Fisheries Journal, 15 (4), 1815-1826 (2025)
http://doi.org/10.29303/jp.v15i4.1706

GASTROPOD COMMUNITY STRUCTURE IN THE MANGROVE ECOSYSTEM OF KEJAWANAN BEACH: RELATIONSHIP BETWEEN ABUNDANCE AND ENVIRONMENTAL FACTORS

Struktur Komunitas Gastropoda Di Ekosistem Mangrove Pantai Kejawanan: Hubungan Parameter Lingkungan Terhadap Kelimpahan

Tinta Yuandita[1*], Donny Juliandri Prihadi[2], Asep Sahidin[3], Sunarto[2], Neng Tanty Sofyana[2], Salsabila Putri Syakilah[2]

[1]Marine Science Study Program, Padjadjaran University, [2]Department of Marine Science, Padjadjaran University, [3]Department of Fisheries, Padjadjaran University

Ir. Soekarno KM.21 Street, Jatinangor, Sumedang Regency 45363, West Java, Indonesia

[*]Corresponding author: tinta21001@mail.unpad.ac.id

(Received Juli 12th 2025; Accepted July 23th 2025)

ABSTRACT

This study aims to determine the structure of the gastropod community and the relationship between environmental parameters and gastropod abundance in the mangrove ecosystem of Kejawanan Beach. This study used a survey method using 10 x 10 m quadrant transects with 1 x 1 m subplots inside, with five points placed at each corner and in the center. The results of the study showed 12 families, including Potamididae, Littorinidae, Cerithiidae, Ellobiidae, Naticidae, Melongenidae, Coniidae, Nassariidae, Clavatulidae, Assimineidae, Ampullariidae, and Achatinidae. The total abundance of gastropods was 32.78 ind/m2. The diversity (H') obtained falls into the moderate diversity category, with a value of 1.61. The evenness (E) obtained falls into the moderate evenness category and indicates a stable community, with a value of 0.62. The dominance (C) of gastropods indicates that no single species dominates across all research stations. The abundance of gastropods in the mangrove ecosystem of Kejawanan Beach shows a strong and positive relationship with environmental parameters such as silt fraction and salinity, and has a negative correlation with sand fraction and Dissolved Oxygen (DO).

Keywords: Ecological Index, Environmental Parameters, Gastropods, Mangroves

ABSTRAK

Penelitian ini bertujuan untuk mengetahui struktur komunitas gastropoda dan hubungan antara parameter lingkungan dengan kelimpahan gastropoda di ekosistem mangrove Pantai Kejawanan. Penelitian ini menggunakan metode survei menggunakan transek kuadran berukuran 10 x 10 m dan terdapat sub plot berukuran 1 x 1 m di dalam dengan lima titik yang ditempatkan pada setiap sudut dan tengah pada empat stasiun penelitian. Hasil penelitian menunjukkan terdapat 12 famili, diantaranya Potamididae, Littorinidae, Cerithiidae, Ellobiidae, Naticidae, Melongenidae, Coniidae, Nassariidae, Clavatulidae, Assimineidae, Ampullariidae, Achatinidae. Kelimpahan total gastropoda adalah 32.78 ind/m2.

Keanekaragaman (H') yang diperoleh termasuk kategori keanekaragaman sedang, yaitu 1.61. Keseragaman (E) yang diperoleh termasuk dalam kategori keseragaman sedang dan komunitas labil, yaitu 0.62. Dominansi (C) gastropoda menunjukkan bahwa tidak terdapat jenis yang mendominasi di seluruh stasiun penelitian. Kelimpahan gastropoda di ekosistem mangrove Pantai Kejawanan menunjukkan hubungan yang erat dan positif dengan parameter lingkungan berupa fraksi lumpur dan salinitas, serta memiliki korelasi negatif dengan fraksi pasir dan Dissolved Oxygen (DO).

Kata Kunci: Gastropoda, Indeks Ekologi, Mangrove, Parameter Lingkungan

INTRODUCTION

Indonesia is home to the largest and most extensive mangrove ecosystem in the world, covering an area of 4.2 million hectares. However, only approximately 3.2 million hectares of mangrove forest remain (Taluke et al., 2019). According to Spalding in Prihadi et al. (2024), Indonesia is home to at least 45 of the 75 mangrove species found worldwide. Kejawanan Beach, located in Cirebon City, is one of the tourist areas with a mangrove ecosystem. It is estimated that the mangrove ecosystem at Kejawanan Beach currently covers approximately two hectares, divided into west and east sides, with various mangrove species, including Avicennia marina and Rhizopora mucronata. According to Setiawan (2013), mangrove ecosystems ecologically serve as feeding grounds, spawning grounds, and nursery grounds. This ecosystem serves as a vital habitat for various marine life, including gastropods.

In the mangrove ecosystem, gastropods are detritus-eating animals, thus their presence functions in decomposing fresh litter. Litter originating from leaves, twigs, fruit, and mangrove stems is decomposed by bacteria and fungi into dissolved nutrients that are utilized by various organisms, including gastropods (Bengen in Pietersz et al., 2022). Furthermore, according to Khade & Mane (2012) in Puryono & Suryanti (2019), several other gastropod species are filter feeders, so the gastropod community plays a role in the nutrient cycle in the ecosystem. The composition and abundance of gastropods in a mangrove ecosystem are influenced by environmental conditions, such as water quality, food availability, substrate type, vegetation, pressure from human activities, and predation (Pratama et al., 2024). To date, information regarding the structure of the gastropod community in the mangrove ecosystem on Kejawanan Beach is still very limited. Therefore, this research is necessary to enrich scientific data on the gastropod community and understand the relationship between its abundance and various environmental parameters.

RESEARCH METHODS

This research was conducted through short-term periodic surveys that were repeated every two weeks for a two-month period in the mangrove ecosystem of Kejawanan Beach. The research location was divided into four stations: the first station was located to the west of Kejawanan Beach, while the second, third, and fourth stations were located to the east of Kejawanan Beach.

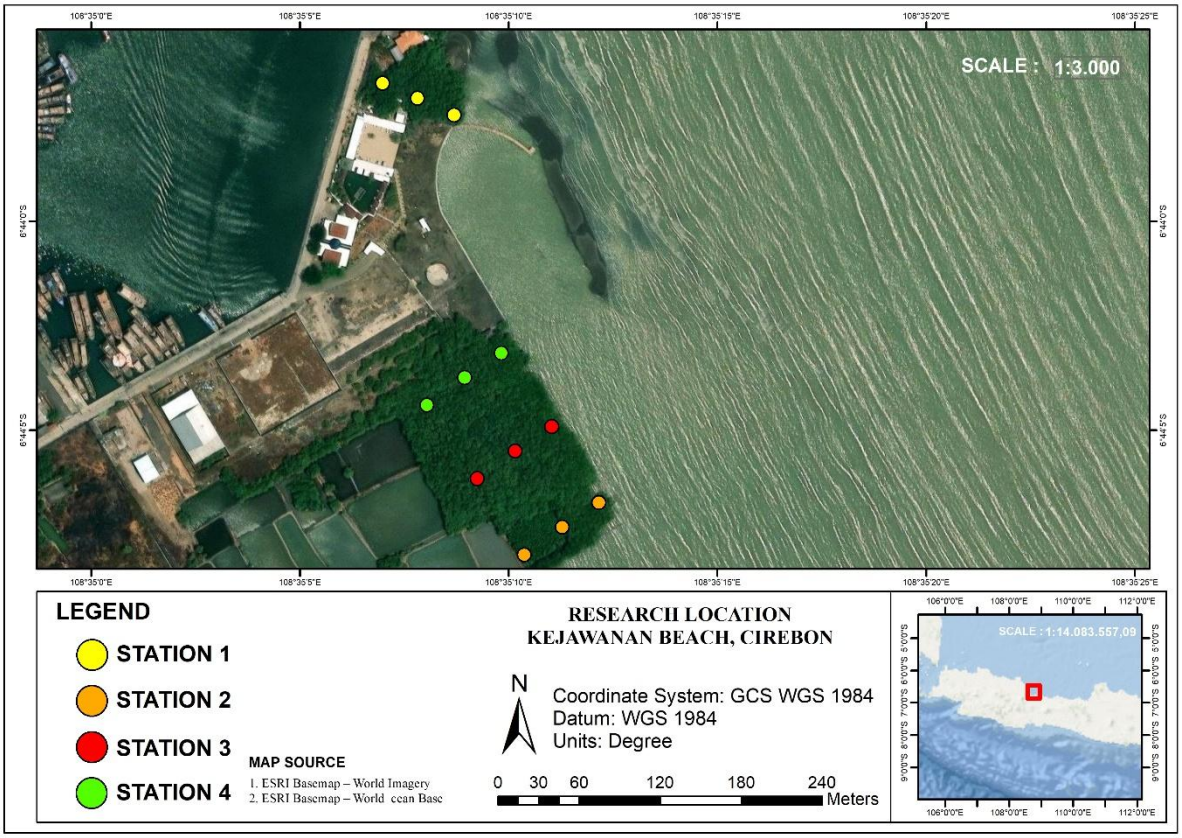

Figure 1. Research Location Map

Gastropod sampling used a 10 x 10 m quadrant transect with a 1 x 1 m subplot within it, with five points placed at each corner and center, and was manually sampled by hand. Samples were identified using the gastropod identification book Recent & Fossil Indonesian Shells (Dharma, 2005). In addition, environmental parameter data, including water quality data consisting of temperature, salinity, pH, dissolved oxygen, and substrate, were also measured through in-situ measurements. These parameters were then analyzed based on Government Regulation of the Republic of Indonesia No. 22 of 2021 concerning the implementation of environmental protection and management. Substrate samples were analyzed to determine substrate type using the Wenworth scale to classify grain size, and organic matter content was measured through the C-organic test using the Walkley-Black procedure.

Data Analysis

Data analysis was carried out by calculating the community structure index values, including calculating abundance to determine the density of gastropods referring to Odum (1993) with the following formula:

$$D = \frac{\sum Ni}{A}$$

Information:
D = Abundance of gastropods (ind/m^2)
ni = Number of individuals in the i-th quadrant transect
A = Area of sampling plot (m^2)

The Shannon-Wienner diversity index is calculated based on the Odum (1993) formula, with the following formula:

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

Information:
H' = Diversity Index
ni = Number of individuals of type i
N = Total number of individuals

The diversity index value categories, namely:
H'< 1 = Low diversity
1 < H'<3 = Moderate diversity
H'>3 = High diversity

The uniformity index is calculated to determine the community balance referring to Krebs (1985), with the following formula:

$$E = \frac{H'}{\log 2\ S} = \frac{H'}{Hmaks}$$

Information:
E = Uniformity index
H' = Diversity index
S = Number of species

The category of uniformity index values, namely:
0 < E ≤ 0,4 = Small uniformity, depressed community
0,4 < E ≤ 0,6 = Moderate uniformity, unstable community
0,6 < E ≤ 1 = High uniformity, stable community

And the dominance index is calculated to determine the dominance of certain species in the gastropod community referring to Odum (1993) with the following formula:

$$C = \sum(ni/N)^2$$

Introduction:
C = Dominance index
ni = Number of individuals of type i
N = Total number of individuals

Dominance index value categories, namely:
0 < C < 0,5 : No type dominates
0,5 < C < 1 : There are dominant types

Statistical data analysis was performed using Principal Component Analysis (PCA) using the Microsoft Excel XLSTAT add-in. The PCA method in this study was used to identify the main patterns in the data and the environmental parameters that most influenced the abundance of gastropods at the study site. Interpretation of PCA results was carried out using a descriptive approach through a biplot graph to determine the relationship between variables. If the abundance of gastropods has a high correlation with one of the main components, then the environmental factor that dominates that component can be identified as the main factor influencing gastropod abundance.

RESULT

To support the analysis of gastropod community structure, several environmental parameters were measured at each observation location. These parameter values are shown in Table 1 below.

Table 1. Environmental Parameters

No	Environmental Parameters	Stasiun				PP RI Quality Standards No. 22 of 2021
		1	2	3	4	
1	Temperature	30 ± 0.4	30.42 ± 0.2	31 ± 0.7	31 ± 0.7	28 - 32
2	pH	6.17 ± 0.1*	6.25 ± 0.1*	6.08 ± 0.1*	6.60 ± 0.1*	7 - 8.5
3	Salinity	24.71 ± 0.6	24.63 ± 0.2	25.17 ± 0.2	25.42 ± 0.4	0 - 34
4	Dissolved oxygen	4.98 ± 0.07*	5.21 ± 0.08	4.9 ± 0.18*	5.03 ± 0.09	> 5
5	Substrate Type	Slightly gravelly sand	gravelly sand	Pebbly muddy sand	Pasir Pebbly muddy sand berkerikil	-

* does not comply with quality standards

Substrate characteristics in mangrove ecosystems are one of the determining factors for gastropod habitat. The results of the substrate type analysis at each station are presented in Table 2 below.

Table 2. Sediment Fraction Composition

Stasiun	Texture (%)			Substrate Type
	Gravel	Sand	Mud	
1	0.9	97.3	1.8	Slightly gravelly sand
2	11.6	80.6	7.8	gravelly sand
3	26.3	61.3	12.3	Pebbly muddy sand
4	14.8	68	17.2	Pebbly muddy sand

In addition to substrate texture analysis, organic matter content was also measured to determine the potential nutrients in the sediment that could influence the presence of gastropods.

Table 3. Organic Matter Content

Stasiun	C - Organik (%)	Organic Materials (%)	Classification
1	0.32 - 0.52	0.55 - 0.90	Low
2	0.32 - 0.68	0.55 - 1.17	Low
3	1.2 - 1.68	2.07 - 2.90	Medium - High
4	0.86 - 1.17	1.48 - 2.02	Currently

The gastropod species found at the four mangrove ecosystem research stations on Kejawanan Beach comprised 11 families, 16 genera, and 20 species. The species with the largest number was Littoraria scabra, with 722 individuals, and the species with the smallest number was Ellobium aurisjudae, with 1 individual (Table 4).

Table 4. Composition of Gastropod Species

Famili	Species	Amount
Achatinidae	*Achatina fulica*	3
Ampullariidae	*Pila ampullacea*	2
	Pomacea canaliculata	11
Assimineidae	*Assiminea grayana*	13
Cerithiidae	*Clypeomorus zonata*	10
Clavatulidae	*Turricula javana*	20
Conidae	*Conus sp*	93
Ellobiidae	*Cassidula mustelina*	148
	Cassidula sowerbyana	9
	Cassidula angulifera	580
	Ellobium aurisjudae	1
	Cassidula nucleus	110
	Pythia plicata	95
Littorinidae	*Littoraria sp*	16
	Littoraria scabra	722
	Littoraria carinifera	12
Melongenidae	*Hemifusus ternatanus*	11

Nassariidae	*Nassarius stolatus*	12
Potamididae	*Telescopium telescopium*	47

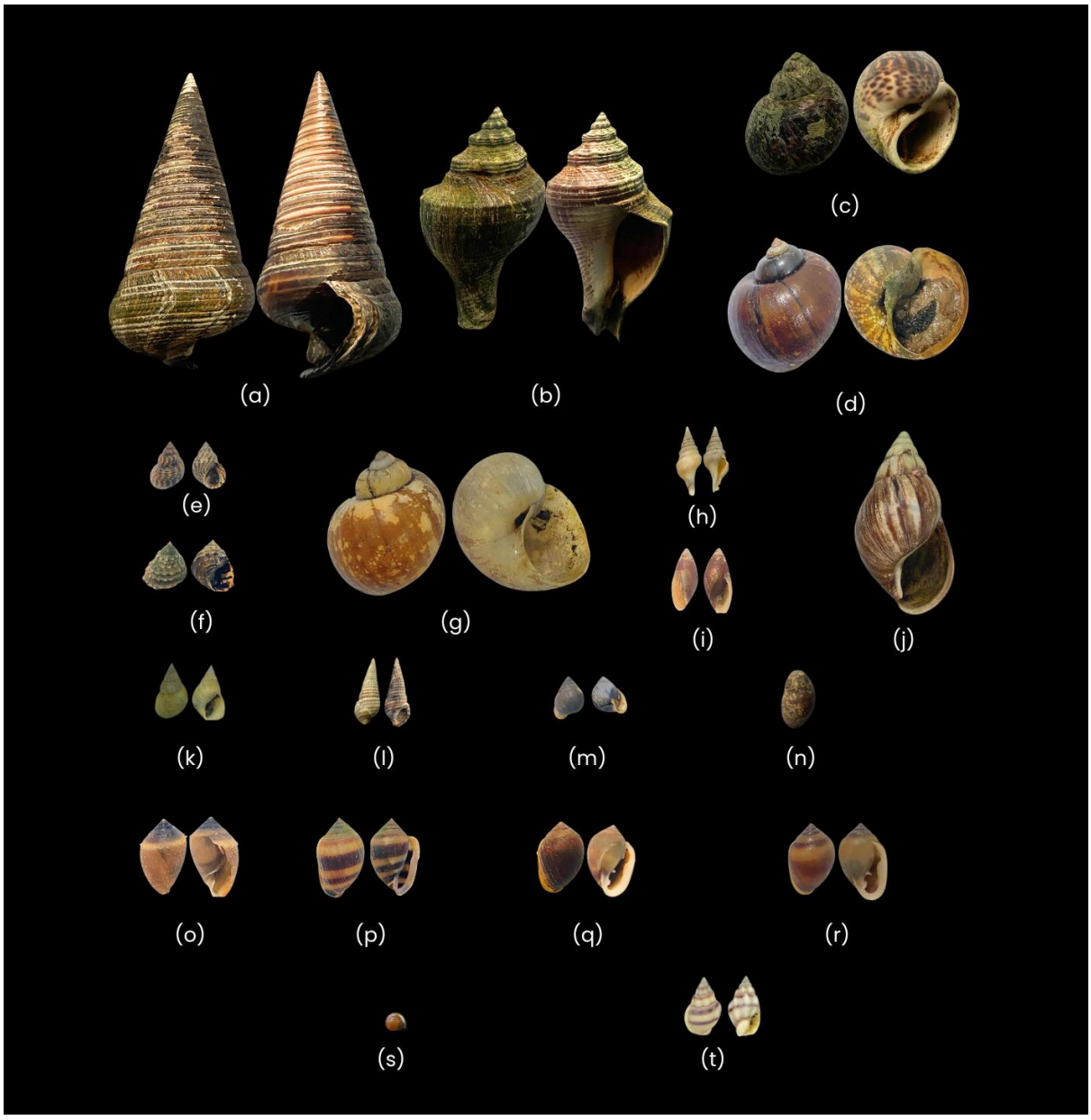

Figure 2. Gastropoda: (a) *Telescopium telescopium.* (b) *Hemifusus ternatanus.* (c) *Paratectonatica tigrina.* (d*) Pila ampullacea.* (e) *Littoraria scabra.* (f) *Littoraria carinifera.* (g) *Pomacea Canaliculata.* (h) *Turricula javana.* (i) *Ellobium aurisjudae.* (j) *Achatina fulica.* (k) *Littoraria sp.* (l) *Clypeomorus zonata.* (m*) Pythia plicata.* (n) *Cassidula sowerbyana.* (o) *Conus sp.* (p) *Cassidula nucleus.* (q) *Cassidula angulifera.* (r) *Cassidula mustelina.* (s) *Assiminea grayana.* (t) *Nassarius stolatus*

The gastropod community structure at each station was analyzed based on individual abundance and ecological index values. The results of these calculations can be seen in Table 5 below.

Table 5. Gastropoda Ecological Index

Stasiun	D	H'	E	C
1	31.27	1.68	0.68	0.28
2	27.20	1.65	0.59	0.34
3	33.67	1.51	0.63	0.30
4	39.00	1.59	0.60	0.27
Average	**32.78**	**1.61**	**0.62**	**0.30**

To reveal the relationship between environmental parameters and gastropod community structure, a Principal Component Analysis (PCA) was conducted. This analysis was conducted to identify the main environmental factors influencing gastropod abundance at the study site.

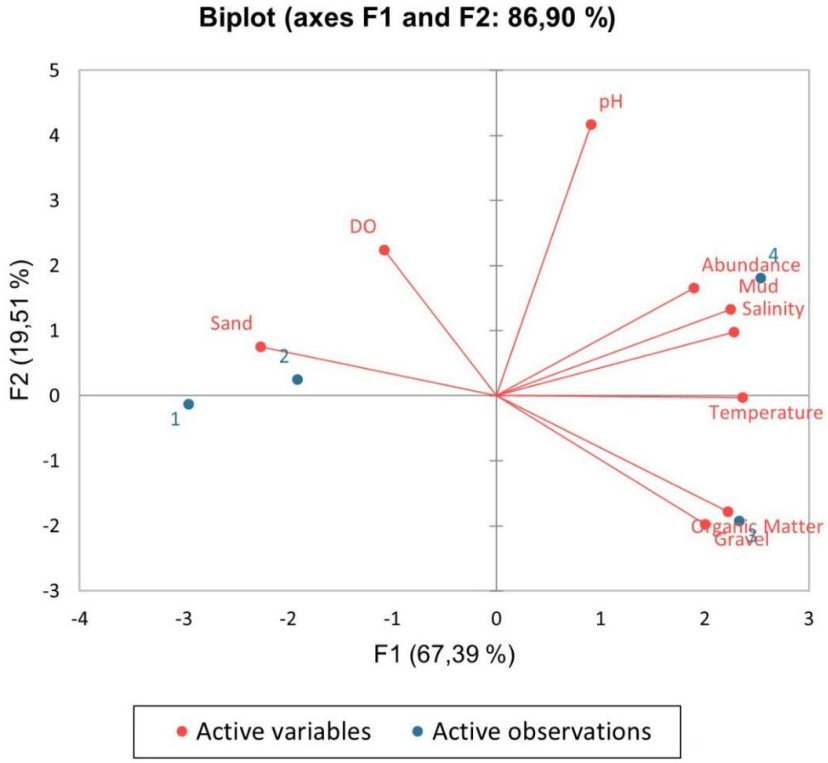

Figure 3. Relationship between Environmental Parameters and Gastropod Abundance

DISCUSSION

Mangrove ecosystems are complex and dynamic coastal ecosystems, where environmental conditions are influenced by various physical, chemical, and biological parameters. Environmental parameters such as temperature, salinity, pH, dissolved oxygen content, and organic matter play a significant role in determining the community structure of organisms living within them, including gastropods. The temperature at Kejawanan Beach showed results ranging from 30 to 31°C, which is still in accordance with the Quality Standards of Government Regulation No. 22 of 2021. This value is also included in the optimal temperature for gastropods to survive and reproduce, namely 29 to 31°C (Hasanah et al., 2023). The degree of acidity (pH) at the research location was in the range of 6.08 to 6.6. This value does not comply with the quality standards, where the ideal pH value for a mangrove ecosystem is in the range of 7 to 8.5. Meanwhile, gastropods generally require a relatively stable water pH ranging from 7 to 8 (Merly & Elviana, 2017). However, Rosanti (2010) stated that gastropod life may still exist at pH values between 5 and 9. The salinity at the research location

ranges from 24.63 to 25.42‰. The salinity range at all stations is in accordance with the quality standards, where all values are good enough for gastropod life. Gastropods require optimal salinity for their growth and survival, which is around 28-34 ppt. However, based on the statement of Ariska (2012) in Suriani et al. (2022), gastropods are generally still able to tolerate wider environmental salinity conditions, namely between 25-40 ppt. The dissolved oxygen content at the research location ranges from 4.98 to 5.21. This range of values is still in accordance with the quality standards, although at stations 1 and 3 there are still DO values of <5. The low DO value is thought to be caused by the measurement of this value being carried out during high tide conditions. According to Poedjirahajoe et al. (2017) in Nurmalasari et al. (2024), tidal conditions in waters can transport muddy material and increase water turbidity. High turbidity levels inhibit sunlight penetration into the waters, thus suboptimal phytoplankton photosynthesis and resulting in low dissolved oxygen production.

The sediment fraction composition at Kejawanan Beach consists of gravel, sand, and mud, with the sand fraction being more dominant than the others. According to Nurainie & Wiyanto (2021), the dominant sand type at the study site is its location in open water. Meanwhile, the organic matter content in the sediment shows a low-high classification. The lowest organic matter value was found at station 1, with a slightly gravelly sand substrate. This low value may be due to the substrate type at that station. Sahilla et al. (2023) explained that gravelly sand substrates collect less organic matter carried by the water supply, thus impacting the low organic matter content in the substrate.

The average abundance of gastropods at the study site was 32.78 individuals/m2. The highest abundance of gastropods was found at station 4, at 39.27 individuals/m2. The high abundance of gastropods at station 4 is thought to be due, among other things, to the moderate organic matter content (1.48 - 2.02%) that serves as a food source for the gastropods. Another factor contributing to the high abundance at this station is thought to be the low level of interspecific competition and the presence of predators. This was revealed by Silaen et al. (2013) who stated that in addition to food availability, gastropod abundance can also be influenced by changes in habitat, food availability, predators, and competition.

The average value of the gastropod diversity index at the study site falls into the moderate diversity category (1.61), reflecting a moderate distribution of individuals among species and indicating a moderate level of community stability (Jana et al., 2024). Meanwhile, the average value of the gastropod evenness index at the study site falls into the moderate evenness and unstable community category (0.62), indicating that the gastropod community is quite stable, although not yet completely even. Some species appear more dominant than others, but other species are still present in sufficient numbers to maintain community diversity. Furthermore, the average value of the gastropod dominance index at the study site falls into the category of no dominant species (0.30). Although several species were found in large numbers, their dominance index values approached zero. It can be concluded that the gastropod community structure in the Kejawanan Beach mangrove ecosystem is unstable, and there is no excessive ecological pressure on the biota within the ecosystem.

To reveal the relationship between environmental parameters and gastropod abundance, a PCA analysis was conducted (Figure 3). The results showed that salinity and mud parameters had a strong relationship with gastropod abundance at the study site. This is because the mud fraction has a higher organic matter content due to dense pore spaces (Taqwa et al., 2014). Generally, the higher the organic matter content, the greater the abundance of gastropods in the waters. This is supported by the results of research by Prasetia et al. (2019), which showed that organic matter has a strong influence or correlation with gastropod abundance. In addition to the mud fraction, salinity parameters also have a strong relationship with gastropod abundance. Salinity is a major environmental factor affecting gastropod abundance in mangrove ecosystems because gastropods have varying osmotic tolerance limits to salinity levels.

Therefore, changes in salinity will directly affect the ability of gastropods to survive, grow, and reproduce. In addition, temperature, organic matter content, pH, and gravel fraction also have a positive correlation with gastropod abundance. This indicates that increasing these parameters has the potential to support an increase in the number of gastropods in the study area. Meanwhile, gastropod abundance showed a negative correlation with sand and DO parameters. This suggests that gastropods tend to be more abundant in muddy, flooded, and organic-rich environments. Sand substrates are typically poor in organic matter and unstable for gastropod movement or shelter (Komang et al., 2024). Meanwhile, high DO is often found in open or non-flooded areas, which are less suitable for detritivorous gastropods accustomed to living in the anaerobic conditions typical of mangroves. This indicates that humid, muddy, and detritus-rich habitats are more supportive of the presence of gastropods in the study area.

CONCLUSION

The structure of the gastropod community in the Kejawanan Beach mangrove ecosystem shows that there are 12 families, including Potamididae, Littorinidae, Cerithiidae, Ellobiidae, Naticidae, Melongenidae, Coniidae, Nassariidae, Clavatulidae, Assimineidae, Ampullariidae, Achatinidae, and there are 16 genera and 20 species of gastropods in it. The total abundance of gastropods is 32.78 ind/m2. The diversity (H') obtained is included in the medium diversity category, namely 1.61. The evenness (E) obtained is included in the medium evenness category and the unstable community, namely 0.62. The dominance (C) of gastropods shows that there is no dominant species at all stations. The abundance of gastropods in the Kejawanan Beach mangrove ecosystem shows a close and positive relationship with environmental parameters in the form of mud fraction and salinity, but has a negative correlation with sand fraction and Dissolved Oxygen (DO).

ACKNOWLEDGEMENT

The author would like to express his gratitude to Donny Juliandri Prihadi, S.Pi., M.Sc., CPM., Ph.D.; Asep Sahidin S.Pi., M.Si., Ph.D.; Dr. Sunarto, S.Pi., M.Si. and Dr. Agr. Sc. Neng Tanty Sofyana S.Pi., M.Eng., as the supervisors and advisors, for their guidance, advice, and direction during the research process and the writing of this article.

REFERENCES

Anggreiny, R., Pratiwi, F. D., & Farhaby, A. M. (2025). Hubungan Bahan Organik dengan Keberadaan Gastropoda pada Ekosistem Mangrove di Desa Riding Panjang. *Jurnal Laut Khatulistiwa*, *8*(1), 10–24.

Darwati, H., Poedjirahajoe, E., Sadono, R., & Soewarno, H. B. (2022). Characteristics of Waters and Dominant Mangrove Species in Padang Tikar II, Kubu Raya District, West Kalimantan. *Jurnal Hutan Lestari*, *10*(4), 1002–1009.

Dharma, B. (2005). *Recent & Fossil Indonesian shells* (1st ed.). Hackenheim, Germany: ConchBooks

Hasanah, H., Ramdani, A., & Syukur, A. (2023). Struktur Komunitas Gastropoda pada Kawasan Mangrove Pantai Gerupuk Lombok Tengah. *Jurnal Sains Teknologi & Lingkungan, 9*(1), 44–59. https://doi.org/10.29303/jstl.v9i1.419.

Hulopi, M., De Queljoe, K. M., & Uneputty, P. A. (2022). Keanekaragaman Gastropoda di Ekosistem Mangrove Pantai Negeri Passo Kecamatan Baguala Kota Ambon. *TRITON: Jurnal Manajemen Sumberdaya Perairan, 18*(2), 121–132. https://doi.org/10.30598/tritonvol18issue2page121-132.

Jana, F. G., Afifa, F. H., Triajie, H., Abida, I. W., & Pramithasari, F. A. (2024). Biodiversitas Gastropoda Berdasarkan Tipe Sedimen pada Kawasan Ekosistem Mangrove Kecamatan Socah, Kabupaten Bangkalan. *Juvenil: Jurnal Ilmiah Kelautan dan Perikanan*, *5*(4),

354–364. https://doi.org/10.21107/juvenil.v5i4.26537.

Komang, N., Wulandari, P., Ernawati, N. M., Luh, N., Rai, G., & Saraswati, A. (2024). Estimasi Total Simpanan Karbon Hutan Mangrove Teluk Gilimanuk, Bali. *Buletin Oseanografi Marina, 13*(3), 424–436. https://doi.org/10.14710/buloma.v13i3.63104

Krebs, C. J. (1985). *Ecology: The Experimental Analysis of Distribution and Abundance* (3rd ed.). New York, NY: Harper & Row.

Kurniawan, R. D. B. (2015). Komposisi, Keanekaragaman, dan Pola Sebaran Jenis Penyusun Vegetasi Mangrove di Pantai Kejawanan, Kota Cirebon, Jawa Barat (*Skripsi sarjana*, Universitas Gadjah Mada).

Merly, S. L., & Elviana, S. (2017). Korelasi Sebaran Gastropoda dan Bahan Organik Dasar pada Ekosistem Mangrove di Perairan Pantai Payum, Merauke. *Agricola*, *7*(1), 56–67. https://doi.org/10.35724/ag.v7i1.590.

Nurainie, I., & Wiyanto, D. B. (2021). Karakteristik Sebaran Sedimen Dasar di Perairan Kalianget Kabupaten Sumenep. *Juvenil: Jurnal Ilmiah Kelautan dan Perikanan, 2*(3), 243–254. https://doi.org/10.21107/juvenil.v2i3.11713.

Nurmalasari, Y., Aji, I. M. L., & Sari, D. P. (2024). Hubungan Parameter Lingkungan dengan Morfometrik Daun Mangrove Jenis *Rhizophora mucronata* pada Kawasan Mangrove Desa Labuan Tereng Kabupaten Lombok Barat. *ULIN: Jurnal Hutan Tropis, 8*(2), 7. https://doi.org/10.32522/ujht.v8i2.13989

Odum, E. (1993). *Dasar-Dasar Ekologi* (T. Samingan (ed.); Ketiga). Gadjah Mada University.

Pietersz, J. H., Pentury, R., & Uneputty, P. A. (2022). Keanekaragaman Gastropoda Berdasarkan Jenis Mangrove pada Pesisir Pantai Desa Waiheru. *TRITON: Jurnal Manajemen Sumberdaya Perairan, 18*(2), 103–109. https://doi.org/10.30598/tritonvol18issue2page103-109

PP RI. (2021). *Penyelenggaraan Perlindungan dan Pengelolaan Lingkungan Hidup* (22).

Pratama, M. T., Zahidah, Bachtiar, E., Prasetiawan, N. R., & Arief, M. C. W. (2024). Keanekaragaman Gastropoda pada Berbagai Kondisi Kawasan Ekowisata Mangrove. *JST (Jurnal Sains dan Teknologi), 12*(3), 790–803. https://doi.org/10.23887/jstundiksha.v12i3.54498.

Prihadi, D. J., Zhang, G., Junirahma, N. S., Pamungkas, W., Dhahiyat, A. P., & Annida, S. B. (2024). A Tourist Destination and Conservation Area for Mangroves in Karangsong Mangroves Ecotourism, District Karangsong, Indramayu regency, West Java Province. *Migration Letters, 21*(5), 1036–1050.

Puryono, S., & Suryanti, S. (2019). Gastropod Diversity in Mangrove Forests of Mojo Village, Ulujami District, Pemalang Regency, Indonesia. *Journal of Ecological Engineering, 20*(1), 165–173. https://doi.org/10.12911/22998993/93940.

Prasetia, M. N., Supriharyono, S., & Purwanti, F. (2019). Hubungan Kandungan Bahan Organik dengan Kelimpahan dan Keanekaragaman Gastropoda pada Kawasan Wisata Mangrove Desa Bedono Demak. *Management of Aquatic Resources Journal (MAQUARES), 8*(2), 87–92. https://doi.org/10.14710/marj.v8i2.24231.

Rosanti, D. (2010). Struktur Populasi *Assiminea brevicula* pada Zona Avicennia Hutan Mangrove Desa Sungai Batang Kabupaten Ogan Komering Ilir. *Sainmatika: Jurnal Ilmiah Matematika dan Ilmu Pengetahuan Alam, 7*(2), 59–65. https://doi.org/10.31851/sainmatika.v7i2.18.

Sahilla, D., Susiana, S., Kurniawan, D., Rochmady, R., & Karyawati, K. (2023). Struktur Komunitas Bivalvia di Perairan Pulau Terkulai Kota Tanjungpinang. *Agrikan: Jurnal Agribisnis Perikanan, 16*(2), 191–199. https://doi.org/10.29239/j.agrikan.16.2.191-199.

Setiawan, H. (2013). Status Ekologi Hutan Mangrove pada Berbagai Tingkat Ketebalan. *Jurnal Penelitian Kehutanan Wallacea, 2*(2), 104. https://doi.org/10.18330/jwallacea.2013.vol2iss2pp104-120

Silaen, I. F., Hendrarto, B., & Nitisupardjo, M. (2013). Distribusi dan Kelimpahan Gastropoda pada Hutan Mangrove Teluk Awur Jepara. *Management of Aquatic Resources Journal (MAQUARES), 2*(3), 93–103. https://doi.org/10.14710/marj.v2i3.418

Suriani, M., Bahri, S., Gazali, M., & Rahmi, M. M. (2022). Kepadatan dan Pola Distribusi *Terebralia palustris* dalam Perairan Ekowisata Mangrove Gampong Baro Kecamatan Setia Bakti Kabupaten Aceh Jaya. *Jurnal Laot Ilmu Kelautan, 4*(1), 28–39. https://doi.org/10.35308/jlik.v4i1.4921.

Taluke, D., Lakat, R. S. M., & Sembel, A. (2019). Analisis Preferensi Masyarakat dalam Pengelolaan Ekosistem Mangrove di Pesisir Pantai Kecamatan Loloda Kabupaten Halmahera Barat. *SPASIAL: Jurnal Perencanaan Wilayah dan Kota, 6*(2), 531–540. https://doi.org/10.35793/sp.v6i2.25357.

aqwa, R. N., & Muskananfola, M. R. (2014). Studi Hubungan Substrat Dasar dan Kandungan Bahan Organik dalam Sedimen dengan Kelimpahan Hewan Makrobenthos di Muara Sungai Sayung Kabupaten Demak. *Management of Aquatic Resources Journal (MAQUARES), 3*(1), 125–133. https://doi.org/10.14710/marj.v3i1.4429.

Umah, K., Subiyanto, -, & Hartoko, A. (2013). Struktur Sedimen dan Sebaran Kerang Pisau (*Solen lamarckii*) di Pantai Kejawanan Cirebon Jawa Barat. Management of Aquatic Resources Journal (MAQUARES), 2(3), 65–73. https://doi.org/10.14710/marj.v2i3.4183