Available online at BIOMA: Jurnal Ilmiah Biologi
Websites:http://journal.upgris.ac.id/index.php/bioma/index
BIOMA: Jurnal Ilmiah Biologi, 13 (1), April 2024, 50-68
DOI: https://doi.org/10.26877/bioma.v13i1.661

MOLLUSCAN DIVERSITY THE MANGROVE ECOSYSTEM OF TARAKAN ISLAND INDONESIA

Bimo Aji Nugroho[1]*, Erisa Ayu Waspadi Putri[2]
[1]Study Program of Biology Education, Faculty of Teacher Training and Education, Universitas Borneo Tarakan, Jalan Amal Lama No. 1, Kota Tarakan, Kalimantan Utara, Indonesia, 77115.
[2]Forestry Departement, Faculty of Forestry, Universitas Tanjungpura, Jl. Prof. Dr. H Jl. Profesor Dokter H. Hadari Nawawi, Bansir Laut, Kota Pontianak, Kalimantan Barat, Indonesia 78124.
**Corresponding author bimoajinugroho29@borneo.ac.id*

ARTICLE INFO

Article history
Submission 2024-01-04
Revision 2024-03-15
Accepted 2024-04-20

Keywords:
Conservation
Gastropods
Mangrove
Molluscan
Tarakan

ABSTRACT

This study evaluated the diversity, dominance, and evenness of Mollusca communities in five mangrove locations on Tarakan Island in the face of threats from increasing human population, habitat destruction, and pollution along the coast. The study, conducted from March to August 2023, recorded the distribution of 54 Mollusca species, consisting of 46 species of Gastropoda and 8 species of Bivalvia. The study recorded the highest diversity index (H') of 2.84 for Gastropoda on Andang Island (PA) and the lowest of 1.92 in Gusong Mangrove (GM). In contrast, Bivalvia demonstrated higher dominance in several locations, particularly in Pennsylvania, with a dominance index (D) of 0.75. The Juwata mangrove forest, located in the northern part of Tarakan Island, exhibited the highest overall diversity. The results of this study document in detail the diversity of Mollusca species in the mangrove ecosystem of Tarakan Island, providing important baseline data to support conservation and management efforts for mangrove ecosystems in this region.

INTRODUCTION

Mangroves are a vascularized vegetation that has been adapted morphologically and physiologically as well due to the dynamics and physical characteristic of coastal zone (Ong & Gong, 2013). Mangrove also hold significant role to the coastal ecosystem because typical colonies were the habitat of numerous aquatic faunas. As a habitat, mangroves could be a feeding ground (Kumari et al., 2020), spawning ground (Rasmeemasmuang & Sasaki, 2015) and animal shelter from predators (Raghunathan et al., 2018). Mangroves also a foundation of a complex yet diverse ecosystem that can be found along the coasts of tropic and subtropics worldwide Contreras et al., 2018; Kruitwagen et al., 2010). Moreover, mangroves also perform as a protective barrier against predators within their root systems, while also serving as a habitat for various species of organisms, including corals, ascidians, barnacles, molluscan, and sponges (Lazzeri, 2017). Molluscan are an essential component of the mangrove ecosystem, serving as water filters, herbivores, predators, or detritivores.

The inevitable urbanization growth along the littoral (Jacquot et al., 2023) lead to the domination of man-made buildings rather than natural ecosystem barrier named mangrove (Kenworthy et al., 2018). Moreover, mangrove forests are subject to anthropogenic pressure due to building projects, garbage dumps (Kesavan et al., 2021), industrial waste (Afonso et al., 2023), ship operations and shrimp ponds (Guerra-García et al., 2021). Uncertainty of natural cycle and environmental processes arise by climate change (Fanous et al., 2023) and human activities are also important factors that exacerbate coastal vulnerability. (Gayo, 2022; Sohaib et al., 2023; Sudhir et al., 2022). This change endangers the flora and fauna in the mangrove ecosystem (Come et al., 2023). The diversity of flora and fauna can be significantly influenced even by minor adjustments leading to the local extinctions.

Molluscan, one of the animals living in the mangrove ecosystem also influenced by the degradation mentioned (Bürkli & Wilson, 2017; Verones et al., 2022). Molluscans constitute a highly heterogeneous and extensively dispersed taxonomic group (López-Alonso et al., 2022). The second most varies invertebrates in terms of diversity which are estimated more than 0.2 million. Approximately 85,000 species have been documented including 52,525 marine molluscans, 24,000 terrestrial molluscans, and 7,000 found in freshwater ecosystems (Chapman, 2009). In addition, moluccas have significant ecological and economic value as food and cosmetic ingredients (Boissery et al., 2022; Duke & Larkum, 2019). Molluscs are one of the dominant groups in marine communities and contribute greatly to local biodiversity (Rueda et al., 2009; Rubal et al., 2018), comprising up to 25% of species in marine benthos (Appeltans et al., 2012). Furthermore, studies on the spatial and temporal distribution patterns of molluscs are generally considered a proxy for the entire marine benthic community (Martins et al., 2014).

Tarakan was a small populous island located in the northern of Borneo. The characteristic of typical small island tends to surround by mangrove ecosystem. However, the densely populated of the island conduce and accelerate coastal degradation of the mangrove ecosystem which directly hits molluscans population. To minimize the degradation leads to molluscans extincion, safeguarding and conserving the mangrove ecosystem of Tarakan Island require a spotlight effort. However, the conservation effort needed to be conduct with an initial study of existing species availability. Study literature found there numerous molluscan identification study conducted specifically in Indonesia include in Tanah Laut (Nugroho et al., 2019), Tolitoli (Yanti et al., 2022), Banyuwangi (Budiawan et al., 2020), Ambon (Pietersz et al., 2022) , Madura (Adharyan Islamy & Hasan, 2020), Rembang (Astriana et al., 2022), Sambas (Ernawati et al., 2019), Mempawah (Sari et al., 2020), and Bangka (Yuliawati et al., 2021). Those study revealed the molluscan species found in the terrestrial arboreal and coastal as well. However, the molluscans study conducted in Tarakan island found in a minimal number, so this study tried to enrich the recognition of the molluscan in Tarakan. Particularly, this study focused on species inventory of molluscans in the mangrove ecosystem of Tarakan Island.

MATERIALS AND METHODS

Detailed description of the region

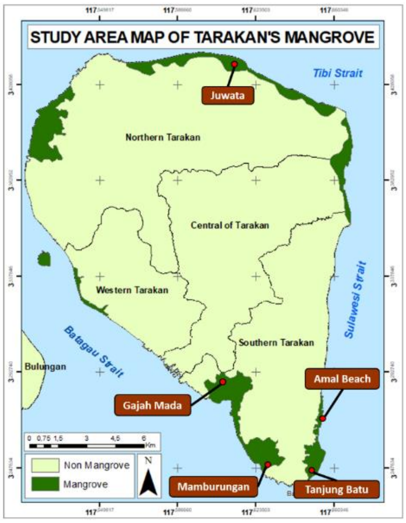

Figure 1. Map showing the study areas in mangrove ecosystem of Tarakan. Figure Legend: Gajah Mada (GM), Mamburungan (MB), Tanjung Batu (TB), Juwata (JW), and Amal Beach (PA).

Situated at the northernmost point of the island of Kalimantan, the island is coordinated by the coordinates 117°30'50"–117°40'12" BT and 3°14'23"–3°26'37" LU. Five neighboring regions comprise the island's mangrove forests: Gajah Mada (GM) at coordinates (N 3°18'15", E 117°34'35), Mamburungan (MB) at 3°16'25", E 118°36'45, Tanjung Batu (TB) at 4°14'27", E 113°38'53, Juwata (JW) at 2°26'21", E 117.34'33", and Amal Beach (PA) at 5°15'33"E 117°39'13.

Collection of specimens

Based on the diversity and habitat characteristics of Figure 1, we selected 5 locations on Tarakan Island, namely Gajah Mada, Mamburungan, Tanjung Batu, Juwata, and Amal Beach, to evaluate the diversity of molluscs. These locations were selected based on their diversity and the characteristics of the habitats depicted in Figure 1. Surveys were done from March to August 2023, coinciding with the watershed period. We made a 100-meter transect line perpendicular from the shoreline to the mangrove forest at each of the 5 locations. Every 10 m of the transect line formed a square (1 x 1 m), with 3 transects at each observation location, and a total of 30 plots at each location covering the entire study area (Figure 2).

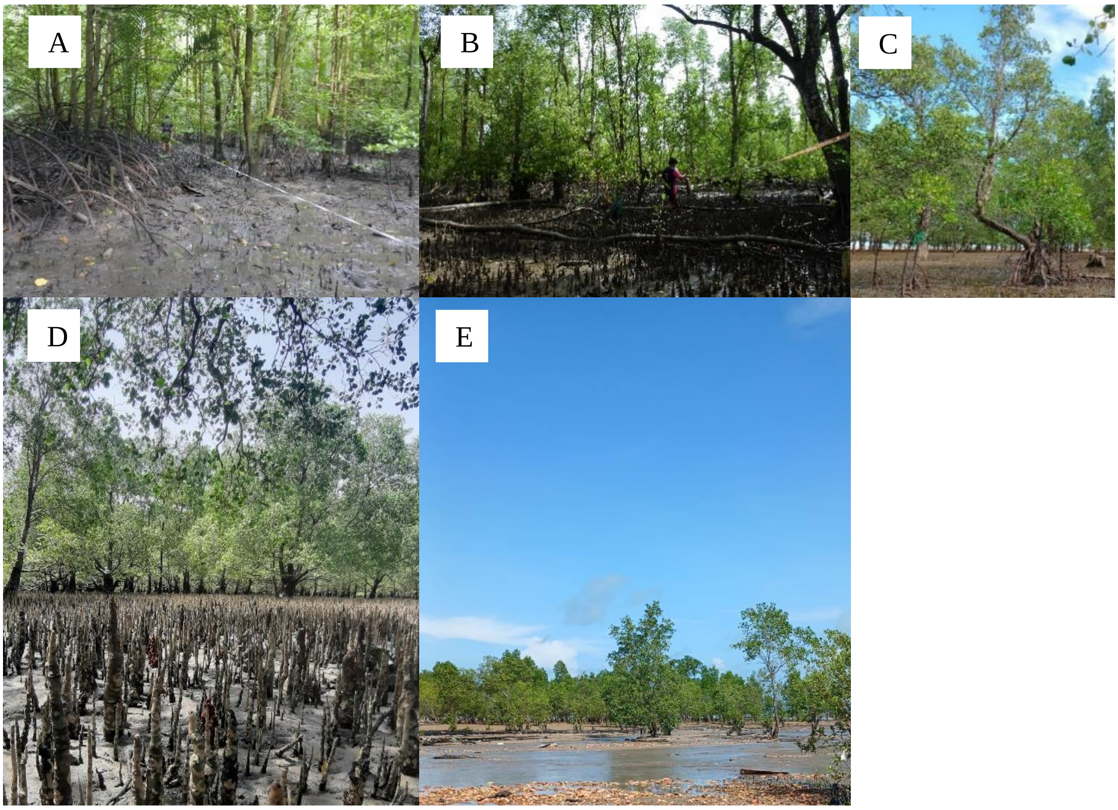

Figure 2. Research location A. Gajah Mada, B. Mamburungan, C. Pantai Amal, D. Tanjung Batu, E. Juwata

Molluscan of various species are systematically collected from square areas, while arboreal Molluscan are obtained from specific structures found in mangroves, such as stems, roots, and pneumatofor. Bivalvia encompasses the remains and scales obtained by abrasion of surfaces such as rocks and shells. The identification process involved referencing taxonomic descriptions provided by (Abbott & Dance, 1982), (Carpenter & Niem, 1998), and (2018) (Jagadis et al., 2018), as well as examining earlier specimens from other locations (Golding et al., 2007).

Statistical analyses

The study's analysis aimed to depict the state of Mollusca in Tarakan Island's mangrove forest area. We calculate the diversity index using the Shannon-Wiener formula (Krebs, 1994). We calculate the dominance index using the dominance formula (D) Simpson (Krebs, 1994). The Morisita index is used to determine the species distribution pattern in the habitat (Brower & Zar, 1998).

RESULTS AND DISCUSSION

In the coastal region of Tarakan Island, a grand total of 54 species were documented. Along the coast of Tarakan Island, up to 46 species of gastropods predominate. As shown in Table 1, bivalves contain eight species. Varying between 20 and 34 species complete the species diversity in each region of Tarakan Island. Bullidae (129), Assimineidae (375), Cerithiidae (463), Littorinidae (550), Nassariidae (158), Neritidae (617), and Potamididae (217) comprise the majority of gastropod families. Mactridae (117) and Placunidae (25) are the subsequent most numerous bivalve families. Apparent arboreal members of the Littorinidae family inhabit the bark, roots, and leaves of mangrove trees. The Amal Beach mangrove forest exhibited the greatest diversity of Molluscan (38 species), whereas the Tanjung Batu mangrove forest exhibited the least (26 species). Certain categories of gastropods, including those belonging to the genera Cerithidea, Cassidula, Melampus, Littoraria, Telescopium, Neripteron, and Pirenella, were found exclusively in muddy substrate mangrove environments. Nerita and Nassarius species are frequently encountered in both mangrove and non-mangrove habitats characterised by rocky substraits. Species of Spisula, the resultant bivalves, were exclusively detected in mangrove habitats.

In every area surveyed, Littoraria melanostoma and Bulla striata were identified. Polinices flemingianus and Polinices mammilla are frequently observed exhibiting activity during low tide in mangroves characterised by sandy substrates. Species of Clithon are frequently observed affixed to roots or concealed behind rocks during low tide, where they establish colonies. All study locations produced representatives of the Ellobidae family, with the exception of Mamburungan mangrove forest, where Auriculastra radiolata was exclusively documented. Saccostrea cucullata and other edible oysters are typically discovered attached to rocks or mangrove forests. Gathering rock oysters from the designated area during low tide can be utilised as a nutrition source. Destroyed piles of Telscopium telescopum shells, which had been utilised as bait or as food, were observed in the mangrove forest (site).

Table 1. List of Molluscann species recorded in mangrove ecosystem of Tarakan Island.

No.	Famili	Spesises	Tarakan Island Mangrove Forest Area				
			GM	MB	TB	PA	JW
Bivalvia							
1	Placunidae	*Placuna sella* (Gmelin, 1791)	4	-	-	4	17
2	Mactridae	*Spisula raveneli* (Conrad, 1832)	-	-	4	3	5
3		*Spisula subtruncata* (da Costa, 1778)	-	2	2	3	-
4		*Meretrix meretrix* (Linnaeus, 1758)	-	-	4	93	1
5	Pholadidae	*Cyrtopleura costata* (Linnaeus, 1758)	-	-	1	-	2
6	Ostreidae	*Saccostrea cuccullata* (Born, 1778)	-	-	1	-	3
7	Arcidae	*Anadara granosa* (Linnaeus, 1758)	2	4	1	5	-
8	Hipponicidae	*Cheilea cicatricosa* (Reeve, 1858)	-	-	-	-	1
	Total attendance		2	2	6	5	6
	Sub-total		6	6	13	108	29
Gasropoda							
1	Ariophantidae	*Macrochlamys indica* (Godwin-Austen, 1883)	-	-	1	3	-
2		*Subulina octona* (Bruguière, 1789)	2	1	-	-	1
3	Assimineidae	*Assiminea brevicula* (L. Pfeiffer, 1855)	283	90	-	1	1
4	Cerithiidae	*Cerithium coralium* (Kiener, 1841)	-	363	-	10	3
5		*Clypeomorus pellucida* (Hombron & Jacquinot, 1848)	-	3	1	3	2
6		Cerithium dialeucum (R. A. Philippi, 1849)	-	57	-	19	2
7	Costellariidae	*Vexillum maduranum* (Dekkers, 2007)	1	-	3	11	-
8	Ellobiidae	*Cassidula aurisfelis* (Bruguière, 1789)	-	6	-	-	-
9		*Pythia pachyodon* (Pilsbry & Y. Hirase, 1908)	4	-	1	4	11
10		*Cassidula nucleus* (Gmelin, 1791)	11	15	-	-	4
11		*Auriculastra radiolata* (Morelet, 1860)	2	-	2	-	1
12		*Pythia cecillei* (R. A. Philippi, 1847)	-	1	-	-	-
13		*Pythia plicata* (Ferussac, 1821)	-	1	-	1	-
14	Haminoeidae	*Haminoea navicula* (da Costa, 1778)	13	-	-	-	-
15	Littorinidae	*Littoraria filosa* (G. B. Sowerby I, 1832)	-	18	126	5	51
16		*Littoraria melanostoma* (Gray, 1839)	10	6	69	-	36
17		*Littoraria bengalensis* (D. Reid, 2001)	23	2	34	6	60
18		*Littoraria intermedia* (R. A. Philippi, 1846)	-	4	31	2	67
19	Mangeliidae	*Eucithara antillarum* (Reeve, 1846)	-	-	-	9	1
20		*Volema myristica* (Röding, 1798)	6	-	-	2	-
21	Nassariidae	*Chicoreus capucinus* (Lamarck, 1822)	4	50	-	19	1
22		*Indothais gradata* (Jonas, 1846)	2	5	-	-	1
23		*Stramonita haemastoma* (Linnaeus, 1767)	-	4	-	4	1

No.	Famili	Spesises	Tarakan Island Mangrove Forest Area				
			GM	MB	TB	PA	JW
24		*Muricopsis chiarae* (Bozzetti, 1991)	7	-	4	-	1
25		*Nassarius melanioides* (Reeve, 1853)	7	-	-	4	1
26		*Nassarius olivaceus* (Bruguière, 1789)	4	-	6	4	-
27		*Nassarius pullus* (Linnaeus, 1758)	1	-	2	6	-
28		*Nassarius stolatus* (Gmelin, 1791)	-	-	9	3	8
29	Neritidae	*Clithon oulaniensis* (Lesson, 1831)	-	-	-	3	-
30		*Nerita balteata* (Reeve, 1855)	-	-	84	2	57
31		*Neritina cornucopia* (W. H. Benson, 1836)	-	-	-	3	-
32		*Nerita squamulata* (Linnaeus, 1758)	-	-	99	5	43
33		*Clithon castaneum* (Hombron & Jacquinot, 1848)	-	-	-	51	-
34		*Nerita chamaeleon* (Linnaeus, 1758)	-	-	22	-	4
35		*Nerita oryzarum* (Récluz, 1841)	-	-	113	2	45
36		*Nerita fulgurans* (Gmelin, 1791)	-	-	30	72	36
37	Potamididae	*Cerithidea obtusa* (Lamarck, 1822)	-	-	-	16	1
38		*Cerithidea quoyii* (Hombron & Jacquinot, 1848)	1	4	-	5	5
39		*Pirenella alata* (R. A. Philippi, 1849)	49	114	-	8	2
40		*Telescopium mauritsi* (Butot, 1954)	8	2	-	4	2
41	Columbellidae	*Zafra minuscula* (Gould, 1860)	-	14	4	-	2
42	Naticidae	*Notocochlis tigrina* (Röding, 1798)	-	-	3	5	1
43		*Polinices didyma* (Röding, 1798)	1	3	-	3	1
44		*Polinices mammilla* (Linnaeus, 1758)	-	-	1	5	1
45	Trochidae	*Umbonium vestiarium* (Linnaeus, 1758)	-	-	-	9	5
46	Bullidae	*Bulla striata* (Bruguière, 1792)	7	11	-	-	2
	Total attendance		21	20	15	28	25
	Sub-total		28	25	20	33	34

In mangrove regions, the diversity of gastropods is greater than that of bivalves because gastropods are more resistant to the harsh conditions of the mangrove environment (Nugroho et al., 2019). Moreover, numerous examples of physiological adaptations exist (Leung et al., 2020; Stickle et al., 2015), morphological (Gutierrez, 1988), and behavioral (Chapperon et al., 2017; Iacarella & Helmuth, 2011; Reid, 1985). These adaptations may differ throughout different life stages (Tanaka & Maia, 2006; Waki, 2017). The specifics of the research's findings are presented in **Table 1**. The findings of this research indicate that the Mamburungan and Tanjung Batu ecosystems possess the greatest diversity of Molluscan, as illustrated in the table 1. Finding of this reaserch was found to be associated with the favourable ecological conditions that continue to exist in both habitats. The physical characteristics of the environment have a crucial role in the survival and activity of gastropods. A favorable habitat is essential for their breeding, foraging, and overall existence (Pyron & Brown, 2015; Satyam & Thiruchitrambalam, 2018). The *Avicennia marina* species is the dominant plant in the coastal mangroves of Tarakan Island. This species is known to create a suitable habitat and provide food, which results in a high diversity of Molluscan. Additionally, it has been observed that the presence of *Avicennia marina* can lower the pH of the environment (Kabir et al., 2014; Mohanta et al., 2020).

The dominant families in the mangrove area are Ellobidae, Littorinidae, Potamididae, and Neritidae. These families are frequently observed in Southeast Asia and the Indo-Pacific (Kantharajan et al., 2018; Mohanraju, 2015). Bivalves are typically found in a restricted range inside the tidal zone due to their specialized diet of larvae and specific environmental needs (Meijer et al., 2021; Queiroz et al., 2020; Vorsatz et al., 2021). There were a restricted number of species observed, precisely 8 types. Meretrix meretrix significantly dominates the mangrove environment. The species exhibits dominance due to its capacity to acclimate to fluctuations in the tidal ecosystem of the mangrove region (Kabir et al., 2014; Kruitwagen et al., 2010).

The mangrove forest on Tarakan Island is severely impacted by illegal logging of mangroves, as well as the introduction of harmful substances and pollutants, particularly from both treated and untreated wastewaterFurthermore, the growth of fish and prawn ponds on Tarakan Island diminishes the area occupied by mangroves, which consequently depletes carbon stocks (Eid et al., 2020), the decrease in organic sediment (Bao et al., 2013), and the deterioration of community health (Sowah et al., 2023). Complex waste management and subsequent impacts on coastal ecosystems ensue as a direct consequence of the correlation between the quantity of garbage produced and the increase in human population (Asante et al., 2023; Jacquot et al., 2023; Sobhani & Danehkar, 2023).

Anadara granosa, *Saccostrea cuccullata*, and *Meretrix meretrix* contribute to inland fisheries in various nations, including Indonesia (Astriana et al., 2022; Kasnadiya et al., 2023; Rohmah & Muhsoni, 2020). Further research is needed to determine the extent to which the reduction in environmental conditions of the mangrove ecosystem on Tarakan Island affects Molluscan species along the shore. The characteristics of mangroves are dominated by tides. Plastic and polyethylene provide a significant risk to biodiversity in several mangrove habitats worldwide (Ahmed et al., 2022; Johnson et al., 2023; Mendes et al., 2023; Xiao et al., 2021). At high tide, plastic garbage originating from residential areas in nearby neighborhoods will accumulate. Rubbish accumulates above mangroves due to their intricate root system. Consequently, the habitat conditions of benthic fauna groups, particularly Molluscan, are impacted by these conditions.

The diversity index (H') provides an overview of the diversity of species in a community. The high H' value in gastropods at the Amal Beach location (2.84) indicates a very diverse community, where many species are present with a relatively balanced number of individuals (Figure 3). This is due to the heterogeneous environment at the Amal Beach Location, which supports the diversity of gastropod species (Alonso et al., 2022). Factors such as the availability of various types of food, diverse microhabitats, and low competitive pressure from other species can contribute to this high diversity (Waki, 2017). Conversely, the lower H' value at the Gajah Mada Location (1.92) indicates a more homogeneous environment or greater competitive pressure from certain dominant species, reducing species diversity. The H' value at the Amal Beach Location (0.59) shows that there are fewer Bivalves species than Gastropods. This could be because Bivalves have trouble adapting to the local environment or because Gastropods are more common and use more of the resources that are there. The high H' value at the Tanjung Batu location (1.61) indicates a greater variety of species and perhaps a more even distribution of resources, supporting the presence of various Bivalvia species (Guerra-García et al., 2021).

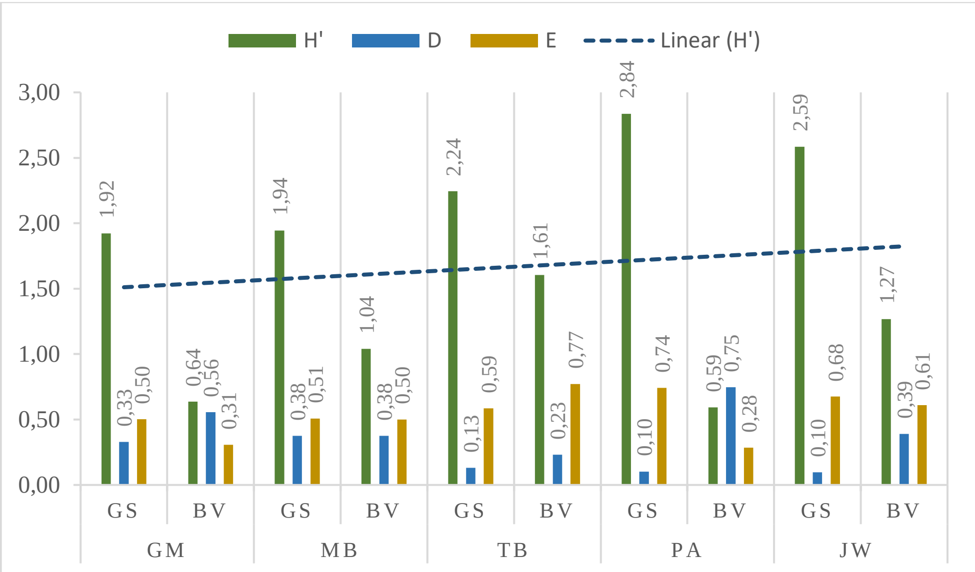

Figure 3. Diversity Index (H'), Dominance Index (D), and Evenness Index (E) of Gastropods and Bivalves in Five Research Locations GM (Gajah Mada), MB (Mamburungan), TB (Tanjung Batu, PA (Pantai Amal, JW(Juwata), BV (Bivalvia), GS (Gastropoda).

The dominance index (D) measures how much one or a few species dominate a community. Lower D values indicate that no species significantly dominates, whereas high D values indicate that a particular species dominates. The low D value for gastropods at the Amal Beach site (0.10) indicates that no species strongly dominates the community, which is consistent with the high diversity and evenness observed. A variety of species exploit resources evenly in this stable and balanced community (Dusabe et al., 2024; Iannuzzi et al., 1996). In contrast, the higher D value at the Gajah Mada site (0.33) may indicate the presence of a more competitive or adaptive dominant species, which controls most of the resources and limits the presence of other species. The high D index for Bivalves at the Amal Beach site (0.75) indicates the strong dominance of one or a few species, which may be due to environmental conditions that only favor certain species. Factors such as water quality, substrate type, or the availability of specific foods may play an important role. This dominance could also mean that Bivalvia faced greater competitive pressure from other groups (e.g., Gastropoda) at the Amal Coast Site, causing only the most adaptive species to survive (Al-Behbehani et al., 2010; Primost et al., 2016).

The evenness index (E) describes the relative distribution of individuals across species in a community. A high E value indicates that species in the community have nearly equal numbers of individuals, while a low E value indicates that some species have significantly more individuals than others. The relatively high evenness index in gastropods, especially in Amal Beach (0.74) and Juwata (0.68), indicates that the populations at these sites are equally distributed among the species. This could indicate that the environment at these sites provides stable conditions where no species has a significant competitive advantage (Ramo´n & Amor, 2001; Wu et al., 2017). In contrast, the lower E value in Gajah Mada (0.50) may indicate an imbalance in the community, where some species dominate while others are less common. The low E index in Amal Beach (0.28) indicates a very uneven distribution of individuals, where one or a few Bivalvia species strongly dominate, while others may only be present in tiny numbers. This could be due to highly selective environmental conditions or to strong ecological pressures, such as predation or competition, which only allow a few species to reproduce effectively (Anderson & Pospahala, 1970; Djamaluddin, 2018; Pietersz et al., 2022).

CONCLUSION

This study evaluated the diversity, dominance, and evenness of Gastropods and Bivalves in five mangrove sites on Tarakan Island, recording 54 species (46 Gastropods and 8 Bivalves). Gastropods showed higher diversity, with diversity indices (H') ranging from 1.92 (lowest in GM) to 2.84 (highest in PA). Species dominance was more prominent in Bivalves, especially in PA, with dominance indices (D) reaching 0.75. In contrast, gastropods had lower dominance indices, ranging from 0.10 to 0.38. Gastropods' evenness (E) was also more stable, with the highest value of 0.74 in PA, whereas Bivalves showed a less even distribution. This study highlights important differences in community structure between Gastropods and Bivalves and their contributions to coastal ecosystem dynamics. The mechanisms underlying these diversity and dominance patterns and their impacts on overall ecosystem function require further research.

REFERENCES

Abbott, R. T., & Dance, S. P. (1982). Compendium of Seashells (1982nd ed., Vol. 1). Adyssey Publishing.

Adharyan Islamy, R., & Hasan, V. (2020). Checklist of mangrove snails (mollusca: gastropoda) in south coast of Pamekasan, Madura Island, East Java, Indonesia. Biodiversitas, 21(7), 3127–3134. https://doi.org/10.13057/biodiv/d210733

Afonso, F., Palma, C., Brito, A. C., Chainho, P., de Lima, R., Heumüller, J. A., Ribeiro, F., & Félix, P. M. (2023). Metal and semimetal loadings in sediments and water from mangrove ecosystems: A preliminary assessment of anthropogenic enrichment in São Tomé island (central Africa). Chemosphere, 334. https://doi.org/10.1016/j.chemosphere.2023.138973

Ahmed, S., Sarker, S. K., Friess, D. A., Kamruzzaman, M., Jacobs, M., Islam, M. A., Alam, M. A., Suvo, M. J., Sani, M. N. H., Dey, T., Naabeh, C. S. S., & Pretzsch, H. (2022). Salinity reduces site quality and mangrove forest functions. From monitoring to understanding. Science of the Total Environment, 853. https://doi.org/10.1016/j.scitotenv.2022.158662

Al-Behbehani, B. E., Hussain, &, & Ebrahim, M. A. (2010). Environmental studies on the mudskippers in the intertidal zone of Kuwait Bay. Nature and Science, 8(5). http://www.sciencepub.net/nature

Alongi, D. M. (2002). Present state and future of the world’s mangrove forests. Environmental Conservation, 29(3), 331–349. https://doi.org/10.1017/S0376892902000231

Alonso, R. L., Sanchez, O., Rodriguez, I. F., & Arias, A. (2022). Diversity and distribution of bivalve molluscs in the Central Cantabrian Sea and the Avilés Canyons System (Bay of Biscay). Estuarine, Coastal and Shelf Science, 273. https://doi.org/10.1016/j.ecss.2022.107907

Anderson, D. R., & Pospahala, R. S. (1970). Correction of Bias in Belt Transect Studies of Immotile Objects. The Journal of Wildlife Management, 34(1), 141–146. http://www.jstor.org

Appeltans, W., Ahyong, S. T., Anderson, G., Angel, M. V., Artois, T., Bailly, N., Bamber, R., Barber, A., Bartsch, I., Berta, A., Błazewicz-Paszkowycz, M., Bock, P., Boxshall, G., Boyko, C. B., Brandão, S. N., Bray, R. A., Bruce, N. L., Cairns, S. D., Chan, T. Y., … Costello, M. J. (2012). The magnitude of global marine species diversity. Current Biology, 22(23), 2189–2202. https://doi.org/10.1016/j.cub.2012.09.036

Asante, F., Hugé, J., Asare, N. K., & Dahdouh-Guebas, F. (2023). Does mangrove vegetation structure reflect human utilization of ecosystem goods and services? IScience, 26(6), 1–26. https://doi.org/10.1016/j.isci.2023.106858

Astriana, B. H., Larasati, C. E., & Putra, A. P. (2022). Persepsi masyarakat terhadap pemanfaatan kerang darah di kawasan mangrove Desa Cemara, Kabupaten Lombok Barat. Jurnal Perikanan Unram, 12(2), 138–148. https://doi.org/10.29303/jp.v12i2.287

Bao, H., Wu, Y., Unger, D., Du, J., Herbeck, L. S., & Zhang, J. (2013). Impact of the conversion of mangroves into aquaculture ponds on the sedimentary organic matter composition in a tidal flat estuary (Hainan Island, China). Continental Shelf Research, 57, 82–91. https://doi.org/10.1016/j.csr.2012.06.016

Boissery, P., Lenfant, P., Lecaillon, G., Gudefin, A., Fonbonne, S., Selfati, M., El Ouamari, N., Brunet, R., Espinosa, F., & Bazairi, H. (2022). The ecological restoration: A way forward the conservation of marine biodiversity. In Coastal Habitat Conservation: New Perspectives and Sustainable Development of Biodiversity in the Anthropocene (pp. 171–191). Elsevier. https://doi.org/10.1016/B978-0-323-85613-3.00002-5

Budiawan, H., Ardiansyah, F., & Nurmasari, F. (2020). Keanekaragaman spesies kelas gastropoda pada hutan mangrove Pantai Bama Taman Nasional Baluran. BIOSENSE, 03(2), 1–13.

Bürkli, A., & Wilson, A. B. (2017). Explaining high-diversity death assemblages: Undersampling of the living community, out-of-habitat transport, time-averaging of rare taxa, and local extinction. Palaeogeography, Palaeoclimatology, Palaeoecology, 466, 174–183. https://doi.org/10.1016/j.palaeo.2016.11.022

Carpenter, K. E., & Niem, V. H. (1998). The living marine resources of the Western Central Pacific (1st ed., Vol. 1). Food and Agriculture Organization of the United Nations.

Chapman, A. D. (2009). Numbers of living species in Australia and the World 2nd edn. https://www.researchgate.net/publication/266375631

Chapperon, C., Studerus, K., & Clavier, J. (2017). Mitigating thermal effect of behaviour and microhabitat on the intertidal snail littorina saxatilis (olivi) over summer.

Journal of Thermal Biology, 67, 40–48. https://doi.org/10.1016/j.jtherbio.2017.03.017

Come, J., Peer, N., Nhamussua, J. L., Miranda, N. A., Macamo, C. C., Cabral, A. S., Madivadua, H., Zacarias, D., Narciso, J., & Snow, B. (2023). A socio-ecological survey in Inhambane Bay mangrove ecosystems: Biodiversity, livelihoods, and conservation. Ocean and Coastal Management, 244. https://doi.org/10.1016/j.ocecoaman.2023.106813

Contreras, D. M., Kintz, J. C., González, A. S., & Mancera, E. (2018). Food web structure and trophic relations in a riverine mangrove system of the tropical Eastern Pacific, Central Coast of Colombia. Estuaries and Coasts, 41(5), 1511–1521. https://doi.org/10.1007/s12237-017-0350-y

Dangan-Galon, F., Dolorosa, R. G., Sespeñe, J. S., & Mendoza, N. I. (2016). Diversity and structural complexity of mangrove forest along Puerto Princesa Bay, Palawan Island, Philippines. Journal of Marine and Island Cultures, 5(2), 118–125. https://doi.org/10.1016/j.imic.2016.09.001

Djamaluddin, R. (2018). Mangrove Biologi, Ekologi, Rehabilitasi, dan Konservasi (1st ed., Vol. 1). Unsrat Press.

Duke, N. C., & Larkum, A. W. (2019). Mangroves and seagrasses. https://www.researchgate.net/publication/330552125

Dusabe, M. C., Kalinda, C., Clewing, C., Hyangya, B. L., Van Bocxlaer, B., & Albrecht, C. (2024). Environmental perturbations and anthropogenic disturbances determine mollusc biodiversity of Africa’s explosive Lake Kivu. Journal of Great Lakes Research, 50(3). https://doi.org/10.1016/j.jglr.2024.102339

Eid, E. M., Khedher, K. M., Ayed, H., Arshad, M., Moatamed, A., & Mouldi, A. (2020). Evaluation of carbon stock in the sediment of two mangrove species, Avicennia marina and Rhizophora mucronata, growing in the Farasan Islands, Saudi Arabia. Oceanologia, 62(2), 200–213. https://doi.org/10.1016/j.oceano.2019.12.001

Ernawati, L., Anwari, M. S., & Dirhamsyah, M. (2019). Keanekaragaman jenis gastropoda pada ekosistem hutan mangrove Desa Sebubus Kecamatan Paloh Kabupaten Sambas. JURNAL HUTAN LESTARI, 7(2), 923–934.

Fanous, M., Eden, J. M., Remesan, R., & Daneshkhah, A. (2023). Challenges and prospects of climate change impact assessment on mangrove environments through mathematical models. In Environmental Modelling and Software (Vol. 162). Elsevier Ltd. https://doi.org/10.1016/j.envsoft.2023.105658

Gayo, L. (2022). Local community perception on the State Governance of mangroves in Western Indian coast of Kinondoni and Bagamoyo, Tanzania. Global Ecology and Conservation, 39. https://doi.org/10.1016/j.gecco.2022.e02287

Golding, R. E., Ponder, W. F., & Byrne, M. (2007). Taxonomy and anatomy of Amphiboloidea (Gastropoda: Heterobranchia: Archaeopulmonata). Zootaxa, 1476, 1–50. www.mapress.com/zootaxa/

Guerra-García, J. M., Martínez-Pita, I., García-García, F. J., & Moreira, J. (2021a). Diversity, community structure and habitat use of molluscs in marinas from the Iberian Peninsula and Northern Africa. Ocean and Coastal Management, 212, 1–11. https://doi.org/10.1016/j.ocecoaman.2021.105795

Guerra-García, J. M., Martínez-Pita, I., García-García, F. J., & Moreira, J. (2021b). Diversity, community structure and habitat use of molluscs in marinas from the Iberian Peninsula and Northern Africa. Ocean and Coastal Management, 212. https://doi.org/10.1016/j.ocecoaman.2021.105795

Gutierrez, P. C. (1988). The ecology and behavior of the mangrove. Biotropica, 20(4), 352–356. http://www.jstor.orgURL:http://www.jstor.org/stable/2388333

Iacarella, J. C., & Helmuth, B. (2011). Experiencing the salt marsh environment through the foot of Littoraria irrorata: Behavioral responses to thermal and desiccation stresses. Journal of Experimental Marine Biology and Ecology, 409, 143–153. https://doi.org/10.1016/j.jembe.2011.08.011

Iannuzzi, T. J., Weinstein, M. P., Sellner, K. G., & Barrett, J. C. (1996). Habitat Disturbance and Marina Development: An Assessment of Ecological Effects. I. Changes in Primary Production Due to Dredging and Marina Construction. Estuarine Research Federation, 19(2A), 257–271.

Jacquot, M. P., Nordström, M. C., De Wever, L., Ngom Ka, R., Ka, S., Le Garrec, V., Raffray, J., Sadio, O., Diouf, M., Grall, J., Tito de Morais, L., & Le Loc'h, F. (2023). Human activities and environmental variables drive infaunal community structure and functioning in West African mangroves. Estuarine, Coastal and Shelf Science, 293. https://doi.org/10.1016/j.ecss.2023.108481

Jacquot, M. P., Nordström, M. C., Wever, L. D., Ngom Ka, R., Ka, S., Le Garrec, V., Raffray, J., Sadio, O., Diouf, M., Grall, J., Tito de Morais, L., & Le Loc'h, F. (2023). Human activities and environmental variables drive infaunal community structure and functioning in West African mangroves. Estuarine, Coastal and Shelf Science, 293, 1–18. https://doi.org/10.1016/j.ecss.2023.108481

Jagadis, I., Mohamed, K. S., Venkatesan, V., & Kavitha, M. (2018). A picture book on marine gastropods (Vol. 1). ICAR-Central Marine Fisheries Research Institute. www.cmfri.org.in

Jagtap, T. G., Naik, S., & Nagli', V. L. (2001). Assessment of coastal wetland resources of central west coast, India, using landsat data. Photonirvachak .Iournal of the Indian Society of Relnote Sensing, 29(3), 143–150.

Jiang, J. X., & Li, R. G. (1995). An ecological study on the mollusca in mangrove areas in the estuary of the Jiulong River. Hydrobiologia, 295, 213–220.

Johnson, J., Peer, N., Sershen, & Rajkaran, A. (2023). Microplastic abundance in urban vs. peri-urban mangroves: The feasibility of using invertebrates as biomonitors of microplastic pollution in two mangrove dominated estuaries of southern Africa. Marine Pollution Bulletin, 196, 1–14. https://doi.org/10.1016/j.marpolbul.2023.115657

Kabir, M., Abolfathi, M., Hajimoradloo, A., Zahedi, S., Kathiresan, K., & Goli, S. (2014). Effect of mangroves on distribution, diversity and abundance of molluscs in mangrove ecosystem: a review. AACL Bioflux, 7(4), 286–300. http://www.bioflux.com.ro/aacl

Kantharajan, G., Pandey, P. K., Krishnan, P., Ragavan, P., Jeevamani, J. J. J., Purvaja, R., & Ramesh, R. (2018). Vegetative structure and species composition of mangroves along the Mumbai coast, Maharashtra, India. Regional Studies in Marine Science, 19, 1–8. https://doi.org/10.1016/j.rsma.2018.02.011

Kasnadiya, Subhan, & Erida, G. (2023). Identifikasi hasil hutan bukan kayu pada ekosistem mangrove dalam kawasan kesatuan pengelolaan hutan wilayah III Aceh (Studi Kasus: Kabupaten Aceh Tamiang). JURNAL ILMIAH MAHASISWA PERTANIAN, 8(2), 590–596. www.jim.unsyiah.ac.id/JFP

Kenworthy, W. J., Hall, M. O., Hammerstrom, K. K., Merello, M., & Schwartzschild, A. (2018). Restoration of tropical seagrass beds using wild bird fertilization and sediment regrading. Ecological Engineering, 112, 72–81. https://doi.org/10.1016/j.ecoleng.2017.12.008

Kesavan, S., Xavier, K. A. M., Deshmukhe, G., Jaiswar, A. K., Bhusan, S., & Sukla, S. P. (2021). Anthropogenic pressure on mangrove ecosystems: Quantification and source identification of surficial and trapped debris. Science of the Total Environment, 794. https://doi.org/10.1016/j.scitotenv.2021.148677

Kruitwagen, G., Nagelkerken, I., Lugendo, B. R., Mgaya, Y. D., & Bonga, S. E. W. (2010). Importance of different carbon sources for macroinvertebrates and fishes of an interlinked mangrove-mudflat ecosystem (Tanzania). Estuarine, Coastal and Shelf Science, 88(4), 464–472. https://doi.org/10.1016/j.ecss.2010.05.002

Kumari, P., Pathak, B., & Singh, J. K. (2020). Potential contribution of multifunctional mangrove resources and its conservation. In Biotechnological Utilization of Mangrove Resources (pp. 1–26). Elsevier. https://doi.org/10.1016/B978-0-12-819532-1.00001-9

Laraswati, Y., Soenardjo, N., & Setyati, W. A. (2020). Komposisi dan kelimpahan gastropoda pada ekosistem mangrove di desa tireman, Kabupaten Rembang, Jawa Tengah. Journal of Marine Research, 9(1), 41–48. https://doi.org/10.14710/jmr.v9i1.26104

Lazzeri, A. M., Bazihizina, N., Kingunge, P. K., Lotti, A., Pazzi, V., Tasselli, P. L., Vannini, M., & Fratini, S. (2014). Migratory behaviour of the mangrove gastropod Cerithidea decollata under unfamiliar conditions. Journal of Experimental Marine Biology and Ecology, 457, 236–240. https://doi.org/10.1016/j.jembe.2014.04.024

Leung, J. Y. S., Russell, B. D., & Connell, S. D. (2020). Linking energy budget to physiological adaptation: How a calcifying gastropod adjusts or succumbs to ocean acidification and warming. Science of the Total Environment, 715. https://doi.org/10.1016/j.scitotenv.2020.136939

López-Alonso, R., Sánchez, O., Fernández-Rodríguez, I., & Arias, A. (2022). Diversity and distribution of bivalve molluscs in the Central Cantabrian Sea and the Avilés Canyons System (Bay of Biscay). Estuarine, Coastal and Shelf Science, 273. https://doi.org/10.1016/j.ecss.2022.107907

MacKenzie, R. A., & Cormier, N. (2012). Stand structure influences nekton community composition and provides protection from natural disturbance in Micronesian mangroves. Hydrobiologia, 685(1), 155–171. https://doi.org/10.1007/s10750-011-0865-3

Martins, R., Sampaio, L., Quintino, V., & Rodrigues, A. M. (2014). Diversity, distribution and ecology of benthic molluscan communities on the Portuguese continental shelf. Journal of Sea Research, 93, 75–89. https://doi.org/10.1016/j.seares.2013.11.006

Meijer, K. J., El-Hacen, E. H. M., Govers, L. L., Lavaleye, M., Piersma, T., & Olff, H. (2021). Mangrove-mudflat connectivity shapes benthic communities in a tropical intertidal system. Ecological Indicators, 130. https://doi.org/10.1016/j.ecolind.2021.108030

Mendes, D. S., Beasley, C. R., Silva, D. N. N., & Fernandes, M. E. B. (2023). Microplastic in mangroves: A worldwide review of contamination in biotic and abiotic matrices. Marine Pollution Bulletin, 195, 1–19. https://doi.org/10.1016/j.marpolbul.2023.115552

Mohanraju, R. (2015). Macrofaunal Assemblages of Carbyn's Cove Mangroves, South Andaman. In Marine Faunal Diversity in India (pp. 473–483). Elsevier. https://doi.org/10.1016/b978-0-12-801948-1.00028-8

Mohanta, M. R., Pradhan, B. K., & Sahu, S. C. (2020). Assessment of species diversity and physicochemical characteristics of mangrove vegetation in Odisha, India. In Biotechnological Utilization of Mangrove Resources (pp. 135–151). Elsevier. https://doi.org/10.1016/B978-0-12-819532-1.00006-8

Morton, B. (1983). Mangrove bivalves. In Ecology (pp. 77–138). Elsevier. https://doi.org/10.1016/b978-0-12-751406-2.50010-6

Nagelkerken, I., Blaber, S. J. M., Bouillon, S., Green, P., Haywood, M., Kirton, L. G., Meynecke, J. O., Pawlik, J., Penrose, H. M., Sasekumar, A., & Somerfield, P. J. (2008). The habitat function of mangroves for terrestrial and marine fauna: A review. Aquatic Botany, 89(2), 155–185. https://doi.org/10.1016/j.aquabot.2007.12.007

Nugroho, B. A., Soendjoto, M. A., & Zaini, M. (2019a). Gastropod density and diversity in the mangrove forest of pagatan besar village, tanah laut regency, indonesia. Ilmu Kelautan: Indonesian Journal of Marine Sciences, 24(4), 179–185. https://doi.org/10.14710/ik.ijms.24.4.179-185

Nugroho, B. A., Soendjoto, M. A., & Zaini, M. (2019b). Gastropod Density and Diversity in the Mangrove Forest of Pagatan Besar Village, Tanah Laut Regency, Indonesia. Ilmu Kelautan: Indonesian Journal of Marine Sciences, 24(4), 179–185. https://doi.org/10.14710/ik.ijms.24.4.179-185

Ong, J. Eong., & Gong, W. Khoon. (2013). Structure, function and management of mangrove ecosystems. The International Society for Mangrove Ecosystems.

Pietersz, J. H., Pentury, R., & Uneputty, P. A. (2022a). 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

Pietersz, J. H., Pentury, R., & Uneputty, P. A. (2022b). 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

Primost, M. A., Bigatti, G., & Márquez, F. (2016). Shell shape as indicator of pollution in marine gastropods affected by imposex. Marine and Freshwater Research, 67(12), 1948–1954. https://doi.org/10.1071/MF15233

Printrakoon, C., Wells, F. E., & Chitramvong, Y. (2008). Distribution of molluscs in mangroves at six sites in the upper gulf of Thailand. THE RAFFLES BULLETIN OF ZOOLOGY, 18, 247–257.

Pyron, M., & Brown, K. M. (2015). Introduction to Mollusca and the Class Gastropoda. In Thorp and Covich's Freshwater Invertebrates: Ecology and General Biology: Fourth Edition (Vol. 1, pp. 383–421). Elsevier Inc. https://doi.org/10.1016/B978-0-12-385026-3.00018-8

Queiroz, R. N. M., Silva, P. M. da, DeSouza, A. M., Silva, L. B., & Dias, T. L. P. (2020). Effects of environmental factors on the distribution of the exotic species Mytilopsis sallei (Récluz, 1849) (Bivalvia: Dreissenidae) on the Northeast coast of Brazil. Journal of Sea Research, 165, 1–19. https://doi.org/10.1016/j.seares.2020.101954

Raghunathan, C., Raghuraman, R., & Choudhury, S. (2018). Coastal and marine biodiversity of India: Challenges for conservation. In Coastal Management: Global Challenges and Innovations (pp. 201–250). Elsevier. https://doi.org/10.1016/B978-0-12-810473-6.00012-1

Ramo´n, M. R., & Amor, M. J. (2001). Increasing imposex in populations of Bolinus brandaris (Gastropoda: Muricidae) in the north-western Mediterranean. Marine Enviromental Research, 52, 463–475. www.elsevier.com/locate/marenvrev

Rasmeemasmuang, T., & Sasaki, J. (2015). Wave reduction in mangrove forests: General information and case study in Thailand. In Handbook of Coastal Disaster Mitigation for Engineers and Planners (pp. 511–535). Elsevier Inc. https://doi.org/10.1016/B978-0-12-801060-0.00024-1

Reid, D. G. (1985). Habitat and zonation patterns of Littoraria species (Gastropoda: Littorinidae) in Indo-Pacific mangrove forests. Biological Journal of the Linnean Socieo, 26, 39–68.

Rohmah, A., & Muhsoni, F. F. (2020). Dinamika populasi kerang tahu (Meretrix meretrix) Di Perairan Bancaran Bangkalan Udara. Juvenil:Jurnal Ilmiah Kelautan Dan Perikanan, 1(3), 331–338. https://doi.org/10.21107/juvenil.v1i3.8561

Rueda, J. L., Gofas, S., Urra, J., & Salas, C. (2009). A highly diverse molluscan assemblage associated with eelgrass beds (Zostera marina L.) in the Alboran Sea: Micro-habitat preference, feeding guilds and biogeographical distribution. Scientia Marina, 73(4), 679–700. https://doi.org/10.3989/scimar.2009.73n4679

Sari, A., Aritonang, A. B., & Helena, S. (2020). Kelimpahan dan keanekaragaman gastropoda di kawasan mangrove Desa Bakau Besar Laut Kabupaten Mempawah. Jurnal Laut Khatulistiwa, 3(3), 97. https://doi.org/10.26418/lkuntan.v3i3.42918

Satyam, K., & Thiruchitrambalam, G. (2018). Habitat ecology and diversity of rocky shore fauna. In Biodiversity and Climate Change Adaptation in Tropical Islands (pp. 187–215). Elsevier. https://doi.org/10.1016/B978-0-12-813064-3.00007-7

Singare, P. U., Ansari, M. V. A., & Dixit, N. N. (2014). Water pollution along the Mahul Creek of Mumbai, India - study of physico-chemical properties. International Letters of Natural Sciences, 11(1), 44–53. https://doi.org/10.18052/www.scipress.com/ilns.16.44

Sobhani, P., & Danehkar, A. (2023). Spatial-temporal changes in mangrove forests for analyzing habitat Integrity: A case of hara biosphere Reserve, Iran. Environmental and Sustainability Indicators, 20, 1–9. https://doi.org/10.1016/j.indic.2023.100293

Sohaib, M., Al-Barakah, F. N. I., Migdadi, H. M., Alyousif, M., & Ahmed, I. (2023). Ecological assessment of physico-chemical properties in mangrove environments along the Arabian Gulf and the Red Sea coasts of Saudi Arabia. Egyptian Journal of Aquatic Research, 49(1), 9–16. https://doi.org/10.1016/j.ejar.2022.11.002

Sowah, E. M. A., Graham, N. A. J., & Watson, N. M. (2023). The contributions of mangroves to physiological health in Ghana: Insights from a qualitative study of key informants. Wellbeing, Space and Society, 4, 1–13. https://doi.org/10.1016/j.wss.2023.100137

Stickle, W. B., Lindeberg, M., & Rice, S. D. (2015). Comparative freeze tolerance and physiological adaptations of three species of vertically distributed rocky intertidal gastropods from southeast Alaska. Journal of Experimental Marine Biology and Ecology, 463, 17–21. https://doi.org/10.1016/j.jembe.2014.10.027

Sudhir, S., Arunprasath, A., & Sankara Vel, V. (2022). A critical review on adaptations, and biological activities of the mangroves. Journal of Natural Pesticide Research, 1. https://doi.org/10.1016/j.napere.2022.100006

Tanaka, M. O., & Maia, R. C. (2006). Shell morphological variation of littoraria angulifera among and within mangroves in NE Brazil. Hydrobiologia, 559(1), 193–202. https://doi.org/10.1007/s10750-005-1449-x

Verones, F., Kuipers, K., Núñez, M., Rosa, F., Scherer, L., Marques, A., Michelsen, O., Barbarossa, V., Jaffe, B., Pfister, S., & Dorber, M. (2022). Global extinction probabilities of terrestrial, freshwater, and marine species groups for use in Life Cycle Assessment. Ecological Indicators, 142. https://doi.org/10.1016/j.ecolind.2022.109204

Vorsatz, L. D., Pattrick, P., & Porri, F. (2021). Quantifying the in situ 3-dimensional structural complexity of mangrove tree root systems: Biotic and abiotic implications at the microhabitat scale. Ecological Indicators, 121. https://doi.org/10.1016/j.ecolind.2020.107154

Waki, T. (2017a). Diversity of terrestrial mollusks and their helminths in artificial environments in Yoyogi Park, Tokyo, Japan. Journal of Asia-Pacific Biodiversity, 10(2), 254–256. https://doi.org/10.1016/j.japb.2016.12.002

Waki, T. (2017b). Diversity of terrestrial mollusks and their helminths in artificial environments in Yoyogi Park, Tokyo, Japan. Journal of Asia-Pacific Biodiversity, 10(2), 254–256. https://doi.org/10.1016/j.japb.2016.12.002

Walthew, G. (1995). The distribution of mangrove-associated gastropod snails in Hong Kong. Hydrobiologia, 295, 335–342.

Wu, H., Guan, Q., Lu, X., & Batzer, D. P. (2017). Snail (Mollusca: Gastropoda) assemblages as indicators of ecological condition in freshwater wetlands of Northeastern China. Ecological Indicators, 75, 203–209. https://doi.org/10.1016/j.ecolind.2016.12.042

Xiao, Y., He, M., Xie, J., Liu, L., & Zhang, X. (2021). Effects of heavy metals and organic matter fractions on the fungal communities in mangrove sediments from Techeng Isle, South China. Ecotoxicology and Environmental Safety, 222, 1–9. https://doi.org/10.1016/j.ecoenv.2021.112545

Yanti, I., Laheng, S., & Putri, D. U. (2022). Keanekaragaman gastropoda di lantai hutan mangrove di Desa Binontoan Kabupaten Tolitoli, Sulawesi Tengah. JAGO TOLIS : Jurnal Agrokompleks Tolis, 2(2), 41–44.

Yuliawati, E., Afriyansyah, B., & Mujiono, N. (2021). Komunitas gastropoda mangrove di sungai perpat dan bunting, Kecamatan Belinyu, Kabupaten Bangka. OLDI (Oseanologi Dan Limnologi Di Indonesia), 6(2), 85–95. https://doi.org/10.14203/oldi.2021.v6i2.361