



Gastropod Diversity on a Tropical Ecotourism Coastline: A Case from Pantai Tengkuylung West Kalimantan

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ABSTRACT

Sungai Nibung Village, West Kalimantan, has been designated as a regional conservation area. This area encompasses diverse coastal ecosystems, including mangroves and sandy beaches such as Pantai Tengkuylung, which hold strong potential for sustainable ecotourism development and biodiversity conservation. The present study aims to analyze the structure of the gastropod community along the coastline of Pantai Tengkuylung to provide baseline ecological information for long-term monitoring and management. Fieldwork was conducted from February to March 2025 at three sampling stations, where samples collection was done using quadratic ($1 \times 1 \text{ m}^2$) transect during low tide. A total of 716 gastropod individuals representing seven species were identified: *Turritella terebra*, *Brunneifusus ternatanus*, *Pusio elegans*, *Indothais malayensis*, *Indothais gradata*, *Paratectonatica tigrina*, and *Littoraria scabra*. Among them, *L. scabra* exhibited the highest abundance (3.10–8.55 ind/m²), reflecting its adaptability to various microhabitats and substrate conditions. The Shannon–Wiener diversity index ($H' = 1.25\text{--}1.42$) indicated moderate species diversity, with high evenness ($E = 0.65\text{--}0.88$) and low dominance ($C = 0.26\text{--}0.35$), suggesting a stable and balanced benthic community structure. These findings imply that the intertidal ecosystem of Pantai Tengkuylung remains in good ecological condition, with minimal anthropogenic disturbance. The results provide essential baseline data for assessing ecosystem health and can guide the development of sustainable ecotourism and community-based conservation strategies within the Sungai Nibung coastal conservation area.

INTRODUCTION

Sungai Nibung Village, located in West Kalimantan has been designated as a regional conservation area under the Minister of Marine Affairs and Fisheries Decree No. 92 of 2020 concerning the conservation of coastal ecosystems and small islands in Kubu

Raya and surrounding waters. Its ecological potential includes a highly diverse mangrove ecosystem with 18 species identified (**Safitri *et al.*, 2023**) and sandy beaches that can be developed as ecotourism destinations, namely Pantai Tengkuylung (**Edo *et al.*, 2025**). Geomorphologically, this beach has a coastline of approximately 16km, dominated by sandy substrates that provide distinctive habitats for various benthic organisms. The characteristics of these substrates are strongly influenced by physical factors such as sediment texture, organic matter availability, and tidal dynamics (**Bozzeda *et al.*, 2023**), which also determine the structure of the existing biota community including mollusks (**Liu *et al.*, 2023; Bozzeda *et al.*, 2025**).

Gastropods, which constitute the largest class within the phylum Mollusca, exhibit remarkable species diversity, with approximately 80,000 species identified worldwide (**Strong *et al.*, 2008**). These organisms inhabit a wide range of environments, including terrestrial, freshwater, and marine ecosystems. Previous studies have reported the occurrence and diversity of gastropod genera in marine and intertidal zones, including *Turritella*, *Menathais*, *Indothais*, *Nassarius*, *Paratectonatica*, *Conus*, *Telescopium*, *Strombus*, and *Cantharus* (**Jeeva *et al.*, 2018; Ramanibai & Govindan, 2018; Das *et al.*, 2025**). Ecologically, gastropods play a crucial role in nutrient cycling through the decomposition of organic materials (**Meyer III *et al.*, 2013**). In coastal ecosystems, countless species function as grazers, detritivores, or micro-predators, contributing to the regulation of algal growth and the maintenance of benthic community balance. Moreover, their sensitivity to environmental fluctuations makes them bioindicators for assessing ecosystem health and detecting habitat disturbances caused by natural and anthropogenic factors (**Supusepa *et al.*, 2023; Purnama *et al.*, 2024; Purnama *et al.*, 2025; Rafael *et al.*, 2025**). In this context, identifying infaunal gastropods is also important, as these sediment-dwelling species reflect the ecological conditions of the intertidal substrate and provide additional information on the habitat characteristics that support gastropod diversity along tropical ecotourism coastlines.

Comprehensive assessments of gastropod community structure in sandy coastal ecosystems, particularly within the conservation area of Sungai Nibung Village, remain limited. Most existing studies have focused primarily on mangrove-associated gastropods, while research on species composition and diversity in sandy intertidal habitats has received little attention. Properly managed ecotourism can coexist with gastropod habitats without causing ecological degradation; provided physical disturbances are minimized and natural conditions are maintained. Unregulated activities may lead to sediment compaction, altering microhabitats where gastropods live and feed. Considering the ecological and conservation importance of this area, baseline information on benthic community composition is vital for evaluating ecosystem health, thus it is therefore essential to support long-term monitoring and management efforts. Continuous monitoring can guide sustainable ecotourism management, ensuring ecological integrity while supporting community-based development. Therefore, this study aims to analyze

the structure of the gastropod community along the coastline of Pantai Tengkuhyung, Sungai Nibung Village, West Kalimantan.

MATERIALS AND METHODS

1. Time and research location

This research was conducted from February to March 2025 in the ecotourism area of Pantai Tengkuhyung, Sungai Nibung Village, West Kalimantan, Indonesia. The sampling sites were determined using a systematic sampling method, consisting of three stations with relatively similar habitat characteristics. Station I located at 00°34'04.65" S and 109°08'50.08" E, station II at 00°33'50.89" S and 109°08'34.10" E, and station III at 00°33'26.87" S and 109°08'17.79" E. The research location is provided in Fig. (1).

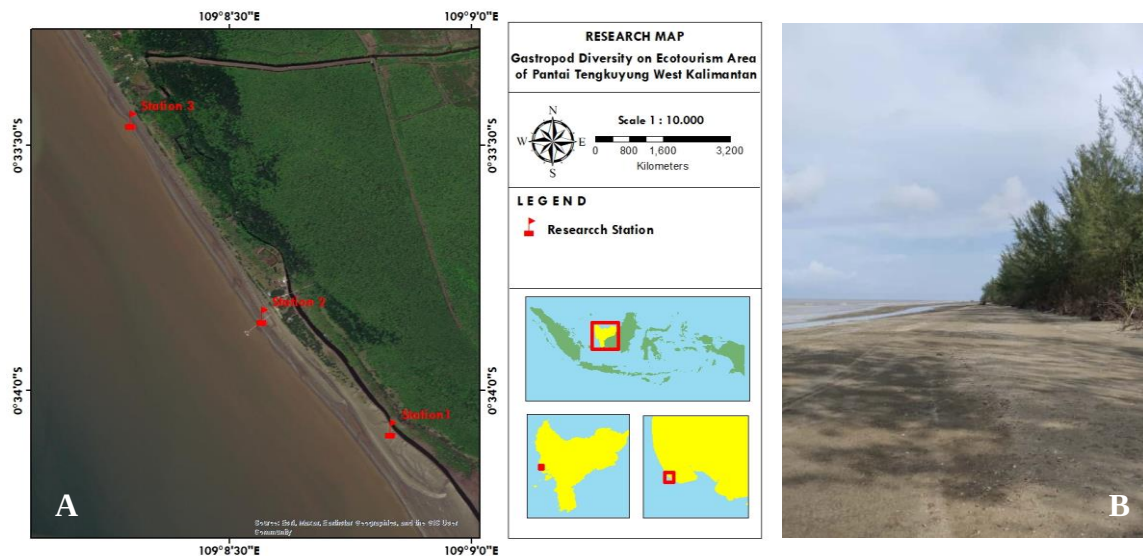


Fig. 1. (A) Site collection of marine gastropods in the ecotourism of Pantai Tengkuhyung, West Kalimantan, (B) dominated by sandy substrate with fine to medium grains, supporting diverse intertidal gastropod communities

2. Gastropods collection and identification

The collection of gastropods was conducted during low tide to facilitate accessibility, using a simple random sampling method with 20 quadrat transects (1×1 m²) per station, randomly placed perpendicular to the shoreline according to the presence of gastropods at each station (Setyono *et al.*, 2019). The sampled individuals included both epifauna found on the surface and infauna buried within the substrate. To obtain infaunal gastropods, the sediment was excavated to a depth of approximately 20cm, allowing the collection of species inhabiting deeper substrate layers. Samples were cleaned, preserved

in 70% alcohol, and subsequently transported to the laboratory for identification and further analysis.

Gastropod identification was carried out at the Laboratory of Marine Science, Faculty of Mathematics and Natural Sciences, Universitas Tanjungpura, by examining shell morphological characteristics. Relevant websites, such as as “Molluscabase” (<https://www.molluscabase.org>), “World Register of Marine Species” (<https://www.marinespecies.org>), and the Collection of Worldwide Seashells (<https://idscaro.net>) were used. Additionally, textbooks and journals were utilized as supporting sources in the species identification process, including **Hombre *et al.* (2016)**, **Robin (2008)**, **Alf *et al.* (2020)**, **Robin (2021)**, **Jirapatrasilp *et al.* (2024)** and **Hamli *et al.* (2024)**.

3. Data analysis

Gastropod density was calculated to describe the number of individuals per unit area. The calculation followed the formula of **Odum (1993)**. In this formula, D is the density (ind/m²), n_i is the number of individuals, and A is the sampled area (m²).

$$D_i = \frac{n_i}{A}$$

The relative density indicates the proportion of individuals of a given species compared to the total number of individuals in the community, calculated following the formula of **Odum (1993)**:

$$RD_i = \frac{n_i}{N} \times 100\%$$

The diversity index (H') was calculated using the Shannon-Wiener formula (**Odum, 1993**):

$$H' = -\sum \left(\frac{n_i}{N} \ln \frac{n_i}{N} \right)$$

Where, H' is the diversity index, n_i is the number of individuals of species i , and N is the total number of individuals of all species. The diversity index is categorized as low ($H' < 1$), moderate ($1 \leq H' \leq 3$), and high ($H' > 3$).

Evenness (E) was calculated to determine the distribution of individuals among species, using the formula:

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

Where, E is the evenness index, H' is the Shannon–Wiener diversity index, and S is the number of species. The classification of evenness follows **Krebs (1972)**, which relates to the condition of community structures: very equally (>0.81), more equally ($0.61–0.80$), equally ($0.41–0.60$), fairly equally ($0.21–0.40$), and not equally (<0.20).

The dominance index (C) was analyzed following Simpson's formula (Odum, 1993):

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

Where, C is the dominance index, n_i is the number of individuals of species i , and N is the total number of individuals of all species. Dominance values range from 0 to 1, where C close to 0 indicates no dominant species, while C close to 1 indicates strong dominance by one or a few species.

RESULTS AND DISCUSSIONS

1. Gastropods diversity from ecotourism coastline of Pantai TengkuYung

The gastropod composition recorded in Pantai TengkuYung ecotourism area, Sungai Nibung Village, West Kalimantan consists of 7 species, which are classified into 6 genera and 6 families. The identified species are *Turritella terebra* (Linnaeus, 1758), *Littoraria scabra* (Linnaeus, 1758), *Brunneifusus ternatanus* (Gmelin, 1791), *Paratectonatica tigrina* (Röding, 1798), *Pusio elegans* (J. E. Gray, 1833), *Indothais gradata* (Jonas, 1846), and *Indothais malayensis* (K. S. Tan & Sigurdsson, 1996) (Fig. 2). Our findings are consistent with several previous studies (Ramanibai & Govindan, 2018; Darwati *et al.*, 2023; Das *et al.*, 2025), which also reported the presence of these species in coastal and intertidal zones. If compared to previous study, the number of species found in this research is lower than the findings of Magdalena *et al.* (2019), who reported 26 species in the waters of Lemukutan Island. The relatively low number of species indicates differences in habitat characteristics and environmental conditions. TengkuYung Beach, characterized by sandy substrates offers limited habitat complexity and food resources. These conditions make the diversity of gastropods tend to be lower when compared to areas with more heterogeneous substrates, such as coral reefs and rocky shores.

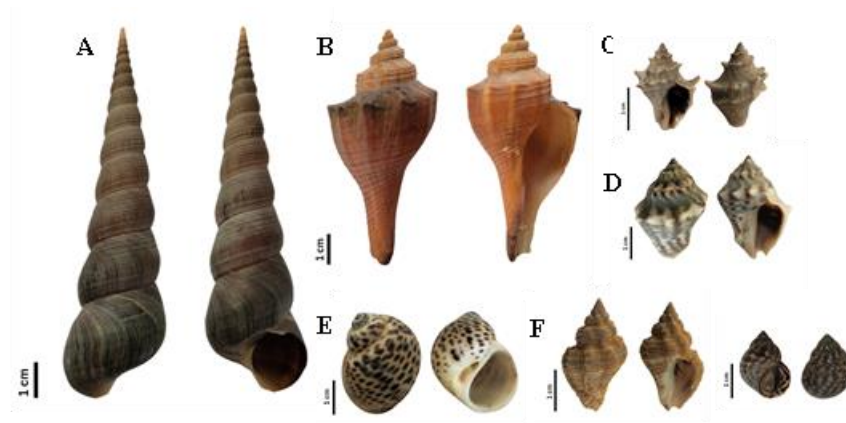


Fig. 2. Gastropods recorded in the present study: (A) *Turritella terebra*, (B) *Brunneifusus ternatanus*, (C) *Indothais malayensis*, (D) *Indothais gradata*, (E) *Paratectonatica tigrina*, (F) *Pusio elegans*, and (G) *Littoraria scabra*

Turritella terebra, locally known as “Tengkuyung”, has the characteristic turritiform (high-spined and elongate) shell typical of cerithiform or turritellid gastropods, consisting of numerous whorls with distinct spiral sculptures (**Chen, 2016**). At Tengkuyung Beach, this species is commonly found as an infaunal organism, burrowing into sandy substrates. The elongated and narrow shell shape facilitates movement within the sediment, allowing the species to maintain stability and access detrital food sources buried in the sand. Similar findings were conducted by **Kadarsah *et al.* (2020)** in the beach of Sungai Bakau Village, where *T. terebra* recorded in the lower intertidal zone with the density of 20.000 ind/ha.

Brunneifusus ternatanus, formerly *Hemifusus ternatanus* (**Dekkers, 2018**) is characterized by an elongated and slender shell (2.42–6.28 cm in length, 1.27–2.78 cm in width). The shell is knot-shaped and relatively swollen body whorl. The shell surface is relatively smooth and lacks angular whorls. The siphonal canal is elongated, accounting for two-thirds of the total shell length. The aperture is narrow and elongated, with a thin outer lip and a smooth columella without folds. The color ranges from light to dark brown with darker shades toward the upper whorls, while the inner aperture appears lighter and glossy. Operculum is thin, reduced, not fully closing the entrance of the aperture and not fully following the outline of the aperture (**Dekkers, 2014; Liu & Yang, 2021**). This species is commonly found in shallow coastal waters, particularly in clean fine subtidal sandy and muddy substrates (**Chan, 2009**), and is occasionally recorded in intertidal areas. The elongated siphonal canal facilitates burrowing and foraging activities beneath the sediment surface. Ecologically, *B. ternatanus* serves as a carnivorous scavenger and opportunistic predator, feeding on carrion and smaller invertebrates within the benthic community.

Indothais, commonly known as murex or rock snails, is a genus of predatory marine gastropods (**Tan, 2000**). In general, this species exhibit a relatively rough shell surface characterized by spiny or tuberculated ridges following the shell’s spiral whorls. The shell is thick and heavy, conical in shape with a blunt apex, and showed distinct spiral sculpturing. The coloration ranges from creamy to brownish or nearly black. In addition, the species is characterized by an ovate aperture and a very short siphonal canal. Such morphological features provide mechanical strength and protection, allowing the snails to withstand strong wave action and potential predators. In the present study, two *Indothais* species were recorded along Tengkuyung Beach. *I. malayensis* had a shell length ranging from 1.84 to 3.42cm and a width of 1.29 to 3.40cm, while *I. gradata* showed a shell length of 1.30 to 3.29cm and a width of 0.85 to 2.65cm. *Indothais* is reported native to the Indo-Pacific region (**Palomares & Pauly, 2024**) and has a wide range of distribution including Indonesian waters (**Ellah, 2025**). In West Kalimantan, *I. gradata* was found in the Padang Tikar mangrove forest, particularly in line II, which is the central zone with muddy substrate characteristics (**Darwati *et al.*, 2023**). Although members of this genus

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are typically associated with mangrove ecosystems, their occurrence in the intertidal zone of Tengkuhyung Beach is likely related to the proximity of the area to mangrove forests.

Paratectonatica tigrina is a marine gastropod found abundantly on sandy or muddy substrates (Pechenik, 2005). Research by Darwati *et al.* (2023) found this species in the Padang Tikar mangrove area, West Kalimantan, particularly on line I located in the seashore area. In this study, *P. tigrina* was characterized by a round shell shape, with a length of 1.78- 3.1cm and a width of 1.56- 2.36cm. Ecologically, this species has been reported as a predator (Takeshita & Maekawa, 2020), preying primarily on sessile or slow-moving invertebrates such as small bivalves and other benthic organisms. *Littoraria scabra*, which is primarily found in mangrove areas as tree infauna (Tuheteru *et al.*, 2014) and fauna (Safitri *et al.*, 2024), can also be found in the intertidal zone, especially at low tide. In this study, *L. scabra* had an oval-conical shell, ranging in length from 3.3mm to 1.25cm and width from 1.9 to 8.6mm. In general, *L. scabra* is herbivorous, but several studies report that the species is a grazer (Jensen, 2000), consuming small invertebrates (Lee *et al.*, 2001). It has also been reported to consume various types of macroscopic and microscopic autotrophic organisms (Alfaro, 2008).

Other species, *Pusio elegans* was commonly found in shallow coastal waters, inhabiting sandy or muddy substrates, including Tengkuhyung Beach, West Kalimantan. This species has a brown-colored shell that is conical to oval in shape, thick and solid, with well-defined spiral whorls. In the present study, *P. elegans* exhibited a shell length of 2.42cm and a width of 1.21cm. Similar to other members of the family Pisaniidae, *P. elegans* is carnivorous or scavenging in nature, feeding on small invertebrates, bivalves, and organic detritus. Its presence in the intertidal zone, particularly in coastal areas adjacent to mangrove ecosystems such as Tengkuhyung Beach, reflects its adaptability to varying environmental conditions.

Table 1. The composition of gastropods in the ecotourism area of Tengkuhyung Beach

Family	Species	Ecological Services	Station		
			I	II	III
Turritellidae	<i>Turritella terebra</i>	Carnivore	+	+	+
Melongenidae	<i>Brunneifusus ternatanus</i>	Carnivore	+	+	+
Pisaniidae	<i>Pusio elegans</i>	Carnivore	-	+	-
Muricidae	<i>Indothais malayensis</i>	Carnivore	-	+	+
	<i>Indothais gradata</i>	Carnivore	+	+	+
Naticidae	<i>Paratectonatica tigrina</i>	Carnivore	+	+	+
Littorinidae	<i>Littoraria scabra</i>	Herbivore	+	+	+

(+) present ; (-) absent.

The gastropod community was dominated by carnivorous species, while only one herbivorous species was observed. The predominance of carnivorous taxa indicated that

the intertidal environment of TengkuYung Beach provides favorable conditions for predatory gastropods, possibly due to the abundance of prey such as bivalves and smaller invertebrates commonly associated with sandy and mixed substrates (Hu *et al.*, 2016). The distribution of species varied among the sampling stations. Station II exhibited the highest diversity with almost all species represented, whereas stations I and III showed slightly lower richness. *T. terebra*, *B. ternatanus*, *P. tigrina*, *L. scabra*, and *I. gradata* were found at all sampling stations, indicating that these species possess a wide ecological tolerance. These species were also dominant throughout the TengkuYung coastal ecotourism area, reflecting their strong adaptability to the dynamic environmental conditions of the intertidal zone. In contrast, other species such as *P. elegans* and *I. malayensis* were only found only at certain stations, indicating a more limited distribution pattern. These species are considered stenotopic (Stigall *et al.*, 2013), with ecological requirements that are narrower and more dependent on specific habitat characteristics. For example, these species were only found at station II, which may indicate a habitat preference with sufficient prey availability and abundance. This distribution pattern is consistent with the feeding behavior of both species, which are active carnivores that prey on sessile invertebrates (Pedro *et al.*, 2023).

2. Gastropods abundance

A total of 716 individuals of marine gastropods were recorded during the sampling conducted in the ecotourism area of TengkuYung Beach, West Kalimantan, Indonesia (Table 3). The number of gastropod individuals varied among the sampling stations, with station II recording the highest total (330 individuals), while station I had the lowest (173 individuals). Among all identified species, *L. scabra* was the most dominant, with 305 individuals found across all stations, contributing 42.60% of the total abundance. The second most dominant species was *I. gradata*, comprising 197 individuals and accounting for 27.51% of the total individuals recorded. *T. terebra* and *P. tigrina* were the third and fourth most abundant species, with a relatively high number of 109 individuals and 84 individuals, respectively. In contrast, other species such as *B. ternatanus* (13 individuals), *I. malayensis* (7 individuals), and *P. elegans* (1 individual) were among the least abundant, occurring only at certain stations.

Table 2. Gastropods abundance in the ecotourism area of TengkuYung Beach

Species	Station I			Station II			Station III		
	Σ (ind)	Di (ind/m ²)	RD _i (%)	Σ (ind)	Di (ind/m ²)	RD _i (%)	Σ (ind)	Di (ind/m ²)	RD _i (%)
<i>T. terebra</i>	26	1.30	15.03	48	2.40	14.55	35	1.75	16.43
<i>B. ternatanus</i>	8	0.40	4.62	2	0.10	0.61	3	0.15	1.41
<i>P. elegans</i>	0	0	0	1	0.05	0.30	0	0	0
<i>I. malayensis</i>	0	0	0	6	0.30	1.82	1	0.05	0.47

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<i>I. gradate</i>	56	2.80	32.37	78	3.90	23.64	63	3.15	29.58
<i>P. tigrine</i>	21	1.05	12.14	24	1.20	7.27	39	1.95	18.31
<i>L. scabra</i>	62	3.10	35.84	171	8.55	51.82	72	3.60	33.80
TOTAL	173	8.65	100	330	16.50	100	213	10.65	100

The abundance and relative abundance of gastropods in the ecotourism area of Tengkuhyung Beach showed spatial variation among the three sampling stations. The highest total abundance was recorded at station II (16.50 ind/m²), followed by station III (10.65 ind/m²) and station I (8.65 ind/m²). The differences among stations indicated variations in environmental conditions, which may influence the distribution and density of gastropods. Among all species, *L. scabra* exhibited the highest abundance, with density values ranging from 3.10 ind/m² (35.84%) at station I to 8.55 ind/m² (51.82%) at station II. The abundance values in this study are higher compared to previous findings in mangrove areas of West Kalimantan, such as in Sutera Village, Kayong Utara Regency (Safitri *et al.*, 2024; Nurdiansyah *et al.*, 2025) and Sungai Bakau Kecil Village, Mempawah Regency (Safitri *et al.*, 2025). The dominance of *L. scabra* observed in the present study is likely related to habitat characteristics. *L. scabra* is known to be abundant in mangrove ecosystems (Marshall *et al.*, 2015) with muddy substrates. In addition, it is found in abundance in intertidal zones (Reid, 2001) characterized by sandy or mixed sediments. The high abundance of this species has also been associated with the availability of food sources such as microalgae, fungi, and biofilms (Jensen, 2000; Alfaro, 2008). Additionally, its high relative abundance indicates strong adaptability to varying habitat conditions.

The second highest abundance was *I. gradata* with values ranging from 2.80 ind/m² (32.37%) at station I to 3.15 ind/m² (29.58%) at station III. The similar abundance values at all stations indicate that this species has high ecological tolerance to various habitat conditions (Marshall *et al.*, 2016). Furthermore, *I. gradata* is a common muricid known for its predatory behavior on sessile invertebrates, and its high abundance may indicate a balanced trophic interaction in the intertidal zone (Siegert *et al.*, 2022). *Turritella terebra* was the third most abundant species, with densities ranging from 1.30 ind/m² (15.03%) at station I to 2.40 ind/m² (14.55%) at station II. This species is a deposit feeder, typically found buried in sandy sediments where it feeds on detritus. The soft sandy sediment that dominates Tengkuhyung Beach may provides favorable conditions supporting the abundance of this species. Other species such as *Paratectonatica tigrina* and *Brunneifusus ternatanus* were recorded in moderate numbers, while *Pusio elegans* and *Indothais malayensis* were relatively rare, each contributing less than 2% of the total abundance and found only at specific stations. Their limited distribution and low abundance may be associated with narrower habitat preferences and limited reproductive success under the existing environmental conditions (Stigall *et al.*, 2013).

3. Gastropods biological index

Gastropods collected from the Tengkuhyung Beach ecotourism area showed variations in biological index values. The community structure of organisms in a given location can be assessed using these indices, including the Shannon–Wiener diversity (H'), evenness (E), and dominance (C) index. Moreover, these indices can serve as indicators of ecosystem health and can be used to detect environmental changes. The biological index values of gastropods at the three sampling stations in Tengkuhyung Beach are presented in Table (3).

Tabel 3. Biological index of gastropods from Tengkuhyung Beach

Biological Index	Station		
	I	II	III
H'	1.42	1.25	1.42
E	0.88	0.65	0.79
C	0.27	0.35	0.26

The diversity index (H') values across the three stations were relatively similar, ranging from 1.25 to 1.42. According to the classification by **Odum (1993)**, this range is categorized to the moderate diversity category. Ecologically, the moderate category indicates a relatively balanced community structure, meaning that no single species dominates excessively and the distribution of individuals among species is fairly even, reflecting a stable ecological condition with moderate environmental stress. Similar moderate diversity levels have also been reported in other condition of gastropods community structure (**Safitri *et al.*, 2024**; **Nurdiansyah *et al.*, 2025**; **Safitri *et al.*, 2025**), indicating similarly stable communities under relatively balanced environmental conditions.

The evenness index values among stations were also relatively similar, ranging from 0.65 to 0.88, which fall into the high evenness category. According to the criteria by **Krebs (1972)**, this condition indicates an ecosystem that is more equal to very equal. Such a pattern suggests that the distribution of individuals among species is fairly uniform, with no single species showing strong dominance, reflecting a stable and balanced community structure. The evenness index values in this study are higher than those reported by **Safitri *et al.* (2024)** for mangrove gastropods in Sutera Village and **Safitri *et al.* (2025)** in Sungai Bakau Kecil Village. However, they are lower than those reported by **Nurdiansyah *et al.* (2025)**. These differences may be influenced by variations in habitat characteristics, such as substrate type, vegetation cover, food availability, or even the presence of pollution (**Mawardi *et al.*, 2023**; **Purnama *et al.*, 2024**), which play important roles in shaping the diversity and distribution of gastropod communities.

The value of dominance index at all stations showed a similar trend, ranging from 0.26 to 0.35, which falls into the low dominance category according to the classification of **Odum (1993)**. In West Kalimantan, similar studies on gastropod community structure (**Safitri et al., 2024; Nurdiansyah et al., 2025; Safitri et al., 2025**) have also reported the same category, namely a low dominance index. Low dominance values indicate the absence of any single species dominating the community. This condition reflects a well-distributed composition of species, suggesting that environmental conditions support a balanced coexistence among gastropod species in Tengkuyung Beach.

CONCLUSION

In the Tengkuyung Beach ecotourism area, West Kalimantan, seven gastropod species were identified: *Turritella terebra*, *Brunneifusus ternatanus*, *Pusio elegans*, *Indothais malayensis*, *Indothais gradata*, *Paratectonatica tigrina*, and *Littoraria scabra*. A total of 716 individuals were recorded, with *T. terebra*, *B. ternatanus*, *P. tigrina*, *L. scabra*, and *I. gradata* found at all stations, indicating broad ecological tolerance, while the remaining species occurred only at specific stations. *L. scabra* showed the highest abundance (3.10–8.55 ind/m²), followed by *I. gradata* and *T. terebra*. The diversity index ($H' = 1.25\text{--}1.42$) indicated moderate diversity, evenness ($E = 0.65\text{--}0.88$) was high, and dominance ($C = 0.26\text{--}0.35$) was low. These results suggest a balanced community structure, reflecting good ecological health in the intertidal ecosystem of Tengkuyung Beach.

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