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Density and Distribution of Gastropods in Mangrove Forests of Concong Dalam Village, Indragiri Hilir, Riau Province

Kepadatan dan Pola Distribusi Gastropoda di Kawasan Hutan Mangrove Desa Concong Dalam Kecamatan Concong Kabupaten Indragiri Hilir Provinsi Riau

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Abstract

Gastropods are mangrove organisms that act as bioindicators in mangrove ecosystems. Mangroves are called productive areas because they are rich in organic matter, which is a source of food and shelter for various biota, such as molluscs and other organisms. Human-induced pressure will cause damage to the mangrove ecosystem. The destruction of the mangrove ecosystem will affect the life of all biota that live in it, including gastropods. This study aims to determine the density and distribution pattern of gastropods in the mangrove area of Concong Dalam Village. This research was carried out in August-September 2024 in Concong Dalam Village. The method used in this study is the survey method. The data obtained is then calculated and analyzed. The results of the study show that there are 11 species of gastropods, nine genera, and six families, including Potamididae (3 types), Neritidae (2 types), Littorinidae (2 types), Ellobidae (1 type), Melogenidae (1 type), and Muricidae (1 type). The six types of mangroves found in this study are *Rhizophora apiculata, R. mucronata, Bruguiera cylindrica, Avicennia alba, Sonneratia alba*, and *Nypa fruticans*. The density value of gastropods obtained in Concong Dalam Village ranges from 2.67 – 11.39 ind/m^2. The distribution pattern found in Concong Dalam Village is uniform, with an id value of 0.31-0.44. The density of mangroves in Concong Dalam Village ranges from 600 to 1967 p/ha, with the damage criteria being very good.

Keywords: Density, Distribution Pattern, Gastropods, Mangrove Forest

Abstrak

Gastropoda merupakan organisme mangrove yang berperan sebagai biondikator di ekosistem mangrove. mangrove disebut sebagai kawasan produktif karena kaya akan bahan organik yang merupakan sumber makanan bagi biota, menjadi tempat berlindung dan memijah berbagai jenis biota seperti moluska dan biota lain. Tekanan akibat dari adanya aktivitas manusia akan menyebabkan kerusakan pada ekosistem mangrove. Rusaknya ekosistem mangrove maka akan mempengaruhi kehidupan semua biota yang hidup di dalamnya, termasuk gastropoda. Penelitian ini bertujuan untuk mengetahui tingkat kepadatan dan pola distribusi gastropoda di kawasan mangrove Desa Concong Dalam. Penelitian ini dilaksanakan pada bulan Agustus-September 2024 di Desa Concong Dalam. Metode yang digunakan dalam penelitian ini adalah metode *survey*. Data yang diproleh kemudian dihitung dan dianalisis. Hasil penelitian menunjukan bahwa terdapat 11 spesies gastropoda, 9 genus, serta 6 famili diantaranya Potamididae (3 jenis), Neritidae (2 jenis), Littorinidae

(2 jenis), Ellobidae (1 jenis), Melogenidae (1 jenis), Muricidae (1 jenis). 6 jenis mangrove yang di temukan pada penelitian ini yaitu *Rhizophora apiculata*, *R.mucronata, Bruguiera cylindrica, Avicennia alba*, *Sonneratia alba,* dan *Nypa fruticans.* Nilai kepadatan gastropoda yang didapat di Desa Concong Dalam berkisar 2,67 – 11,39 ind/$m^{2.}$ Pola distribusi yang ditemukan di Desa Concong Dalam yaitu distribusi seragam dengan nilai id 0,31-0,44. Kerapatan mangrove di Desa Concong Dalam berkisaran 600-1967 p/ha dengan kriteria rusak-sangat baik.

Kata kunci: Gastropoda, Hutan Mangrove, Kepadatan, Pola Distribusi

1. Introduction

Gastropods are a group of invertebrate animals commonly known as snails. They can serve as good bioindicators for monitoring environmental pollution. Gastropods are also easily found in mangrove ecosystems, as these areas provide suitable habitats, feeding grounds, and spawning sites. The destruction of mangrove ecosystems can affect the survival of all biota living within them, including gastropods. Pressures such as mangrove logging and waste disposal contribute to the degradation of these ecosystems.

Mangrove ecosystems are considered highly productive areas because they are rich in organic matter, which serves as a food source for various organisms. They also function as shelters and spawning grounds for many species, including molluscs and other biota of high economic value. Gastropods utilize substrates such as soil and mangrove roots or stems as their living areas. Mangrove forest ecosystems have high productivity because large amounts of nutrients are transported and deposited by river estuaries (Kusmana, 2013).

Concong Dalam Village is one of the villages located in Concong District, Indragiri Hilir Regency. It lies in the waters at the mouth of the Indragiri River and has abundant fishery resources. This village is also part of the outermost island cluster of Riau Province, directly bordering the Riau Islands. Concong Dalam Village covers an area of approximately 83.89 km², or about 28.51% of the total area of Concong District (BPS, 2024). Residents of Concong Dalam Village exert increasing pressure on mangrove forests through activities such as plantation expansion, aquaculture, and mangrove logging for local needs. These activities are suspected to have both direct and indirect impacts on the density and distribution patterns of gastropods.

Mangrove forests play an important ecological role as habitats for various species, including gastropods. The mangrove ecosystem in Concong Village, Indragiri Hilir Regency, represents a coastal ecological zone that supports biodiversity. However, environmental pressures resulting from human activities may threaten the survival of existing biota, including gastropods. Therefore, studying the density and distribution patterns of gastropods in this area is important for understanding current ecological conditions and providing insight into the dynamics of gastropod populations.

Based on a preliminary survey, several gastropod species were found in the mangrove ecosystem of Concong Dalam Village. However, there is still no detailed information regarding their species composition and abundance. These gastropods also serve as an additional source of livelihood for the local community. Excessive harvesting without considering its sustainability raises concerns about population decline. Likewise, changes in mangrove forest function can disrupt the long-term sustainability of these gastropods. Therefore, this study aims to investigate the density and distribution patterns of gastropods in the mangrove area of Concong Dalam Village.

2. Material and Method

2.1. Time and Place

The research was carried out in August-September 2024 in Concong Dalam Village, Concong District, Indragiri Hilir Regency, Riau Province. Data analysis was carried out at the Laboratory of Ecology and Aquatic Environmental Management, Faculty of Fisheries and Marine, Universitas Riau.

2.2. Methods

In this study, a survey method was used, specifically direct observation of mangrove forests in Concong Dalam Village as the research location. Gastropod identification will be conducted at the Laboratory of Aquatic Environmental Ecology and Management, Faculty of Fisheries and Marine, Universitas Riau, using a method. The data required for this study includes both primary and secondary data. The primary data consist of the density and distribution patterns of gastropods. Meanwhile, secondary data was obtained from the Concong Dalam Village Office regarding the area's topography and other related agencies, as well as from various supporting literature related to this research.

2.3. Procedures

2.3.1. Determination of the Research Station

The determination of stations is carried out using the purposive sampling method. This involves selecting sampling locations in mangrove areas by considering various conditions of the research area. The research location is divided into 3 (three) stations. Station I is located in the condition of mangroves in relatively sparsely populated areas and close to residential areas. Station II is located in the condition of mangroves with good or moderate density and little community activity, and Station III is located in mangrove conditions with very good or natural density, and there is no community activity.

2.3.2. Gastropod Sampling

Gastropod sampling by determining line transects from the seashore to the shoreline, which is adjusted to the research location. On each transect line, a plot is placed, measuring 10 x 10m. Sampling was carried out 3 times with a time interval of 2 weeks at low tide. The sampling method is carried out using hand (hand collecting) from each plot used.

2.3.3. Environmental Parameters Measurement

Environmental parameters are measured directly in the field, and environmental variable measurements are conducted simultaneously with gastropod sampling. In this study, physical parameters (temperature), chemistry (pH, salinity, phosphate, and nitrates), biology, sediment fractions, and organic matter are used as secondary data.

2.4. Data Analysis

2.4.1. Density of Gastropods

The density of gastropods can be calculated based on the formula of Brower et al. (1977):

$$Ki = \frac{\text{ni}}{\text{A}}$$

Information:

Ki = Species density
ni = Number of individuals of the ith species (ind/ m^2)
A = observation area (m^2)

2.4.2. Mangrove Density Calculation

The distribution pattern of gastropods is calculated by the calculation method with the Morista index formula, calculated using the formula Hartono et al. (2016); Hasanah (2023), as follows:

$$Id = n\frac{\sum X^2 - N}{N\,(N-1)}$$

Information:

Id = Index of the spread of Morisita
n = Total number of plots in a single station
N = Number of individuals in n plot
Σx^2 = Square of the number of individuals per plot

By criteria: Id=1 = Shows a pattern of random/random distribution (R); Id>1 = Shows clustering distribution pattern (C); Id<1 = Shows the distribution pattern (U)

2.4.3. Mangrove Density Calculation

Mangrove density provides an idea of the number of trees in the sample plot (plot). Mangrove density can be calculated using a formula according to English et al.(1994), namely:

$$\frac{\text{Total number of individuals of each type}}{\text{Plot speed}} \text{ x } 10000$$

Based on Environmental Decree No. 201 of 2004 concerning mangrove density criteria, namely: The density of > trees of 1,500 p/ha is categorized as very good; The density of trees >1,000 p/ha is categorized as moderate; The density of < trees of 1,000 p/ha is categorized as damaged.

3. Result and Discussion

3.1. Types and Density of Gastropods

The results of the calculation of gastropod density in the Mangrove area of Concong Dalam Village at each station varied from 0.89-3.80 ind/m^2. There are three stations of the lowest density of the *Cerithidea cingulata* type because the *C. cingulata* snail, which is commonly called by the residents of the cincincot snail, can be consumed by the local community. The highest density at three stations is the *Nerita balteata* type because the community does not consume the snail, but it is only used as fishing bait. The highest density at station III is 3.80

ind/m^2. The lowest density is at station I, which is 0.89 ind/m^2. The high density of gastropods at station III is suspected to be due to favourable environmental conditions and a good mangrove density (1967 p/ha), as well as high organic matter and a muddy substrate type, which support the growth of gastropod species. According to Febrita et al. (2015), mud substrates are highly preferred by gastropods because they have a smooth texture and have higher nutrient levels than coarse-textured substrates. This is because organic matter is a food source for gastropods. The abundance of organic matter is very beneficial for the survival of gastropods. The density of gastropods in Concong Dalam Village is shown in Table 1.

Table 1. Gastropod density in mangrove ecosystems in Concong Dalam Village, Concong District, Indragiri Regency, Riau

No	Types of Gastropod	Density of Gastropods (ind/m^2)		
		I	II	III
1	*Telescopium telescopium*	0,29	0,67	0,74
2	*Cerithidea Obtusa*	0,60	1,25	1,30
3	*Cerithidea cingulata*	0,02	0,80	0,88
4	*Nerita balteata*	0,58	1,17	1,69
5	*Neritina violacea*	0,11	0,41	0,49
6	*Littoraria Scabra*	0,29	0,41	1,54
7	*Litoraria Melanostoma*	0,28	0,42	0,61
8	*Casidulla Aurisfelis*	0,19	0,83	1,54
9	*Volegalea cochlidium*	0,05	0,63	0,79
10	*Indothais gradata*	0,09	1,11	1,16
11	*Chicoreus capucinus*	0,17	1,27	1,30
	Total	2,67	8,96	11,39

Based on the results of the study, the density of gastropod types varied at the three stations. The highest density of gastropods was found at Station III (natural), with a density of 3.80 ind/m^2, while the lowest density was found at Station I (near settlement), with a density of 0.89 ind/m^2. The density of gastropods at Station II (near settlements, but more natural) is moderate, with a density of 8.98 ind/m^2. The high density of gastropods at Station III is suspected to be due to the natural environmental conditions, the dense mangrove cover (1,967 trees per hectare), high organic matter, and the type of muddy substrate at the location. These factors support the growth and development of gastropods. On the other hand, the low density of gastropods at Station I is suspected to be due to the low density of mangroves (600 trees per hectare) and unfavourable environmental conditions.

3.2. Distribution Patterns of Gastropods

Based on the results, most of the gastropods found at the research site exhibit a distribution pattern characterised by three types: random, clumped, and uniform. The pattern of spread has a close relationship with environmental conditions. The distribution pattern of gastropods in Concong Dalam Village is shown in Table 2.

Table 2. Gastropod distribution patterns in mangrove ecosystems in Concong Village, Concong District, Indragiri Regency, Riau

No	Types of Gastropoda	Station					
		I		II		III	
		Id	Distribution Pattern	Id	Distribution Pattern	Id	Distribution Pattern
1	*Telescopium telescopium*	1,02	C	0,98	U	0,98	U
2	*Cerithidea Obtusa*	0,97	U	0,99	U	0,99	U
3	*Cerithidea cingulata*	0	U	0,98	U	0,98	U
4	*Nerita balteata*	0,97	U	0,99	U	1,00	R
5	*Neritina violacea*	1,04	C	0,95	U	0,96	U
6	*Littoraria Scabra*	0,98	U	0,97	U	0,98	U
7	*Litoraria Melanostoma*	1,05	C	0,96	U	0,98	U
8	*Casidulla Aurisfelis*	1,01	C	0,99	U	1,00	R
9	*Volegalea cochlidium*	0,5	U	1,02	C	1,01	C
10	*Stramonita gradata*	0,83	U	0,98	U	1,45	C
11	*Chicoreus capucinus*	0,93	U	0,99	U	0,99	U
	Total	0,44	U	0,31	U	0,31	U

The distribution pattern at station I is around 0.44, at station II it is around 0.31, and at station III, the distribution pattern ranges from 0.31. Based on Table 2, a pattern of gastropod distribution is found in Concong Dalam Village, characterised by a uniform distribution with an id of 0.31-0.44 and according to Adi et al. (2013) stated that the distribution pattern of gastropods is influenced by various factors including food availability, substrate conditions, physical factors, chemistry including how they carry out adaptation strategies and interactions between populations. In accordance with the statement of Budiman in Kamalia et al. (2014), gastropods in mangrove forests generally have a uniform distribution pattern and group due to several factors, such as environmental conditions, eating habits, and reproduction methods.

The distribution pattern of gastropods in the three stations is generally uniform, with the value of the morisita index ranging from 0.31-0.44. This indicates that the distribution pattern of gastropods in Concong Dalam Village is uniform, rather than random or clustered. The distribution pattern of gastropods in the three stations is generally

uniform, with the value of the morisita index ranging from 0.31-0.44. This indicates that the distribution pattern of gastropods in Concong Dalam Village is uniform, rather than random or clustered. The distribution pattern of gastropods, which tends to be uniform at these three stations, can be influenced by several factors, such as relatively homogeneous environmental conditions, equitable food availability, and supportive habitats. Types and Density of Mangroves

Based on the results of research in Concong Dalam Village, six types of mangroves were found, consisting of *N.fruticans, R. apiculata, R. mucronata, B.cylindrica, A.alba*, and *S. alba* (Table 3).

Table 3. Types and density of mangroves in Concong Dalam Village

Stasiun	Types of Mangrove	Mangrove Density (p/ha)	Criteria based on KEPMENLH No. 201 of 2004
1	*Nypah fruticans*	200	Damaged
	Rhizopora apiculata	300	
	Bruguiera cylindrica	100	
	Total	600	
2	*Nypah fruticans*	400	Medium
	Rhizopora apiculata	267	
	Rhizopora mucronata	233	
	Bruguiera cylindrica	233	
	Avicenia alba	67	
	Total	1200	
3	*Nypah fruticans*	367	Very good
	Rhizopora apiculata	300	
	Rhizopora mucronata	433	
	Bruguiera cylindrica	267	
	Avicenia alba	467	
	Soneratia alba	133	
	Total	1967	

Table 3 shows that the mangrove forest area in Concong Dalam Village has varying mangrove densities. The density of mangroves in Concong Dalam Village ranges from 600-1967 p/ha. Based on research, at Station I, there are three types of mangroves with an average mangrove density value of 600 p/ha. Station I has the lowest density because it is a residential area with community activities, such as forest conversion into settlements. In this area, there is a reduction in mangrove forest land used as residential areas, and mangrove trees are felled for household needs, such as using trunks for making home materials. Human activities that can cause changes in mangrove land include illegal logging, the need for home-made firewood, and a lack of public knowledge about various mangrove functions. The density of mangroves at Station II is moderate, with an average value of mangrove density of 1200 trees per hectare. This condition is relatively better than Station I because community activity around the mangrove area is not too high. The high density of mangroves at station III is due to this area remaining natural and having very little activity. The density of mangroves is still categorised as relatively very good. In this area, there are six types of mangroves with a density value of 1967 p/ha. This is in accordance with the decision of the Ministry of Foreign Affairs No. 201/MENLH/2004, which categorises each station in Concong Village in station III as very good, based on various average values. Concong Dalam Village has an area of about 500 hectares of mangrove forest, which is overgrown with several types of mangroves, including *N. fruticans, R. apiculata, R. mucronata, B. cylindrica, A. alba*, and *S. alba*. The mangrove forest zone in Concong Dalam Village is generally located at the mouth of the river, with a substrate type that is muddy and sandy.

3.3. Environmental Parameter Measurement

Based on the research results in Concong Dalam Village, environmental parameter measurements in the mangrove area were conducted at each station. The quality standards used are based on the Ministry of Environment and Forestry No. 51 of 2004 concerning seawater quality standards, which pertains to the average results of environmental quality parameters (Table 4).

Table 4. Measurement of environmental parameters of mangrove areas in Concong Dalam Village

No	Parameter	Unit	Stasion			Quality standart
			I	II	III	
1.	Temperature	°C	31	30	30	28-32
2.	Water pH	-	7,33	7,46	7,51	7-8,5
3.	Soil pH	-	6,33	6,66	6,66	6,5-8,5
4.	Salinity	‰	23	20	20	16-31
5.	phosphate	-	0,074	0,268	0,074	0,015
6.	Nitrate	-	0,122	0,076	0,134	0,008
	Substrate	%	Mud	Mud	Mud	-
7.	Organic matter		5,20 `	5,33	5,54	-

The results of temperature measurements taken at the three stations ranged from 30-31°C. The lowest temperature was found at Stations II and III. In contrast, the highest temperature was found at Station I. Still, so

far the range of differences in the three stations in the mangrove of Concong Dalam Village can support the life of gastropods, where according to Maturbongs et al. (2017) explains that a good temperature for gastropods can survive in the range of 29-32°C and based on quality standart (KEMEN LH no 51 of 2004) temperature conditions in mangrove waters in the normal category to support gastropod life.

The value of the degree of acidity (pH) of the water in the mangrove area in Concong Dalam Village ranges from 7.33 to 7.51. The lowest value of water pH is found at Station I. In contrast, the highest water pH is found at Station III, while the highest soil pH is at Station I, with the highest water pH at Station II. At the same time, the pH value of the soil ranges from 6.33 to 6.66. The pH value at each station is not too different.

The salinity measured in the research in Table 4 is 20-23. The highest salinity at Station I is 23. This location is quite close to the sea, so during higher tides, the seawater rises and causes high salinity. While the lowest salinity is found in Stations II and III, this may be due to the research location being far from the sea and drained by freshwater rivers, resulting in a smaller seawater influence compared to freshwater. So the salinity between all stations has a great influence on gastropods because gastropods have a wide tolerance to salinity. Based on the results of the research, gastropods generally require a salinity of 16-31 according to quality standards.

The results of measuring environmental parameters at the research site ranged from 0.074 to 0.268 mg/L. This figure is far from the quality standard. (KEMEN LH no. 51 of 2004) It was stated that the phosphate quality standard for marine life is 0.015, which is a significant difference. The high concentration of phosphate in the waters of Concong Dalam Village may be due to the mangrove area's proximity to residential areas, leading to domestic waste from household activities and mangrove areas. Gurning et al. (2020) said that the phosphate concentration>0.100 is included in waters with good fertility, while the phosphate concentration <0.051 is included in waters with sufficient fertility. High phosphate values can also result from the regeneration and release of total phosphorus from the mud to the bottom of the waters due to turbulence and mixing.

Gurning et al. (2020) said that the phosphate concentration>0.100 is included in waters with good fertility, while the phosphate concentration <0.051 is included in waters with sufficient fertility. High phosphate values can also result from the regeneration and release of total phosphorus from the mud to the bottom of the waters due to turbulence and mixing. This is supported by Hutami et al. (2018); Soeprobowati et al. (2020), who stated that high nitrate levels may result from domestic wastewater discharge, which increases nitrate concentrations. High nitrate concentrations can indicate eutrophic conditions in a water body. According to Gurning et al. (2020), high nitrate concentrations may also reflect the eutrophic status of aquatic environments.

The organic matter obtained at each research station ranged from 5,208-5,549. The highest value of organic matter is found at station II, which is 5.549, while the lowest value of material is found at station I, which is 5.208. Based on the results of the calculation of organic matter, the highest organic matter content is found at station II. The high content of organic matter at station II is due to increased mangrove litter falling to the bottom, where it is utilised by decomposing bacteria, forming organic matter from fallen leaves to enhance water productivity.

The type of substrate obtained from each research station in Concong Dalam Village is muddy, ranging from 84.61 to 87.17, and sandy, ranging from 12.24 to 14.61, providing a habitat for gastropod organisms. Based on the data grouping substrate types according to the Shepard triangle, the percentage of substrate types in the waters is dominated by mud substrates, which serve as gastropod habitats. Soil texture, consisting of clay with a small diameter of 0.002 mm and mud (slit) with a diameter of 0.002-0.05 mm, plays a very important role in the growth of mangroves and gastropod organisms. Determination of soil texture can be done by paying attention to mineral composition. The most dominant soil minerals are mm and sand (sand) with a diameter of 0.005-2 mm. According to Nento et al. (2013), types of muddy substrates and sandy mud, which are substrates that are widely preferred by gastropods in mangrove ecosystems

4. Conclusions

The research results included 11 species of gastropods with a density value of 2.67-11.39 ind/m^2. Based on the results, the distribution pattern ID value of 0.44-0.31 indicates that the pattern at the study site is a uniform distribution. The mangrove density of Concong Dalam Village ranges from 600 to 1967 p/ha. The mangrove density of the study site is categorised as damaged to varying degrees of good.

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