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Gastropod Community Structure in the Mangrove Ecosystem of Sukadana West Kalimantan

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ABSTRACT

West Kalimantan is home to extensive mangrove ecosystems, which are widely distributed along its coastal regions, including the Sukadana Subdistrict. These ecosystems play crucial roles in coastal environments, one of which is providing habitat for a variety of aquatic organisms, including gastropods. However, the mangrove ecosystems in this area face significant challenges, particularly deforestation due to land conversion for agricultural activities. Increasing human activities continue to exert considerable pressure on these habitats. This study analyzed gastropod diversity and community structure in the mangrove ecotourism area of Sukadana, North Kayong Regency, West Kalimantan. Field sampling was conducted in September 2024 using a 10 × 10 m² transect quadrat. Within each transect, five 1 × 1 m² subplots were established—one at each corner and one in the center. A total of 12 species from 9 genera and 7 families were identified, with *Pirenella alata* and *Chicoreus capucinus* being the most dominant, contributing 33.05 and 30.63% of the total individuals, respectively. The Littorinidae family exhibited the highest species richness. Species were categorized by habitat preference: arboreal (50%), epifaunal (25%), and both arboreal and epifaunal (25%). Diversity indices (H′) indicated low to moderate diversity, with values ranging from 1.06 to 1.84, while evenness (E) ranged from 0.59 to 0.97. The highest dominance value (C= 0.42) was recorded at station 5, indicating an uneven species distribution. These findings highlight the ecological importance of the Sukadana mangroves in supporting gastropod diversity and emphasize the need for targeted conservation efforts to safeguard these valuable ecosystems.

INTRODUCTION

Mangroves, as one of the most productive ecosystems, play a crucial role in coastal environments, functioning as feeding and breeding grounds, spawning areas, and habitats

for various aquatic organisms **(Mandiangan *et al.*, 2024)** including gastropods. Gastropods, belonging to the phylum Mollusca, represent the largest class of mollusks, with 80,000 identified species **(Bouchet *et al.*, 2005)**. These species are widely distributed in freshwater, marine, and brackish environments, as well as in mangrove forests.

Numerous studies have documented gastropod species associated with mangroves, including *Cassidula*, *Pirenella*, *Cerithidea*, *Chicoreus*, *Cerithiidea*, *Ellobium*, *Littoraria*, *Littorina*, *Nerita*, *Neripteron*, *Clypeomorus*, *Telescopium*, *Terebralia*, *Assiminea*, *Clithon*, *Onchidium*, *Platevindex*, and *Sphaerassiminea* **(Mawardi *et al.*, 2023; Safitri *et al.*, 2024, 2025; Simanullang *et al.*, 2024)**. In mangrove habitats, gastropods can be found in three main ecological categories based on their habitat preferences, reflecting adaptations to the variable environmental conditions present in these ecosystems.

The first group, infauna, live burrowed into muddy or sandy substrates, using these sediments as protection from predators and extreme environmental conditions such as high temperatures or desiccation at low tide. The second group, epifauna, live on the surface of the substrate, feeding on biofilms, detritus, and algae. Some epifaunal species possess thick shells as a defense against predators **(Vermeij, 2017a, b)**. The third group, treefauna, attach to various parts of mangrove trees, including roots, stems, and leaves. These species avoid high tides, predators and anaerobic substrate conditions **(Dahdouh-Guebas *et al.*, 2007; Purnama *et al.*, 2024a)** by living above ground. They feed on lichens, algae, and organic matter on tree surfaces, and their adaptations enable survival under fluctuating salinity conditions **(Wang *et al.*, 2024)**.

Gastropods play important ecological roles in mangrove systems, functioning as decomposers and nutrient recyclers **(Meyer III *et al.*, 2013; Astor *et al.*, 2015)**, improving sediment structure, and serving as bioindicators of environmental and mangrove ecosystem health **(Baharuddin & Satyanarayana, 2024; Purnama *et al.*, 2024b)**.

West Kalimantan is home to extensive mangrove ecosystems, which are widely distributed along its coastal regions, including the North Kayong Regency. In Sukadana Subdistrict, located within this regency, most coastal zones are covered by mangrove forests, with an estimated area of 17,780 ha **(Regional Development Planning Agency of North Kayong Regency, 2018)**. Mangrove vegetation is especially abundant in Sutera Village, where previous studies have recorded species such as *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, *Xylocarpus granatum*, and *Ceriops decandra*, with tree densities ranging from 48 to 192 individuals per hectare **(Harnanda *et al.*, 2018)**.

Since 2017, portions of the mangrove area in Sukadana have been developed for ecotourism as part of the Gunung Palung National Park conservation area. The program aims to promote sustainable tourism while preserving the ecological functions of mangrove forests as habitats for diverse aquatic biota. However, these mangroves face increasing pressures from deforestation caused by agricultural expansion, as well as from

coastal infrastructure development, pollution, aquaculture, and port expansion. Such human activities contribute to habitat degradation, negatively impacting both mangrove health and the biodiversity they support.

Given these pressures, ecological assessments of gastropod communities in mangrove habitats are essential to inform sustainable management and conservation strategies. This study aimed to assess the gastropod communities in the mangrove ecotourism area of Sukadana, West Kalimantan, Indonesia.

MATERIALS AND METHODS

1. Research location

This study was conducted in September 2024 in the mangrove ecotourism area of Sukadana, North Kayong Regency, West Kalimantan, Indonesia. Sampling points were selected using a purposive sampling method, comprising five stations representing different environmental characteristics. A complete description of each sampling station is shown in Fig. (1) and Table (1).

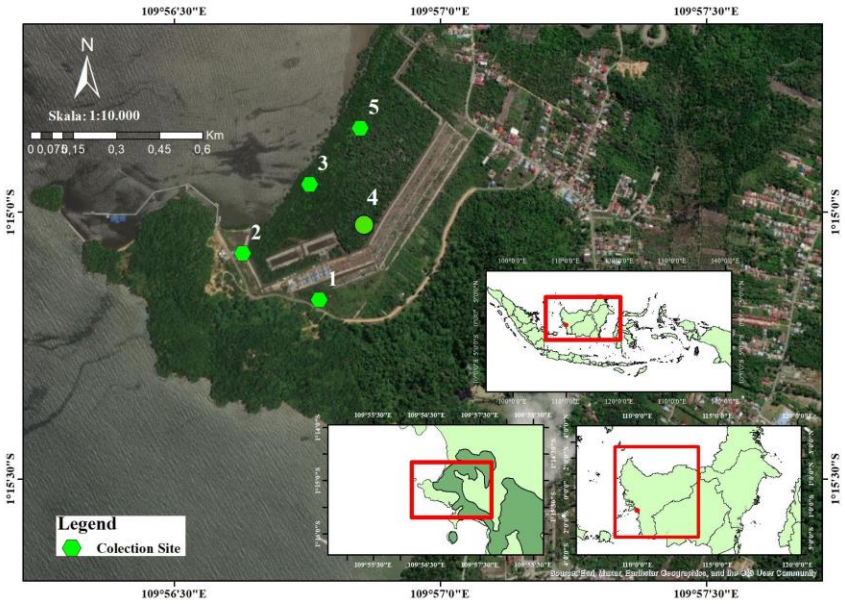

Fig. 1. Sampling location of mangrove gastropods in the mangrove tourism area of Sukadana, West Kalimantan

Table 1. Coordinates, Substrate, Type of Mangrove Vegetation, and Description of The Sampling Station

Station	Coordinates	Substrate	Vegetation	Site Description	Location
I	12°5'45.80"S 109°94'60.00"E	Silt	*Rhizophora*	Station 1 is situated near residential areas where the mangroves are widely used by local people for firewood and charcoal. Mangrove density is relatively rare, with the category including seedling and tree levels	
II	12°50'68.60"S 109°94'43.00"E	Silt	*Bruguiera*, *Rhizophora*	Station 2 is located close to a river that flows into the sea. Mangrove density is quite high with the category dominated by tree stage	
III	12°47'43.10"S 109°94'68.00"E	Silt	*Bruguiera*, *Rhizophora*	Station 3 is in the central of mangrove zone, also near settlements. Mangrove density is relatively low, with trees dominating the category. Many local communities collect mangrove snails at this location	
IV	12°49'00.15"S 109°94'89.37"E	Silt	*Rhizophora*	Station 4 is positioned near an area of former pond land. The mangrove density is relatively high, though some dead trees were found	
V	12°44'91.12"S 109°94'83.10"E	Silt loam	*Avicennia*, *Sonneratia*	Station 5 is located close to the coastline, with mangrove area dominated by *Avicennia* species. Mangrove density is rare	

2. Samples collection

Gastropod sampling was conducted using a 10 × 10 m² transect quadrat, designed to systematically capture species distribution within the mangrove habitat. Within each transect, five subplots measuring 1 × 1 m² were established—one at each corner and one in the center—serving as replicates to ensure representative data collection. Sampling was carried out during low tide to optimize visibility and accessibility to gastropods. The collected specimens included epifauna found on the substrate surface and treefauna attached to various parts of mangrove trees, including roots, trunks, and leaves. All specimens were preserved and transported to the laboratory for further identification and analysis.

Species identification was carried out at the Marine Science Laboratory, Faculty of Mathematics and Natural Sciences, Universitas Tanjungpura, using references such as Molluscabase (https://www.molluscabase.org), the World Register of Marine Species (https://www.marinespecies.org), and the Collection of Worldwide Seashells (https://idscaro.net). Additional references included textbooks and peer-reviewed publications, namely **Dharma (1998, 2005)**, **Poutiers (1998)**, **Cappenberg *et al.* (2006)**, **Arbi (2014)**, **Dolorosa and Gallon (2014)**, **Reid and Ozawa (2016)**, **Islamy and Hasan (2020)** and **Hilmi *et al.* (2022)**.

3. Data analysis

In the mangrove ecosystem, species abundance of gastropods—representing the number of individuals per unit area—was calculated using the formula by **Yasman (1998)**:

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

Where, K is the abundance of a gastropod species (ind/m²), n_i is the number of individuals of the species (ind), and A is the sampling area (m²).

The Shannon–Wiener index **(Odum, 1993)** was applied to determine gastropod diversity. The calculation of this index followed the methodology provided by the online tool at: https://www.alyoung.com/labs/biodiversity_calculator.html.

$$H' = -\sum_{k=1}^{n} pi \ln pi$$

Where H' represents the Shannon–Wiener diversity index, $p_i = n_i / N$, n_i denotes the number of individuals of gastropod species i (ind), and N is the total number of

gastropod individuals (ind). The diversity index was classified into three categories: low diversity ($H' < 1$), moderate diversity ($1 < H' \leq 3$), and high diversity ($H' > 3$).

The evenness index (E) was determined using the formula by **Odum (1993)**:

$$E = \frac{H'}{In\ S}$$

In this formula, H' denotes the diversity index, while S represents the total number of gastropod species recorded. The evenness index is categorized as low if $E \leq 0.5$, moderate if $0.5 < E \leq 0.75$, and high if $0.75 < E \leq 1$.

The dominance index of mangrove gastropods was determined following the Simpson's theory (C) by **Odum (1993)**, as follows :

$$D = \sum_{i=1}^{n} pi^2$$

Where $p_i = n_i / N$, D represents the dominance index, n_i is the number of individuals of species i, and N is the total number of individuals of all species. The dominance index was classified into three categories: low dominance ($0.00 < D \leq 0.30$), moderate dominance ($0.30 < D \leq 0.60$), and high dominance ($0.60 < D \leq 1.00$).

RESULTS AND DISCUSSIONS

1. Composition of gastropods from the mangrove tourism area of Sukadana

The composition of gastropods found in the Sukadana mangrove ecotourism area, West Kalimantan, consisted of 12 species belonging to 9 genera and 7 families. Compared to previous studies in West Kalimantan, **Rupmana *et al.* (2021)** identified 20 gastropod species in the mangrove forest of Desa Sutera; **Sofiana *et al.* (2023)** reported 5 genera of snails from the mangrove habitat of Desa Bakau; **Safitri *et al.* (2024)** documented 9 species in the mangrove area of Sungai Nyirih Village; and **Safitri *et al.* (2025)** recorded 11 species from the mangrove ecosystem of Sungai Bakau Kecil Village.

In this study, the identified species were *Littoraria scabra* (Linnaeus, 1758), *L. melanostoma* (Gray, 1839), *L. carinifera* (Menke, 1830), *L. angulifera* (Lamarck, 1822), *Pirenella alata* (R.A. Philippi, 1849), *Cerithidea quoyii* (Hombron & Jacquinot, 1848), *Nerita balteata* (Reeve, 1855), *Neripteron violaceum* (Gmelin, 1791), *Cassidula aurisfelis* (Bruguière, 1789), *Chicoreus capucinus* (Lamarck, 1822), *Optediceros breviculum* (L. Pfeiffer, 1855), and *Platevindex tigrinus* (Stoliczka, 1869) (Fig. 2).

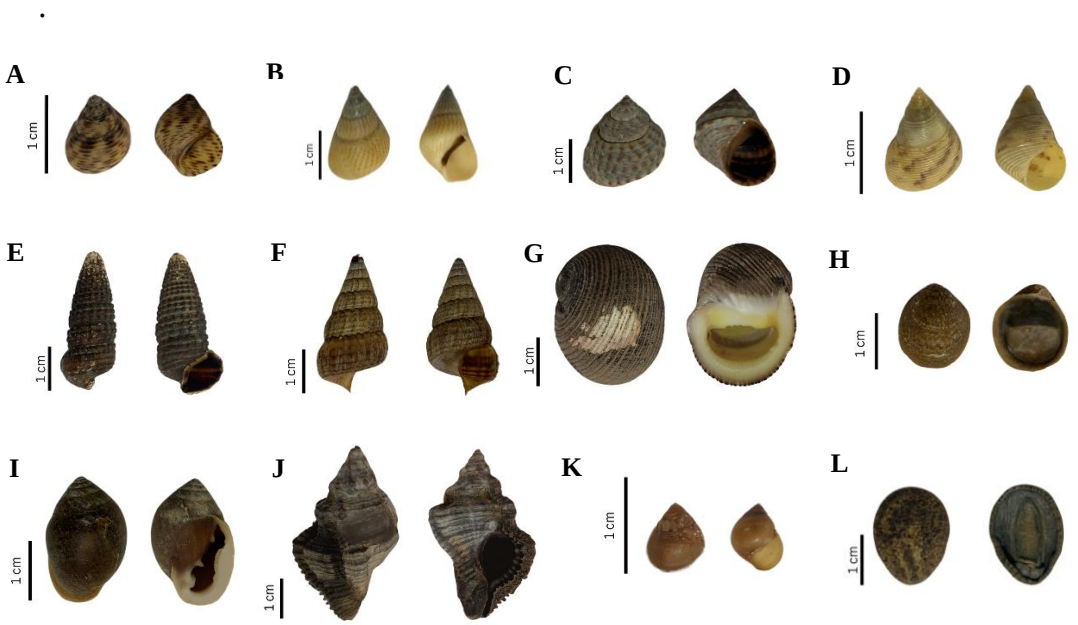

Fig. 2. Gastropods found at the study sites: (A) *Littoraria scabra*, (B) *L. melanostoma*, (C) *L. carinifera*, (D) *L. angulifera*, (E) *Pirenella alata*, (F) *Cerithidea quoyii*, (G) *Nerita balteata*, (H) *Neripteron violaceum*, (I) *Cassidula aurisfelis*, (J) *Chicoreus capucinus*, (K) *Optediceros breviculum*, and (L) *Platevindex tigrinus*

Our results are consistent with those of previous studies **(Abdulla-Al-Asif *et al.*, 2023; Prasetiawan *et al.*, 2023;Simanullang *et al.*, 2024; Safitri *et al.*, 2025)**, which also recorded many of the same species in mangrove habitats. Based on their presence in mangrove ecosystems, gastropods exhibit diverse lifestyles and can be classified into three groups: native species (true mangrove residents) that permanently live, reproduce, and depend heavily on the specific conditions of the mangrove environment; facultative species that can inhabit either mangrove or other ecosystems; and transient visitors that do not permanently reside or breed in mangroves but may occur there temporarily.

The high diversity of species at the study site indicates that the Sukadana mangrove area provides favorable habitat conditions to support a variety of aquatic biota including gastropods. In addition, mangroves function as sediment traps and nutrient sources that sustain gastropod life cycles. Mangrove litter decomposes through microbial activity, producing detritus that serves as a primary food source for many species.

In terms of species distribution, among all identified species, only *Littoraria carinifera* and *Chicoreus capucinus* were found at all sampling stations, while the remaining species occurred only in specific locations (Table 2). This pattern reflects

differences in ecological tolerance. Species present at all stations generally have wide ecological tolerance (eurytopic) and can adapt to a broad range of environmental conditions. Such traits make them dominant species and potential indicators of mangrove ecosystem stability. Conversely, species restricted to certain stations display a narrower ecological tolerance (stenotopic) **(Stigall *et al.*, 2013)**, inhabiting only specific and relatively narrow environmental conditions. This specialization renders their distribution more limited and makes them more vulnerable to environmental change.

Table 2. Gastropods composition from the mangrove tourism area of Sukadana

Family	Species	Behavioral Characteristics	Station				
			I	II	III	IV	V
Littorinidae	*Littoraria scabra*	MV	+	-	-	-	+
	Littoraria melanostoma	MV	+	-	-	-	-
	Littoraria carinifera	MV	+	+	+	+	+
	Littoraria angulifera	MV	-	+	-	-	-
Potamididae	*Pirenella alata*	SS, MV	+	+	+	-	+
	Cerithidea quoyii	SS, MV	-	-	-	+	+
Neritidae	*Nerita balteata*	MV	+	-	-	+	-
	Neripteron violaceum	SS	-	+	+	-	-
Ellobiidae	*Cassidula aurisfelis*	SS, MV	-	-	-	+	-
Muricidae	*Chicoreus capucinus*	SS	+	+	+	+	+
Assiminidae	*Optediceros breviculum*	SS	+	-	-	-	-
Onchidiidae	*Platevindex tigrinus*	MV	+	-	-	+	+

(+) present ; (-) absent ; (SS) Substrate Surface ; (MV) Mangrove Vegetation

In terms of species richness, the family Littorinidae exhibited the highest diversity in the study area, represented by four species: *Littoraria scabra*, *L. melanostoma*, *L. carinifera*, and *L. angulifera*. This family, categorized as arboreal fauna, inhabits mangrove roots, trunks, and leaves, and is known for its high adaptability to intertidal environments characterized by fluctuating salinity and tidal regimes. High diversity within the Littorinidae family has also been reported in numerous studies **(Wiraatmaja *et al.*, 2022; Simanullang *et al.*, 2024; Safitri *et al.*, 2025)**. According to **Reid *et al.* (2012)**, this family includes more than 200 identified species worldwide, most of which are associated with mangrove habitats, particularly *Rhizophora* stands.

The families Potamididae and Neritidae were each represented by two species. Potamididae consisted of *Pirenella alata* and *Cerithidea quoyii*, which are typically found on muddy substrates, while Neritidae consisted of *Nerita balteata* and *Neripteron violaceum*, which generally inhabit hard substrates and possess high tolerance to desiccation during low tide. Potamididae is the only gastropod family whose members exclusively inhabit mangrove ecosystems **(Jamabo & Chinda, 2010; Jamabo & Davids, 2012)**, including former aquaculture sites **(Arbi, 2013; Arbi *et al.*, 2019)**, where

they are considered native species **(Arbi *et al.*, 2022)**. These snails are commonly found on muddy sediments or attached to mangrove roots and trunks. **Mawardi *et al.* (2023)** also recorded Potamididae dominance at their study site, documenting 10 species. Population size in this family is often influenced by the level of human activity, with lower activity supporting higher diversity. High diversity and dominance of Potamididae and Neritidae have also been reported in the mangrove ecosystem of Totobo Village, Southeast Sulawesi **(Purnama *et al.*, 2024)** and in mangrove habitats in Tarakan, North Kalimantan **(Nugroho *et al.*, 2025)**, indicating that both families exhibit strong adaptability to fluctuating aquatic environmental conditions.

The other families identified in this study were Ellobiidae (*Cassidula aurisfelis*), Muricidae (*Chicoreus capucinus*), Assiminidae (*Optediceros breviculum*), and Onchidiidae (*Platevindex tigrinus*), each represented by a single species.

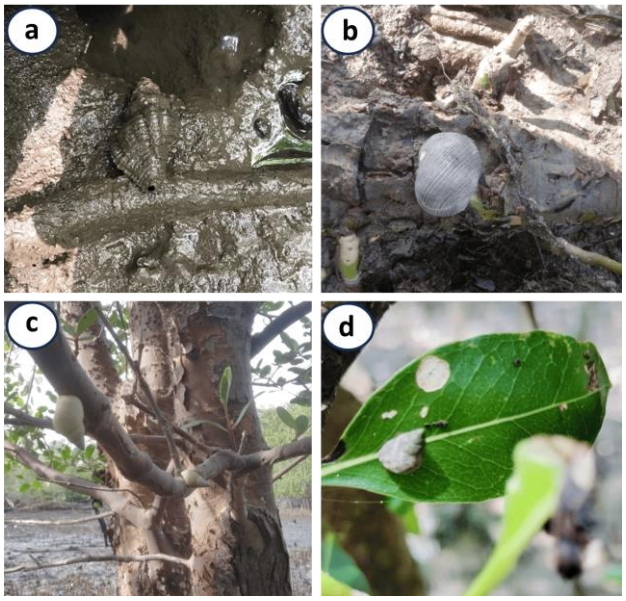

Fig. 3. Various types of gastropods in the mangrove tourism area of Sukadana found as epifauna and arboreal fauna (A) *Chicoreus capucinus*, (B) *Nerita balteata*, (C) *Littoraria melanostoma*, (D) *Littoraria carinifera*

Based on behavioral observations, gastropod species at the study site exhibited distinct habitat preferences. Our findings showed that 25% of the species were epifauna, occurring on the substrate surface, while 50% were arboreal fauna, attached to various parts of mangrove plants such as roots, trunks, twigs, and leaves. Their occurrence on different substrates reflects ecological and physiological adaptations, foraging strategies,

and strategies for protection against environmental factors such as tidal changes or predators.

The genera *Cassidula* and *Optediceros* were primarily found on the upper substrate surface. These species possess robust shells and can burrow into the mud to locate organic matter or detritus as food. Epifaunal species often seek protection by burrowing or by closing their operculum when environmental conditions are unfavorable **(Vermeij, 2017)**. In contrast, arboreal fauna, such as certain *Littoraria* species, have strong feet and shells that allow them to cling tightly to mangrove roots, trunks, and leaves. They also tolerate desiccation during low tide and primarily feed on biofilms, microalgae, lichens, or organic matter trapped on tree surfaces **(Asplund *et al.*, 2018)**.

Interestingly, 25% of the observed species displayed a broader habitat range, functioning primarily as epifauna but occasionally occurring as treefauna. The ability to exploit both ground and arboreal microhabitats may provide adaptive advantages in dynamic mangrove ecosystems, where spatial and temporal habitat variability is high. Such adaptability is a key factor for the long-term sustainability of gastropod populations **(Tan *et al.*, 2020; Tan & Zheng, 2020)**.

Abundance of mangrove gastropods

A total of 826 gastropod individuals were recorded in the Sukadana Mangrove Tourism Area, North Kayong Regency, West Kalimantan (Table 3). Species distribution varied across stations, with Station 5 recording the highest total number (378 individuals) and Station 3 the lowest (64 individuals). Overall, the most abundant species was *Pirenella alata,* with 273 individuals, representing 33.05% of the total. This species occurred at four stations, showing peak abundance at Station 5 (200 individuals) and being absent from Station 4.

The second most abundant species was *Chicoreus capucinus* (253 individuals; 30.63%), which was recorded at all five stations, with the highest number at Station 5 (138 individuals) and the lowest at Station 4 (15 individuals). *Littoraria melanostoma* ranked third in abundance (21 individuals), occurring exclusively at Station 1. *L. scabra* was found only at Stations 1 and 5 (38 individuals combined), while *L. carinifera* was relatively widespread with 78 individuals. Several species occurred in moderate to low numbers, such as *Neripteron violaceum*, *Cerithidea quoyii*, and *Cassidula aurisfelis*. The least abundant species included *Nerita balteata* (12 individuals), *Platevindex tigrinus* (19 individuals), and *Optediceros breviculum* (13 individuals), each with scattered occurrences at one or two stations. *L. angulifera* was recorded only at Station 2 (17 individuals).

In addition, abundance per unit are varied among stations, with Station 5 recording the highest total abundance (75.60ind/ m^2) and Station 3 the lowest (12.80ind/ m^2). *P. alata* had the highest species abundance overall, with densities ranging from 3.40ind/ m^2 (26.56%) at Station 3 to 40.00ind/ m^2 (52.91%) at Station 5. This species often occurrs in

dense aggregations, with tens to hundreds of individuals clustered on the substrate surface.

The dominance of *P. alata* in this study supports previous findings **(Wintah *et al.*, 2021; Haqqi *et al.*, 2024)** that highlight its role as a key ecological component in mangrove ecosystems. Its widespread occurrence in diverse mangrove habitats indicates high tolerance and adaptability. Members of the genus *Pirenella* are known to inhabit a broad range of environments, from brackish and marine waters to freshwater lakes **(Pribadi *et al.*, 2009; Islamy & Hasan, 2020)**. They are often closely associated with mangroves **(Reid & Ozawa, 2016)**. Their high abundance is further supported by strong reproductive capacity and a relatively short life cycle **(Solanki *et al.*, 2017)**, traits that enhance competitiveness in habitats with high environmental fluctuations. Such characteristics are advantageous in mangrove habitats influenced by tidal cycles, salinity changes, and anthropogenic pressures.

Table 3. Mangrove gastropods abundance in Sukadana mangrove area

Species	Station I			Station II			Station III			Station IV			Station V		
	Σ (ind)	K (ind/m^2)	KR (%)	Σ (ind)	K (ind/m^2)	KR (%)	Σ (ind)	K (ind/m^2)	KR (%)	Σ (ind)	K (ind/m^2)	KR (%)	Σ (ind)	K (ind/m^2)	KR (%)
L. scabra	15	3.00	11.19	0	0	0	0	0	0	0	0	0	23	4.60	6.08
L. melanostoma	21	4.20	15.67	0	0	0	0	0	0	0	0	0	0	0	0
L. carinifera	12	2.40	8.96	18	3.60	14.88	15	3	23.44	23	4.60	17.83	10	2.00	2.65
L. angulifera	0	0	0	17	3.40	14.05	0	0	0	0	0	0	0	0	0
P. alata	21	4.20	15.67	35	7.00	28.93	17	3.40	26.56	0	0	0	200	40.00	52.91
C. quoyii	0	0	0	0	0	0	0	0	0	52	10.40	40.31	2	0.40	0.53
N. balteata	2	0.40	1.49	0	0	0	0	0	0	10	2.00	7.75	0	0	0
N. violaceum	0	0	0	21	4.20	17.36	6	1.20	9.38	0	0	0	0	0	0
C. aurisfelis	0	0	0	0	0	0	0	0	0	21	4.20	16.28	0	0	0
C. capucinus	44	8.80	32.84	30	6.00	24.79	26	5.20	40.63	15	3.00	11.63	138	27.60	36.51
O. breviculum	13	2.60	9.70	0	0	0	0	0	0	0	0	0	0	0	0
P. tigrinus	6	1.20	4.48	0	0	0	0	0	0	8	1.60	6.20	5	1.00	1.32
TOTAL	**134**	**26.80**	**100**	**121**	**24.20**	**100**	**64**	**12.80**	**100**	**129**	**25.80**	**100**	**378**	**75.60**	**100**

Another species that exhibited high abundance in the study area was *Chicoreus capucinus*, particularly at Station 5, where its density reached 27.60ind/ m². Its relatively large size and distinctive shell morphology made it easy to recognize and identify during field observations. This species was recorded in all sampling locations, highlighting its wide distribution and ecological adaptability within the mangrove ecosystem. *C. capucinus* is a native component of mangrove habitats, and its long-standing association with these environments implies strong evolutionary adaptation to their unique conditions. The fact that it occurred in all sampling locations suggests that its population is not constrained by specific limiting factors—a characteristic of native species that have evolved within, and are well adapted to, local environmental conditions.

As a member of the family Muricidae, *C. capucinus* is a carnivorous gastropod and serves as a top invertebrate predator in mangrove food webs **(Ernawati *et al.*, 2019)**. Its predatory role likely influences the structure and dynamics of benthic communities by regulating prey populations and maintaining ecological balance. The high abundance

observed in this study may reflect favorable environmental factors, such as substrate type and food availability, which support the establishment and persistence of this species across the study area. Previous studies have also documented the frequent occurrence and ecological significance of *C. capucinus* in mangrove regions **(Wells & Bryce, 2000; Wells *et al.*, 2001; Tan & Oh, 2002; Chalermwat & Wells, 2008)**.

In contrast, *Nerita balteata* was recorded with the lowest total abundance across all stations, accounting for approximately 0.92% of the total gastropod population. This species was found only at Station 1 (0.40ind/ m^2) and Station 4 (2.00ind/ m^2) and was absent from the other three stations. Although in other coastal areas this species has been reported as highly dominant **(Mustapha *et al.*, 2021)**, it occurred in low numbers in the present study.

The low abundance and restricted distribution of *N. balteata* in the study area may be linked to several ecological factors. This species typically inhabits rocky or hard substrates in the intertidal zone **(Mustapha *et al.*, 2021)**, whereas the sampling locations were dominated by mudflats. **Yuliawati *et al.* (2021)** classified *N. balteata* as a facultative resident in mangrove ecosystems, meaning it is not an obligate mangrove species but can utilize mangroves when conditions are favorable. Its presence at stations 1 and 4, although limited, may be due to microhabitats with exposed roots or pneumatophores that offer suitable conditions for temporary colonization. The absence of *N. balteata* at other stations may reflect unsuitable habitat, higher levels of disturbance, or competition with other dominant species.

Low abundance could also indicate that the current habitat does not represent optimal conditions for this species. Additionally, populations may be in the early stages of colonization or declining due to anthropogenic influences. In the Kayong Utara Regency, *N. balteata* is collected by local communities as a traditional food due to its palatability, typically being prepared by boiling or cooking with chili sauce. While harvesting occurs on a small scale, continuous and unmanaged collection, especially when combined with habitat degradation, could cumulatively impact population size and distribution over time.

Diversity, evenness, and dominance inndex of mangrove gastropods

Mangrove gastropods in the Sukadana tourism area exhibited varying values for biological indices across all stations. Shannon–Wiener diversity (H′), evenness (E), and Simpson's dominance (D) indices provide insights into the community structure of gastropods in coastal habitats. These indices are useful for assessing ecosystem health and detecting environmental changes over time.

The calculation of these indices also serves as a basis for identifying priority conservation zones, formulating sustainable management strategies for mangrove tourism areas, and determining the environmental carrying capacity for human activities such as ecotourism. The diversity, evenness, and dominance indices of mangrove gastropods

across the five sampling sites in Sukadana, North Kayong Regency, are presented in Table (4).

Tabel 4. Diversity, evenness, and dominance indices of mangrove gastropods

Biological Index	Station				
	I	II	III	IV	V
H’	1.84	1.57	1.28	1.59	1.06
E	0.88	0.97	0.92	0.89	0.59
C	0.19	0.22	0.30	0.24	0.42

The Shannon–Wiener diversity index (H′) ranged from 1.06 to 1.84. According to the diversity level criteria proposed by **Odum (1993)**, these values fall within the low to moderate category. The highest diversity was recorded at Station 1 (H' = 1.84), indicating a relatively balanced gastropod community, although certain species were more dominant than others. This pattern suggests that the environment at Station 1 is not severely degraded, but there may be pressures from human activities or habitat changes that limit the optimal survival of all species. In contrast, Station 5 recorded the lowest diversity (H' = 1.06), suggesting that the gastropod community there is less diverse and dominated by only a few species. Ecologically, such a pattern may indicate environmental stress or disturbance.

The evenness index (E) ranged from 0.59 to 0.97, placing it in the moderate to high category based on **Odum’s (1993)** classification. The highest evenness was observed at Station 2 (E= 0.97), indicating that individuals were almost evenly distributed among species—a condition typically reflecting balanced ecological interactions and lower interspecific competition. In contrast, Station 5 had the lowest evenness (E= 0.59), indicating that individuals were unevenly distributed, with certain species, notably *Pirenella alata* and *Chicoreus capucinus*, being far more abundant than others. Such low evenness often implies ecological imbalance, where a few dominant species outcompete or replace less abundant ones.

The dominance index (C), calculated using Simpson’s index, ranged from 0.19 to 0.42, corresponding to a low to moderate dominance level according to **Odum (1993)**. Station 1 recorded the lowest dominance value (C= 0.19), which aligns with its high diversity and even species distribution. Conversely, the highest dominance was observed at Station 5 (C= 0.42), indicating the prevalence of a few dominant species—primarily *P. alata* and *C. capucinus*—which may have adapted more effectively to stressful or changing environmental conditions.

CONCLUSION

A total of 12 gastropod species from 9 genera and 7 families were identified in the Sukadana mangrove ecotourism area, Kayong Utara, West Kalimantan, Indonesia. Of these, approximately 50% were classified as arboreal, 25% as epifaunal, and 25% exhibited both habitat preferences. The family Littorinidae had the highest species richness, followed by Potamididae and Neritidae, while Ellobiidae, Muricidae, Assimineidae, and Onchidiidae were the least represented. A total of 826 individuals were recorded, with *Pirenella alata* and *Chicoreus capucinus* each reaching an abundance of 27.60ind/ m². Only *Littoraria carinifera* and *C. capucinus* were present at all sampling stations, indicating a wide ecological tolerance.

The Shannon–Wiener diversity index (*H'*) ranged from 1.06 to 1.84, reflecting low to moderate diversity, while evenness (*E*) ranged from 0.59 to 0.97, indicating moderate to high levels. The dominance index (*C*) ranged from 0.19 to 0.42, falling into the low to moderate category. Overall, these results suggest that the Sukadana mangrove area supports a diverse but unevenly distributed gastropod community. This highlights the need for conservation measures, and local authorities should consider incorporating gastropod diversity as a bioindicator in strategies for sustainable mangrove ecotourism management.

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