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Research Article

Diversity of snails (Mollusca: Gastropoda) in the Mangrove Area of Karangsong, Indramayu Regency, West Java Province, Indonesia

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ABSTRACT
The Karangsong mangrove forest region has significantly advanced in the administration and exploitation of natural resources, transforming into an ecotourism hotspot and silvofishery area for fish aquaculture. The aim of this study is to analyse the composition of gastropod communities, essential for the stability of mangrove ecosystems and biodiversity management. The study was carried out during May-June 2024 in the Karangsong mangrove ecosystem of Indramayu Regency, Indonesia. Purposive sampling was used based on three different mangrove habitats in Karangsong. Mangrove density was measured using three random transect plots (10 x 10 m^2) and five quadrants (1 x 1 m^2) for gastropod collection. The present study identified two distinct species of mangroves, namely *Avicennia marina* and *Rhizophora mucronata*. The discovered snails consist of six families: Potamididae, Ellobiidae, Littorinidae, Terebridae, Nassariidae, and Onchidiidae. Gastropod diversity is moderate (H' = 1.62), with no species dominating any research site (C = 0.24). The prevalence of gastropods significantly correlates with the mangrove biodiversity (r = 0.671). The results indicate that the gastropod community within the Karangsong mangrove habitat is stable.

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INTRODUCTION

Mangrove areas are nutrient-dense environments, where organic material from mangrove leaf litter plays a vital role in sustaining the food chain within the ecosystem (Hasan et al. 2023). This can sustain the livelihoods of diverse wildlife throughout the environment. Ecologically, mangrove ecosystems function as feeding grounds, spawning grounds, and nursery grounds for aquatic organisms (Setiawan 2013). Mangrove environments exhibit elevated richness and intricate biological interactions both beneath and above the water surface, including invertebrates from the gastropod class (Kasihiw et al. 2024).

The term gastropod derives from the Greek words *gaster* (stomach) and *podos* (foot), denoting shelled organisms that locomote utilizing their stomachs (Isroni et al. 2023). Gastropods is a taxonomic category within the phylum Mollusca, comprising a diverse array of snails or slugs (Persulessy & Arini 2018). Mangroves provide gastropods with habitat and abundant food resources, enabling them to sustain their existence. Epifaunal gastropods use epiphytic biomass on seagrass leaves, whereas infaunal gastropods depend on litter present on the substrate surface (Isroni et al. 2023). Furthermore, gastropods and mangroves may exhibit a symbiotic relationship, with gastropods significantly contributing to the stability of the mangrove environment. Benthic invertebrates are important to fundamental ecological functions, including nutrient cycling, and act as essential mediators of system productivity (Mattone & Sheaves 2024). Plants and other living forms can harness the resulting breakdown of this organic material into more basic molecules, such as nitrogen, phosphorus, and carbon (Sari et al. 2017).

Alterations in environmental conditions are anticipated to influence the abundance, distribution, and composition of invertebrate fauna due to fluctuations in the physical environment, water quality, and the accessibility of new recruits (Mattone & Sheaves 2024), encompassing the density of mangroves. The Karangsong mangrove area has more than 25 hectares in Indramayu Regency (Prihadi 2019). The mangrove forest, which spans, is the outcome of rehabilitation efforts undertaken by "Kelompok Tani Pantai Lestari" since 2008 (Gunawan et al. 2018). The Karangsong mangrove forest region has grown substantially in terms of management strategies and natural resource exploitation. It has been effectively converted into an ecotourism activity and currently includes land designated for aquaculture within the mangrove area.

Prior studies have examined the composition of macrozoobenthos communities in the Karangsong mangrove area using metrics such as species abundance, diversity, and similarity (Putri et al. 2021). Other research has explored biota associated with mangroves, including gastropods (Prihadi 2019). However, these studies primarily address biota in a broad context. This study specifically focuses on the prevalence of invertebrates, particularly gastropods, and their ecological roles within the mangrove ecosystem. Analysing the composition of gastropod communities is essential for maintaining the stability of mangrove ecosystems and developing proactive management strategies to safeguard biodiversity. Investigating the relationship between gastropods and mangroves, especially within a conservation framework, is crucial to determine whether the presence of gastropods will be protected. To ensure the sustainability of gastropods, the preservation of mangrove forests must remain a priority. Therefore, this study aims to examine the structure of gastropod communities in the Karangsong mangrove area, Indramayu Regency.

MATERIALS AND METHODS

Time and Location Study

This study was conducted from May until June 2024 in the Mangrove Area of Karangsong, Indramayu Regency (Figure 1). The site selection approach utilized purposive sampling across three distinct mangrove habitats: EM (Estuary Mangroves), CM (Ecotourism Mangroves), and SM (Silvofishery Mangroves). The description of these locations is provided along with their GPS coordinates recorded using a Garmin eTrex 10 (Table 1).

Environmental Data

Environmental parameters were sampled concurrently with gastropod sampling, specifically biweekly with three repetitions. Observations were conducted during low tide from 08.00 AM to 03.00 PM in the silvofishery mangrove, followed by the ecotourism mangrove, and concluding at the estuary mangrove. The environmental parameters quantified include water quality parameters such as temperature, measured using a mercury thermometer; pH, measured using a Smart Sensor AS218; salinity, measured using a Refractometer Salinity Meter ATC 0-100 %; dissolved oxygen, measured using a Lutron DO-5510; and substrate properties, including sediment composition and organic carbon concentration. Two substrate samples, each weighing 500 grams, were collected from each location. The substrate samples were analysed for sediment grain size using Gradistat version 8.0 and subsequently classified according to the Wentworth (1922) method. The organic carbon content in the second substrate sample was analysed using the Walkley-Black technique (Batjes & Oostrum 2023).

Mangrove Data Collection

This study's mangrove data collection pertains to the Decree of the State Minister for the Environment Number 201 (Kepmen LH 2004), aimed at assessing the density and extent of mangrove degradation according to tree vegetation classifications. The data collection for mangrove trees at each station employs three randomly distributed square transects (10 × 10 m^2), following a modified approach detailed in a recent study (Sraun et al. 2022). The parameters for the growth phase of a tree are a height of >1 meter and a diameter of > 4 centimeters (Dinilhuda et al. 2020). Wetlands International (Noor et al. 2006) established guidelines for the collection of data on the bo-

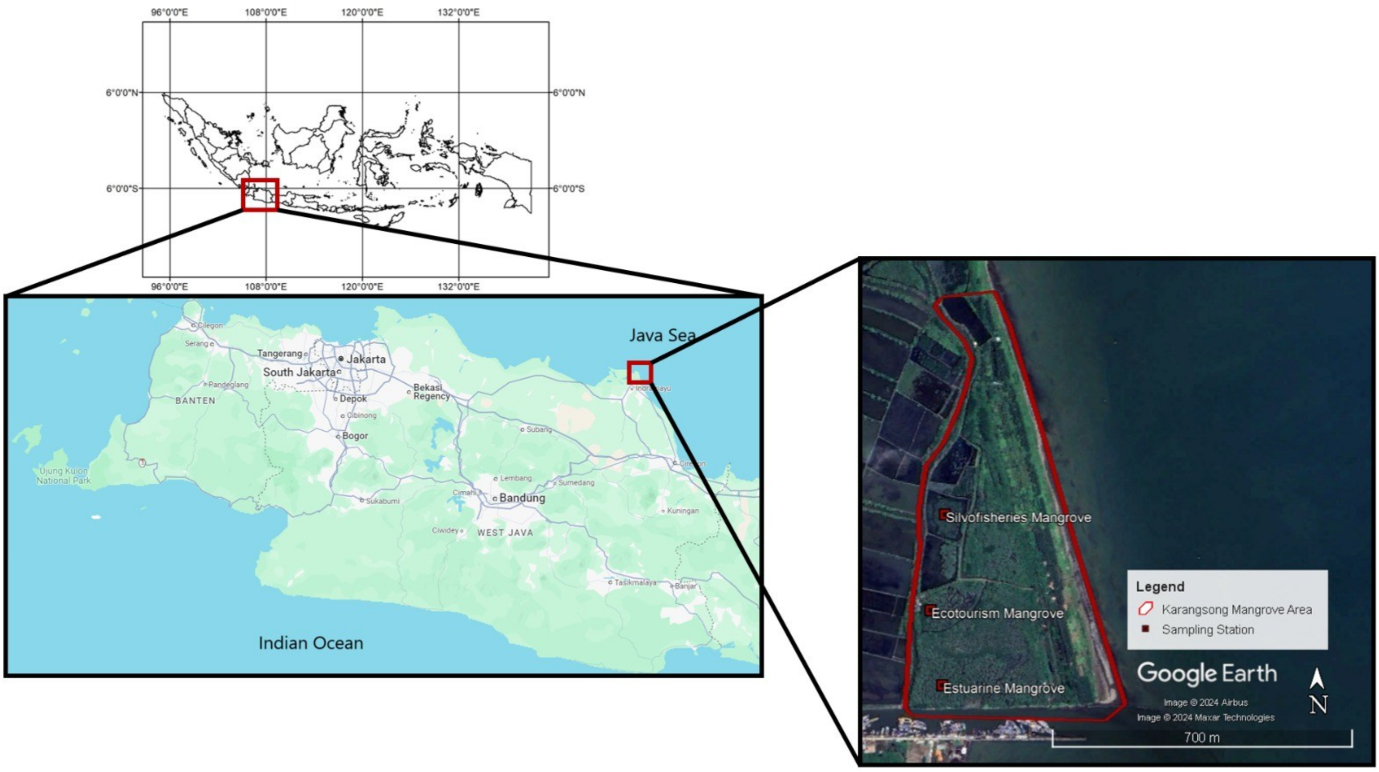

Figure 1. Site sampling: Estuary Mangrove, Ecotourism Mangrove, and Silvofishery Mangrove.

Table 1. Description of the research location based on the characteristics of mangrove utilization and tidal influences.

Location	Coordinate Point		Description
	Latitude	Longitude	
EM	6°18'16.39" S	108°22'6.30" E	An estuary is a region located at the river's terminus or downstream of a river. This site exhibits a region that is constantly flooded and affected by tidal fluctuations from the estuary.
CM	6°18'9.73" S	108°22'6.27" E	An ecotourism is a tourism destination emphasizing the preservation of mangrove forest ecosystems. This region is not perpetually inundated and see less tidal variations than estuaries.
SM	6°18'2.80" S	108°22'7.67" E	A silvofishery is a water body or fish pond characterised by the presence of living mangrove vegetation. This region is not directly influenced by tidal movements.

tanical characteristics of leaves, fruits, and roots for the identification of mangrove species.

Gastropods Data Collection

The collection of gastropod samples occurred concurrently with the sampling of environmental parameters and was repeated three times at two-week intervals. The gastropods were collected from five transect (1 x 1 m^2), randomly positioned within the mangrove area plot (10 × 10 m^2). Gastropod specimens from treefauna were collected through hand selecting from mangrove vegetation. Epifauna and infauna gastropods were collected using a shovel to a depth of ± 20 cm, in accordance with reference study (Setiawan et al. 2024). Gastropod specimens were washed and preserved in a 4 % formalin solution. The sample was identified using the guidebook from Dharma (2005). Morphological characteristics of mangrove snails, such as shell shape, width, length, colour, apex, whorl, siphonal canal, spire, suture, aperture, and column, were also used in observations (Isroni et al. 2023). The collected samples were counted for species and individual number, then analysed for abundance (D), diversity index (H'), and dominance index (C).

Data Analysis

The collected data were afterward analyzed using Microsoft Excel software, including formulas for density parameters based on Dharmawan et al. (2020), gastropod abundance, diversity Shannon-Wiener index (Metcalfe 1989), and dominance Simpson index (Magurran 2004). With the following formula:

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

Description :
D = Density of species-i (trees/m^2)
ni = The number of species-i (trees)
A = Total area of the sampling site (m^2)

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

Description:
A = Abundance (ind/m^2)
xi = Total of individuals of species-i (ind)
ni = Total area of the sampling site (m^2)

$$H' = -\sum \left[\left(\frac{ni}{N}\right) \times \ln\left(\frac{ni}{N}\right) \right]$$

Description:
H' = Diversity index
ni = Total of individuals of species-i
N = Total individuals in the community

$$C = \sum \left(\frac{ni}{N}\right)^2$$

Description:
C = Dominance index
ni = Total of individuals of species-i
N = Total individuals in the community

The next analysis was simple linear regression analysis. Simple linear regression analysis utilising Microsoft Excel software will be conducted to ascertain the association and impact of mangrove density on gastropod abundance. The independent variable (X) represents mangrove density, while the dependent variable (Y) represents gastropod abundance. The formula used is based on (Samuels et al. 2016).

$$Y = b_0 + b_1X$$

Description:
Y = Mangrove density
X = Gastropod abudance
b_0 = Intercept
b_1 = Slope

RESULTS AND DISCUSSION

Environmental Parameters

The results of environmental parameter measurements are presented in Table 2. Based on the analysis of water quality, no significant differences were found between the analysed locations. Furthermore, the water quality values remain within the standard parameter limits, as stipulated in the Indonesian Government Regulation (PP RI No.22 of 2021) concerning seawater quality standards that may affect mangrove ecosystems. These water quality parameters support the life of gastropods and the growth of mangroves. Research by Pratama et al. (2024) indicated that the findings of the water quality analysis suggest that the location is a suitable habitat for mangroves, as it meets the majority of the water quality and substrate characteristics required for mangrove ecosystems.

The analysis of substrate organic carbon content revealed significant differences between the ecotourism site and other mangrove locations (Table 2). According to the substrate parameter criteria from the Soil Research Institute (Sulaeman et al. 2005), the organic carbon content at the mangrove ecotourism site, characterised by sandy mud sediment, was categorized as high (3.4 %). The sandy mud sediment type has a higher organic content compared to the muddy sand substrate. This is consistent with Wang et al. (2021), who found that the grain size of mud sediments is smaller and exhibits more impermeable properties compared to sand sediments, thereby enhancing the ability of microbes to process organic matter. In contrast, the organic carbon content at the mangrove estuary site (2 %) was categorised as low with muddy sand sediment. This is due to its proximity to the river mouth, where sediment transport from tidal and river flow influences the substrate. Similarly, the organic carbon content at the silvofishery mangrove site was also categorized as low (1.5 %), with muddy sand sediment. This is supported by the lowest mangrove vegetation composition in this area, resulting in a lower production of litter as a source of organic matter.

Table 2. Results of environmental parameter analysis compared to quality standards.

Environmental Parameters	Location[a]			Quality Standards[b]
	EM	CM	SM	
Water quality:				
Temperature (^{O}C)	31 ± 2	30.1 ± 0.8	30.5 ± 1.5	28 - 32
pH	7.3 ± 0.3	7.2 ± 03	7.2 ± 0.1	7 - 8.5
Salinity (‰)	22.6 ± 2.1	22 ± 1.7	21.6 ± 3.1	0 - 34
Dissolve oxygen (mg/L)	5.7 ± 0.8	5.6 ± 0.6	6.5 ± 1.0	>5
Substrate:				
C-organic (%)	2 ± 0.4	3.4 ± 1.8	1.5 ± 0.4	-
Sediment type	Muddy sand	Sandy mud	Muddy sand	-

Notes: [a] EM (Estuary Mangrove), CM (Ecotourism Mangrove), and SM (Silvofishery Mangrove)
[B] Indonesian Government Regulation (PP RI No. 22 of 2021)

Mangrove Composition

Result in the Karangsong area has two mangrove species, *Rhizophora mucronata* and *Avicennia marina*. Consistent with the findings of Hapsari et al. (2022), the Karangsong mangrove forest area only cultivates *Rhizophora* and *Avicennia* mangrove species. The identification results indicate that *A. marina* exhibits the highest density in all locations, with a total of 60 trees (Table 3). This finding is consistent with the study by Petra et al. (2012), which identified *A. marina* as the predominant mangrove species in Karangsong Beach, Indramayu Regency.

The analysis results of mangrove tree vegetation density levels are presented in Table 3. The estuary mangrove has the most significant magnitude of mangrove density, measuring 1267 trees/hectare, which falls under the moderate category. Tidal flows contribute significantly to the deposition of organic material at this location. Moreover, the roots of *A. marina* mangroves serve as sediment traps, creating deltas that furnish an optimal environment for the establishment of mangroves (Yulma et al. 2013). The mangrove density at the silvofishery mangrove is reportedly 333 trees/hectare, which is classified as low. Due to their classification as agricultural property, the pond area's mangroves are restricted. At the silvofishery mangrove location, mangroves predominantly sprout along the embankment or around the pond's edges.

Gastropod Diversity

The detected gastropods comprise six families, 11 genera, and 14 species (Figure 2). The predominant family identified was Potamididae, with species such as *Telescopium telescopium*, *Pirenella cingulata*, *Cerithidea obtusa*, *Cerithidea cingulata*, *Cerithidea alata*, and *Terebralia palustris*. Potamididae, generally referred to as mudwhelks or mud creepers, are only located in mangrove forests and their related intertidal environments (Reid et al. 2008). *Telescopium telescopium* displayed the most substantial shell size, measuring ± 10.5 cm. Conversely, the shell dimensions of *P. cingulata*, *C. obtusa*, *C. cingulata*, *C. alata*, and *T. palustris* averaged approximately 4 cm. This investigation identified all six species prevalent on and within muddy bottoms under mangrove plants.

The second most prevalent family was Ellobiidae, exemplified by *Pythia plicata*, *Cassidula aurisfelis*, and *Cassidula nucleus*. The Ellobiidae family, known as hollow-shelled snails, is a notable element of tidal and supratidal zones in mangrove forests and muddy tropical coasts globally (Romero et al. 2015). This investigation identified these three species predominantly on muddy surfaces and affixed to mangrove plants. *P. plicata* was frequently discovered beneath accumulations of mangrove leaf litter from *Avicennia marina*. The shell dimensions of *C. nucleus* and *C. aurisfelis* varied from 2.4 to 2.7 cm, while

Table 3. Results of the analysis of mangrove composition and density levels categorised according to Indonesian policy.

Mangrove Parameters	Location[a]		
	EM	CM	SM
Avicennia marina (trees)	27	23	10
Rhizophora mucronata (trees)	11	13	0
Density (trees/hectare)	1267	1200	333
Density category[b]	Moderate	Moderate	Low

Notes: [a] EM (Estuary Mangrove), CM (Ecotourism Mangrove), and SM (Silvofishery Mangrove)
[b] Consistent with the Indonesian policy (Kepmen LH No. 201 2004)

P. plicata exhibited the smallest shell size, at ± 1.7 cm.

The Littorinidae family was represented by *Littorina scabra* and *Littoraria angulifera.* Littorinidae is among the limited mollusk taxa intimately linked to mangrove ecosystems (Reid et al. 2010). This study identified *L. scabra* residing primarily on muddy bottoms (epifauna) and partially on mangrove vegetation (tree fauna). In contrast, *L. angulifera* was represented solely by a single individual observed on muddy substrates (infauna). The shell dimensions of this species were diminutive, with *L. angulifera* measuring ±1.3 cm and *L. scabra* about 1.9 cm.

Three supplementary families were represented by one species each: Onchidiidae (*Onchidium griseum*), Terebridae (*Terebra lima*), and Nassariidae (*Nassarius callospirus*). Members of the Onchidiidae family primarily reside in marine habitats, typically buried in tidal and intertidal zones, while certain species are terrestrial (Heding et al. 2011). In this study, *O. griseum* was frequently observed affixed to mangrove tree trunks, with a shell size of ± 2.3 cm. The Terebridae family consists of marine gastropods found in most tropical and subtropical oceans (Castelin et al. 2012). This study identified *T. lima* stranded in the mangrove estuarine zone, significantly affected by tidal and riverine currents, with a shell size of ± 5.5 cm. Finally, the Nassariidae family, recognized for its scavenging behavior, primarily resides in soft seabeds and rocky coastlines (Galindo et al. 2016). This study included one individual of *N. callospirus,* measuring 1.2 cm in shell size.

The most abundant gastropod species is *T. telescopium* (13,4 ind/m^2; Figure 3). A local species, the *Telescopium* gastropod thrives in mangrove forests and exhibits remarkable resilience to fluctuations in environmental conditions (Rangan 2010). The distribution of this gastropod species was generally uniform across all sites, with higher concentrations observed at the estuary mangroves and ecotourism mangrove locations. *Telescopium telescopium,* as described by Rahmadhani and Martuti (2023), thrives in marshy environments characterised by flooding and abundant organic soil. Both sites exhibit standing water and a moderate density of mangroves, leading to a greater abundance of organic material preferred by *T. telescopium* compared to silvofishery mangroves. In addition to the appropriateness of environmental conditions for telescopium, the prevalence of this species is derived from observational interviews with the local community, which indicated that this particular type of snail has not yet been utilised . Furthermore, gastropod species with the lowest composition are *L. angulifera* and *N. callospirus.* Only one individual of each species was detected at the silvofishery mangrove. Rangan (2010) defines visiting mollusks as species serendipitously encountered in mangrove ecosystems. Typically, they inhabit the marginal region between the mangrove forest and their ecological niche.

Estuary mangroves exhibited the greatest concentration of gastropods (32.93 ind m^{-2}; Figure 4). Estuary mangroves have the greatest concentration of mangroves, leading to a higher litter generation. Based on the category of

Soil Research Institute (Sulaeman et al. 2005), the organic carbon value of litter used as a nutrient source for gastropods is relatively moderate (2 ± 0.4 %; Table 1). The river estuary's tidal characteristics facilitate the gastropods' transportation by the surface current. In addition to providing nutrition, mangroves serve as habitats and shelters for gastropods from the threats of currents and waves. Mangroves create a complex ecosystem that enhances substrate stabilisation and mitigates wave energy, promoting the deposition of fine materials (Karimi et al. 2022).

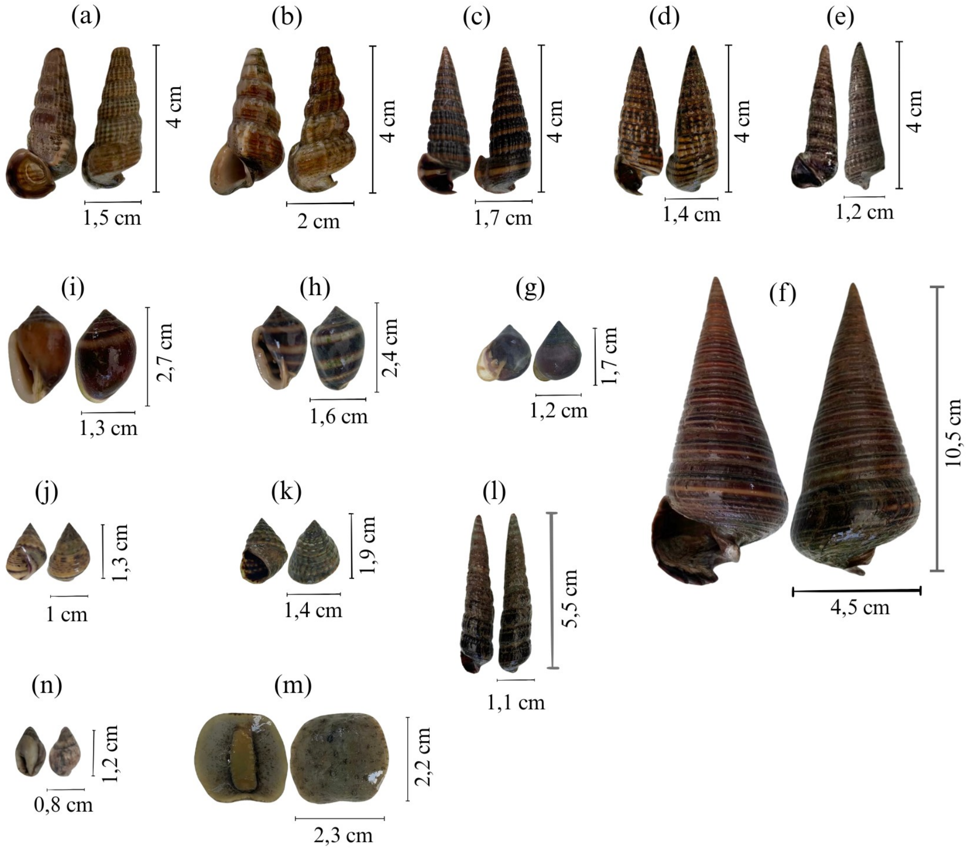

Figure 2. Documentation of the gastropod species found, including shell length and width. (a) *Cerithidea cingulata*, (b) *Cerithidea obtusa*, (c) *Cerithidea alata*, (d) *Pirenella cingulata*, (e) *Terebralia palustris*, (f) *Telescopium telescopium*, (g) *Pythia plicata*, (h) *Cassidula nucleus*, (i) *Cassidula aurisfelis*, (j) *Littorina angulifera*, (k) *Littorina scabra*, (l) *Terebra lima*, (m) *Nassarius callospirus*, (n) *Onchidium griseum.*

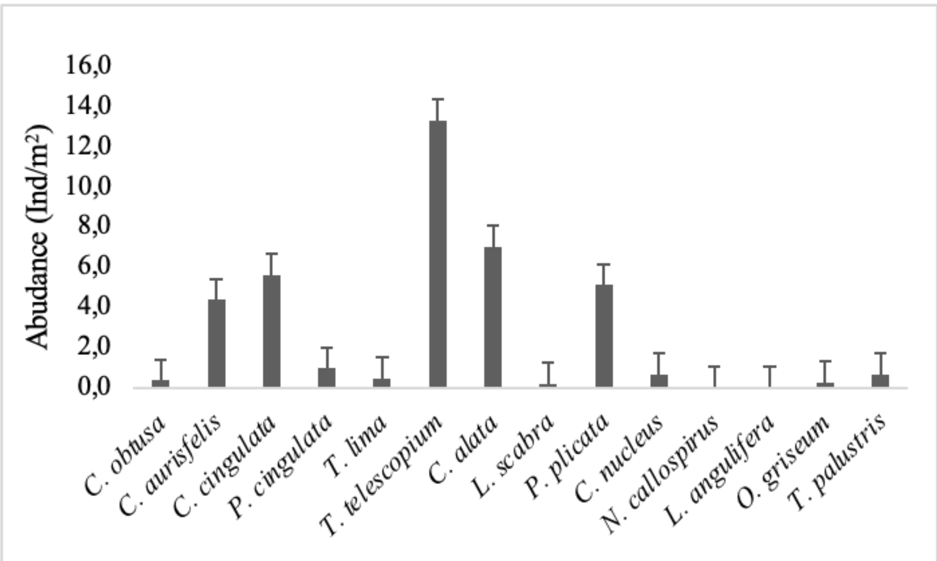

Figure 3. Results of abundance analysis based on gastropod species.

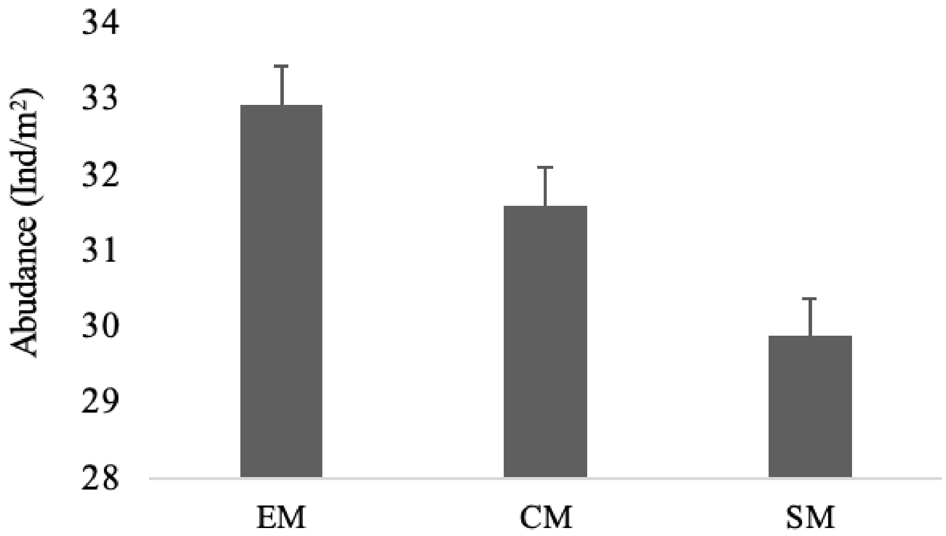

Figure 4. Results of the analysis of gastropod abundance based on mangrove location.

The gastropod population is least abundant at the silvofishery mangrove (29.87 ind m^{-2}; Figure 4). The reason for this is the sparse distribution of mangroves at the silvofishery mangrove, leading to less litter than the other location. This is consistent with the organic carbon levels at silvofishery mangroves, which are classified as low (1.5 ± 0.4 %; Table 1). As per the findings of Salim et al. (2019), a correlation exists between low abundance levels of gastropods and low mangrove density and restricted food supply. While silvofishery mangrove has the lowest quantity of gastropods, the magnitude of this difference is insignificant when compared to estuary mangroves and ecotourism mangroves locations. The superior water quality at silvofishery mangrove sets it apart from all the other locations. A study by Ayu et al. (2013) found that the population size of an organism is affected by several elements, including the physicochemical parameters of the water, such as temperature, salinity, currents, pH, water depth, and substrate.

The diversity index values for estuary mangroves (1.68), ecotourism mangroves (1.29), and silvofishery mangroves (1.88) (Table 4), result in a mean diversity index classified as moderate (H′=1.62H' = 1.62). These findings align with Odum's (1993), assertion that gastropods with a moderate diversity index fall within the range of $1<H'<3$, indicating that the proportion of different gastropod species relative to the total number of snail species at each observation site is nearly equal. This diversity index suggests that the gastropods in the Karangsong mangrove area exhibit ecological stability. As stated by Zhang et al. (2023), higher biodiversity contributes to the maintenance of ecosystem functions and stability, even under changing environmental conditions.

The dominance index values for estuary mangrove (0.22), ecotourism mangrove (0.31), and silvofishery mangrove (0.19) (Table 4). The mean dominance index value of gastropods obtained from all locations suggests the absence of a dominating gastropod species (C = 0.24). This is consistent with Odum's (1993) assertion that a species cannot be considered dominant when the dominance index coefficient is $0<C<0.5$. Based on the findings of Romdhani et al. (2016) a low dominance index suggests a more balanced distribution of species within the community. Hence, within the Karangsong mangrove ecosystem, dominant gastropod species are absent due to the very uniform distribution of all snail species.

Table 4. Results of the analysis of gastropod dominance and diversity index categorised according to Odum's (1993).

Location	C	C Category	H'	H' Category
EM	0.22	No Dominance	1.68	Moderate
CM	0.31	No Dominance	1.29	Moderate
SM	0.19	No Dominance	1.88	Moderate

Notes: C = dominance index and H' = diversity index.

Gastropod and Mangrove Associations

The regression analysis produced the linear equation Y = 35.21X + 28.151 (Figure 6), where Y denotes the numerical value of gastropod abundance and X is the numerical value of mangrove density. An analysis of the function equation reveals a positive correlation between variables X and Y. Consequently, a rise in mangrove density will result in a corresponding surge in gastropod population, whereas a decline in mangrove density will lead to a simultaneous decrease in gastropod population.

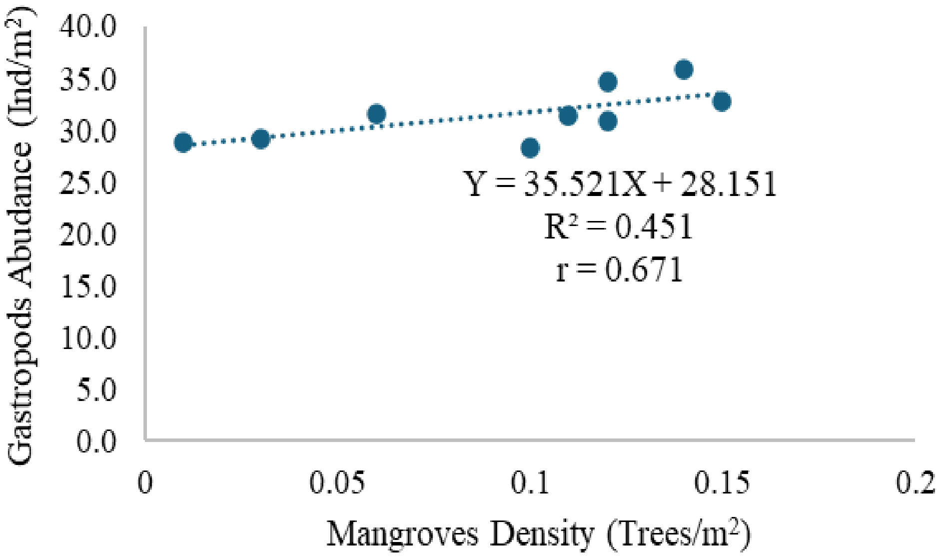

Figure 5. The correlation between mangrove and gastropod.

The coefficient of determination (R^2) of 0.451 indicates that 45 % of gastropod life is influenced by mangrove vegetation, while the remaining 55 % is affected by additional factors. The correlation coefficient (r) of 0.671 (Figure 5) demonstrates a strong relationship between mangrove density and gastropod abundance. This strong correlation is further supported by the gastropod ecological index analysis, which suggests that these biota remain stable within the Karangsong mangrove ecosystem. According to Imamsyah et al. (2020), the presence of gastropods in mangrove ecosystems reflects favorable environmental conditions and contributes to maintaining ecosystem stability. Similarly, Purnama et al. (2024) noted that the high sensitivity of mangrove gastropods to environmental changes underscores their potential as bioindicators of ecosystem health and degradation.

The relationship between gastropods and mangroves is evidenced by the identification of several individuals of the species *P. plicata* beneath a pile of mangrove leaf litter (Figure 6). This finding aligns with the study by Silaen et al. (2013), which reported that the gastropod species *P. plicata* is frequently found in humid conditions and under layers of decomposed mangrove foliage. Research by Athasyah et al. (2023) further revealed that mangroves in the Muara Badak region of East Kalimantan exhibit a significant correlation (r = 0.9562) with litter production, which enhances the organic material content in sediment through accumulated litter. Similarly, Lasalu et al. (2015) demonstrated that mangrove litter accumulating at the water's bottom transforms into nutrient-rich sediment, which can serve as an optimal habitat for macrozoobenthic fauna. Consequently, dense mangrove vegetation can increase litter production, enhance nutrient availability, and act as a supporting factor for gastropod proliferation. Furthermore, apart from serving as a source of food, the high density of mangroves also offers a habitat that serves as a refuge and nesting site for gastropods. According to Masni et al. (2016), epifaunal gastropods utilise mangroves as their habitat, refuge, and reproductive sites by affixing Species of gastropods employ the roots, trunks, and leaves of mangroves as a means of concealment from predators.

Figure 6. Association of the gastropod *P. plicata* with *A. marina* leaves. **Notes:** The species *P. plicata* is spotted within the yellow circle.

However, within the context of the Karangsong ecosystem, which is a result of rehabilitation efforts, several gastropod species typically found in natural mangrove habitats were not identified. This is likely due to environmental conditions that have not yet fully replicated those of natural mangrove habitats, where factors such as substrate structure, litter availability, and ecosystem stability play crucial roles. In line with Irma and Sofyatuddin (2012), the transformation of mangrove forests from their natural vegetation prior to degradation into newly rehabilitated vegetation significantly impacts community structure, particularly in terms of abundance and diversity. Additionally, the limited movement of gastropods is another potential reason why certain species were not found in Karangsong. Therefore, the absence of these gastropod species suggests that the rehabilitated ecosystem may require more time or further adjustments to reach conditions that are suitable for their natural habitats.

CONCLUSIONS

The Karangsong mangrove habitat comprises two distinct species of mangroves: *Avicennia marina* and *Rhizophora mucronata*. The gastropod species with the most abundance is *Telescopium telescopium* (13.4 ind m^{-2}). A moderate level of gastropod variety is observed (H' = 1.62), with no species exhibiting dominance across all research locations (C = 0.24). A significant association (r = 0.671) exists between mangrove vegetation and gastropod habitats. These findings suggest that the gastropod community in the Karangsong mangrove ecosystem is stable. Based on this, further research is recommended, particularly routine monitoring of mangrove conditions, considering the direct relationship between mangrove vegetation and gastropods. Additionally, developing infrastructure to prevent waste that could harm mangrove vegetation is essential for preserving this habitat.

AUTHOR CONTRIBUTION

L.A. designed the research, collected and analysed the data, and wrote the manuscript. M.C.W.A. reviewed the manuscript, provided critical feedback, and secured research funding. J. reviewed the manuscript and provided critical feedback, and A.S. designed the research and supervised the entire process.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that influenced research reported in this paper.

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