the size among subzones does not differ significantly ($p > 0,05$).

Keywords: Population structure, *Nerita articulata*, Intertidal Zone, Bengkalis

1. INTRODUCTION

Bengkalis Regency is one of the regencies in Riau Province, Indonesia, with its capital in Bengkalis Kota. The territory of this regency covers the eastern part of Sumatra Island and island areas[1]. The potential natural resources and extensive coastal and marine areas give Bengkalis Regency opportunities to develop fisheries and marine sectors. The fisheries resources in Bengkalis Regency consist of Pisces (mudskipper fish, milkfish, mullet), crustacea (mangrove crabs, violin crabs, tiger prawns, glass prawns), Bivalvia (bamboo clams, cockles), and gastropods (mangrove snails, periwinkles, round-shelled mangrove snails). One of the gastropod species also found in Bengkalis is *Nerita articulata*.

The species *N. articulata* has both economic and ecological benefits. Ecologically, it serves as a consumer in the food chain, while economically, it can be consumed by communities. Communities often collect this biota through direct capture in their habitat, and this harvesting is done without consideration for the quantity or size of what is captured. The capture tends to focus on larger sizes, affecting the proportion of smaller sizes. The harvesting

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activities occurring in the intertidal zone result in a tendency for the population to decline. This harvesting also impacts the abundance and size of the shells.

Another factor affecting the population is habitat destruction. The opening of land and the influx of anthropogenic waste into the waters can influence the population structure of this species and affect the habitat conditions for growth and reproduction, leading to pressure and a decrease in population presence. Such conditions will also affect the population abundance and shell size differences among subzones.

Therefore, research on the population of *N. articulata* is being conducted to maintain the sustainability of this species in the intertidal zone of Teluk Lancar Village, Bengkalis Regency. Population studies, especially population structure, are crucial for determining the status or condition of a population in a habitat. This allows efforts to be made to conserve that population.

However, research on the Population Structure of *N. articulata* in Teluk Lancar Village, Bengkalis Regency. This encourages the authors to conduct such research. With information about this species, future resource management can be performed correctly, ensuring the preservation of this species' population.

2. RESEARCH METHOD

Time and Place

This research was conducted in December 2023 in the intertidal zone of Teluk Lancar Village, Bengkalis Regency, Riau Province (Figure 1).

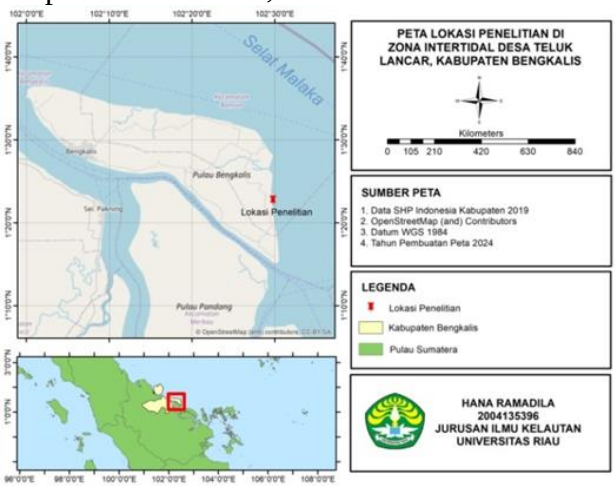

Figure 1. Maps of location

Method

This research used a survey method. The survey method involves direct observation and sampling in the field to obtain primary data. The parameters measured in this study include abundance, shell size frequency distribution, and distribution pattern of *N. articulata.* Other parameters include substrate type, sediment organic matter content, and water quality. Then, the samples are analyzed at the Laboratory of Marine Biology and Marine Chemistry, Department of Marine Science, Faculty of Fisheries and Marine, Universitas Riau.

Procedures

Determination of Sampling Locations

The observation locations are situated in the intertidal zone of Teluk Lancar Village, Bengkalis Regency, Riau Province, where the area is relatively flat. Samples are taken from different subzones. The intertidal zone is divided into three subzones: 1) upper subzone, 2) middle subzone, and 3) lower subzone. The research station consists of three transects, each composed of three plots. The distance between plots is ±60 m, the distance between subzones is ±100 m, and the width of the intertidal zone is ±300 m (Figure 2).

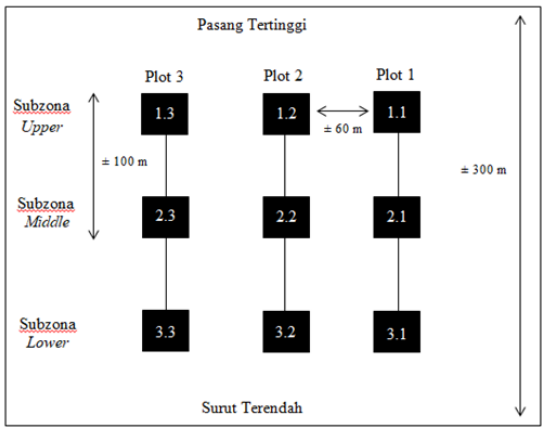

Figure 2. Scheme of plot location on the transect

Sampling

Sampling of *N. articulata* gastropods is conducted in the early half of the month (first quarter phase), specifically on the 8th day. The sampling is conducted during low tide. Quadrat plots measuring 1x 1 m are placed along the transects. The surface sediment of approximately ±5 cm is collected using a scoop and then put into a benthic sieve bucket. The samples of this species are sieved using a benthic sieve bucket of 1 mm. The sieved sample is then placed into sample plastic bags, labeled with the respective transect and plot, and stored in an ice box.

Sediment Sampling

Sediment sampling uses a scoop to determine each intertidal subzone's substrate type and organic matter content. Samples are taken up to 500 g from the surface to a 5-10 cm depth. Then, the samples are placed into plastic bags and labeled according to the subzone of collection.

Sample Analysis

Identification *N. articulata* sample

The *N. articulata* samples are first placed into trays according to the label of each transect and plot. Taxonomic identification is then conducted by referring to WoRMS[2]. Subsequently, identification based on the morphology of this species is carried out according to the research findings[3].

Shell Width Measurement *N. articulata*

The width of the *N. articulata* shell is measured using a caliper. The shell width is measured from the apex to the outer lip of the shell (Figure 2). The shell width indicates the growth of this species[4]. The measurement of shell width is divided into 3 categories: small, medium, and large.

Figure 2. Scheme of measuring shell width of *N. articulata*

Sediment Fraction Analysis

The sediment fraction analysis employs two methods: wet sieving and pipette method. The wet sieving method is used to obtain Ø-1- Ø4 fractions, while the pipette method utilizes volumetric pipettes to obtain Ø5-Ø7 fractions[5].

Analysis of Organic Matter Content

The analysis of organic matter content is conducted at the Chemical Oceanography Laboratory, Department of Marine Science, Faculty of Fisheries and Marine Sciences, Universitas Riau, using the loss by ignition method[6]. Organic matter is calculated using formula[7]:

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

Information:
BOT = Total organic weight
Wt = Total weight before ignition
Wa = Total weight after ignition
C = Weight of empty crucible

Data Analysis

Data obtained will be tabulated into a table, depicted in a graph, analyzed descriptively, and tested for abundance between subzones and shell size of *N. articulata* among subzones using ANOVA.

Abundance

Abundance data obtained based on the number of individuals per unit area is calculated using formula[8]:

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

Information:

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

Frequency of Shell Width

The width size data of the shells, which have been measured in the laboratory and grouped into 3 size classes: small, medium, and large, refer to the formula:

$$f = \frac{\text{big size} - \text{small size}}{3}$$

Information:

f = size frequency
3 = constant

Distribution Pattern

The distribution pattern data of *N. articulata* obtained in the intertidal zone of Teluk Lancar Village, Bengkalis Regency, Riau Province, is used for the Morisita's Dispersion Index[9]:

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

Information:

Id = Dispersion index of Gastropoda *N. articulata*
n = Number of plots
$\sum x$ = Total number of individuals in each plot
$\sum x^2$ = The sum of squares of the number of individuals

With the following criteria: Id<1 (Uniform distribution pattern), Id=1 (random distribution pattern), dan Id>1: (aggregated distribution pattern).

3. RESULT AND DISCUSSION

General Conditions of Research Locations

Teluk Lancar Village is in the Bantan District of Bengkalis Regency, Riau Province. Bantan District covers an area of 424 km^2. The geographic coordinates of Bantan District range from 1°18'27" to 1°35'29" N and from 102°6'32" to 102°30'14" E[10]. Teluk Lancar has a muddy sediment type characterized by mangrove forests with various species such as *Avicennia alba*, *A.marina*, and *Sonneratia alba*, among others. The current velocity in Teluk Lancar is generally slow.

Substrate Type

The sediment fractions in each subzone of the intertidal zone of Teluk Lancar Village are based on the proportion of gravel, sand, and mud content. Substrate types can be classified according to the Shepard Triangle. The weight percentage of sediment fractions and substrate types (Table 1).

Based on Table 1, it can be seen that the substrate types in the intertidal subzones of Teluk Lancar Village consist of 3 types: mud, sandy mud, and muddy sand. However, the dominant substrate type is mud, with a percentage of 89,40% in the upper subzone.

Total Organic Matter

The total organic matter content in the intertidal subzones of Teluk Lancar Village and the percentage values of organic matter in the intertidal subzones of Teluk Lancar Village vary (Table 2).

Table 2 shows that the percentage of total organic matter content in the intertidal subzones of Teluk Lancar Village ranges from 0,78% to 19,29%, with an average of 12,08%. The highest organic matter content is 19,29% in the upper subzone, while the lowest is 0,78% in the lower subzone.

Water Quality Parameters

Water quality parameters were measured during the research to assess the condition of the water in Teluk Lancar Village. The results of the water quality parameter measurements (Table 3). Based on the table, the average temperature among

subzones is 28°C, salinity is 27,3 ppt, pH is 7, and current velocity is 0,01 m/s

Table 1. Percentage of sediment fraction and substrate type in the intertidal subzone of Teluk Lancar Village

Subzona	Sediment fractions (%)			Substrate types
	Gravel	Sand	Mud	
Upper	0,04	10,38	89,40	Mud
Middle	0,04	47,73	52,17	Sandy mud
Lower	0,04	66,83	33,06	Muddy sand

Table 2. Total organic matter in sediments in the intertidal subzones of Teluk Lancar Village

Subzona	Total organic matter (%)	Average (%)
Upper	19,29	
Middle	16,19	12,08
Lower	0,78	

Abundance *N. articulata*

The abundance of *N. articulata* varies, and it is classified as high, moderate, and low. The highest abundance is found in the upper subzone, while the lowest is in the lower subzone for a more precise comparison of *N. articulata* abundance among subzones (Figure 3).

Table 3. Results of water quality measurements in the intertidal subzones of Teluk Lancar Village

Sub zona	Parameter			
	Temp (°C)	Salinity (ppt)	pH	velocity (m/s)
Upper	28	28	7	0,01
Middle	28	27	7	0,01
Lower	27	27	7	0,01

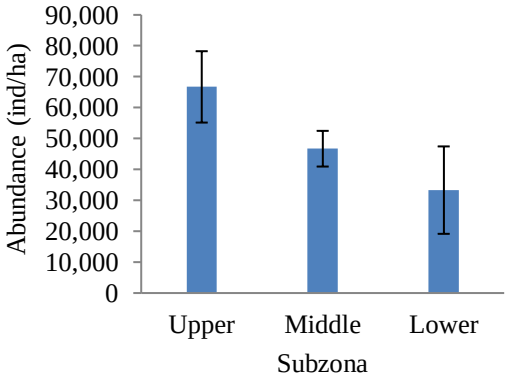

Figure 3. The abundance of *N. articulata* in the intertidal subzones of Teluk Lancar Village

The highest abundance of *N. articulata* is found in the upper subzone. This subzone is located in an area with dense mangrove vegetation. Mangrove forests contain abundant organic matter and food sources for animals, and the density of mangroves significantly influences gastropod abundance. Mangrove forests can serve as food sources for all organisms living within them in various forms, including organic matter and nutrients[11].

In the upper subzone, the substrate type includes mud (Table 1). The mud substrate influences the abundance of this species in the upper subzone. The mud substrate texture is fine, making it favorable for gastropods[12]. Indeed, this makes the habitat highly conducive to the life of gastropods. Additionally, current velocity can also influence substrate types. Currents can cause characteristic patterns of nutrient dispersion and substrate types[13].

The organic matter content in the upper subzone (Table 2) is higher compared to the other subzones. This high amount of organic matter impacts the abundance of this species because the organic matter is present in the mangrove forest area. Marine organisms living on substrates rely on

organic matter as their food source[14]. Numerous microorganisms, including gastropods, often support substrates rich in organic matter. Currents also influence the abundance in the upper subzone because the currents in this subzone are slow (Table 3). Strong currents can affect the distribution or movement of macrozoobenthos from one place to another in the water[15].

The lowest abundance of *N. articulata* is found in the lower subzone. This is believed to be influenced by human activities such as harvesting, which can affect the abundance of this species. Additionally, the species' food chain involves competition for survival and predators. The shells of *Nerita* sp indicate its involvement in the food chain, with its predators being groups of marine crabs and Echinodermata phylum[16].

In the lower subzone, the organic matter content is low (Table 2) because the dominant substrate type is sand. Sandy substrates have low organic matter content because more significant pore water allows for rapid oxidation, leading to the quick depletion of organic matter[17].

Furthermore, the lower subzone has a substrate consisting of sandy mud (Table 1), where sand has a higher fraction value and low organic matter content. Gastropods struggle to survive in sandy substrates because they do not support their life. Sandy substrates cannot provide attachment sites for gastropods; these attachment sites act as barriers to wave action that continuously mobilize the substrate, affecting the abundance of *N. articulata*[18].

The abundance of *N. articulata* in the intertidal zone of Teluk Lancar Village, Bengkalis District, is relatively low compared to research conducted in coastal areas such as East Aceh, Aceh Province, which reported 530,000 ind/ha[19], the mangrove forest of Sungai Cingam Village, Rupat Subdistrict, Bengkalis District, which reported 103,000 ind/ha[20], and the mangrove area of Kuala Kampar Subdistrict, Pelalawan District, Riau Province, which reported 64,400 ind/ha[21]. Meanwhile, the abundance of *N. articulata* in the intertidal zone of Teluk Lancar Village, Bengkalis District, is relatively high compared to research conducted in the South Beach of Pamekasan District, Madura, which reported 44,400 ind/ha[22], and the mangrove ecosystem in the South Coast of East Lombok, which reported 29,500 ind/ha[23].

Frequency Distribution of Shell Width Measures of *N. articulata*

In general, both large and small-sized *N. articulata* occupy the upper subzone. The population in the upper subzone consists of individuals of all sizes, including large, medium, and small. Meanwhile, the populations in the middle and lower subzones mainly consist of small and medium-sized individuals. The difference in the frequency of shell width sizes of *N. articulata* among subzones is visible in Figure 4.

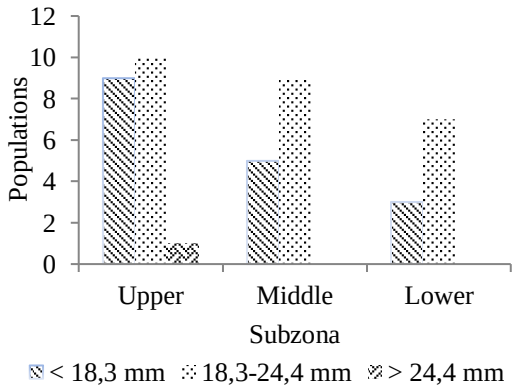

Figure 4. Frequency of shell width sizes of *N. articulata*

The frequency of medium-sized shells is high in the upper subzone, and the highest total shell size is found in the upper subzone. The contributing factor is that the larger group has strong adaptive abilities and the capability to evade predators compared to the smaller group. The high frequency of medium-sized shells is due to this size group's strong adaptability and ability to avoid predators[24].

The smallest shell size frequency is found in the upper subzone's larger category, likely due to human activities such as harvesting, which is suspected of targeting

larger *N. articulata* specimens to meet daily needs. Meanwhile, the lowest total shell size in the lower subzone with a sandy substrate is found. Gastropods struggle to survive in sandy substrates because they do not support their life. Sandy substrates cannot provide attachment sites for gastropods; these attachment sites act as barriers to wave action that continuously mobilizes the substrate[18].

Two factors can influence the growth of organisms: internal factors and external factors. Internal factors include genetics, gender, parasites/diseases, age, and maturity. External factors include the quantity and size of available food, the number of organisms utilizing food sources, temperature, dissolved oxygen, ammonia levels in the water, and salinity[25].

The frequency of shell width sizes of *N. articulata* in size classes in the intertidal zone of Teluk Lancar Village, Bengkalis District, is relatively low compared to research conducted on mangrove ecosystems in industrial and non-industrial areas in Sungai Sembilan Subdistrict, Dumai City, Riau, which reported sizes ranging from 7,84 to 33,71 mm[26]. Meanwhile, the frequency of shell width sizes of *N. articulata* in the intertidal zone of Teluk Lancar Village, Bengkalis District, is relatively high compared to research conducted on mangrove ecosystems in Basilam Baru Subdistrict, Dumai City, Riau Province, which reported sizes ranging from 8,87 to 25,56 mm[27], and in the mangrove ecosystem of Tongke-Tongke Village, Sinjai District, which reported sizes ranging from 7,50 to 26,50 mm[28].

Distribution Pattern *N. articulata*

The distribution pattern of *N. articulata* is uniform, with Morisita's distribution index values of 0,92 in the upper and middle subzones and 0,80 in the lower subzone (Table 4).

The uniform distribution pattern in Teluk Lancar Village's intertidal zone indicates that each subzone's environmental conditions are similar, including substrate, food availability, and water quality. Adaptation ability, habitat suitability, and favorable physical and chemical parameters support the uniform distribution pattern[29]. In other words, gastropods found with a uniform pattern indicate that each species can compete for space and food resources.

Table 4. Distribution pattern of *N. articulata* in the intertidal subzones of Teluk Lancar Village

Subzona	Morisita Distribution Index (Id)	Distribution pattern
Upper	0,92	Similar
Middle	0,92	Similar
Lower	0,80	Similar

The dominant substrate in the intertidal zone of Teluk Lancar Village, mud, with its high organic matter contents, provides a favorable habitat for *N. articulata* to obtain food. Additionally, this species prefers muddy habitats suitable for its reproduction. The factor causing the uniform distribution pattern is likely due to negative individual interactions, such as competition for food availability[30].

In addition to the factors mentioned earlier, factors influencing the distribution of an organism include vectorial factors originating from external environmental conditions (such as wind, water movement, and light intensity), reproductive factors related to the organism's reproductive model (such as cloning and regeneration from offspring), social factors stemming from organism behavior (such as territorial behavior), and coactive factors arising from intraspecific interactions (such as competition)[31].

The distribution pattern in the intertidal zone of Teluk Lancar Village, Bengkalis District, is uniform. This is consistent with research conducted in the intertidal zone of Tablolong Beach, Nusa Tenggara Timur[32], and the waters of Hutumuri Village, South Leitimur Subdistrict[33].

4. CONCLUSION

Based on the research findings, the following conclusions can be drawn: Overall, the abundance of *N. articulata* is relatively low, but the highest abundance is found in the upper subzone, while the lowest is in the lower subzone. There is a significant difference in the abundance of *N. articulata* among the intertidal subzones.

The frequency distribution of shell width sizes varies, including large, medium, and small. The largest and smallest individual sizes are generally found in the upper subzone. However, there is no significant difference in the frequency distribution of shell width sizes of *N. articulata* among the subzones. The distribution pattern of *N. articulata* is uniform.

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