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Diversity of Mollusca and Arthropoda in the Intertidal Zone of Rumut Island, Batam, Indonesia

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ABSTRACT

Rumut Island, located in Batam City, is a coastal area that possesses considerable potential for faunal diversity, particularly within its intertidal zone. This study aimed to analyze the faunal composition, community structure, and the influence of environmental conditions on the occurrence of Mollusca and Arthropoda in the area. The study employed the quadrat transect method and direct observations at several sampling stations. Data collected included species composition, individual abundance, diversity, evenness, and dominance indices, as well as environmental parameters such as temperature, pH, water depth, and substrate type. The results revealed a total of 15 species, consisting of 11 Mollusca species and 4 Arthropoda species, with 53 individuals recorded during the survey. Gastropoda exhibited the highest species richness, whereas Malacostraca accounted for the greatest number of individuals. Environmental conditions within the study area remained generally favorable for supporting benthic organisms, with an average water temperature of 29.5°C and a pH value of 8.1. In addition, variations in water depth and substrate type influenced the distribution of organisms, with sandy substrates tending to support higher diversity compared to muddy substrates. These findings highlight the importance of environmental factors in shaping the community structure of benthic organisms within the intertidal zone of Rumut Island.

Keywords: *Arthropoda, diversity, intertidal, Mollusca, Rumut Island*

1. INTRODUCTION

Indonesia is recognized as one of the world's most biodiverse countries due to its wide variety of ecosystems that support numerous species of flora and fauna. As an archipelagic nation with a tropical climate, Indonesia provides favorable conditions for many animal species to survive and thrive. This faunal diversity is distributed across various regions, including coastal areas, which possess unique environmental characteristics and serve as important habitats for numerous organisms. In addition to functioning as natural habitats, coastal ecosystems play a crucial ecological role in maintaining ecosystem balance and supporting food webs for a wide range of fauna (Sari et al., 2022).

Coastal areas represent transitional zones between terrestrial and marine environments and are characterized by dynamic environmental conditions influenced by tidal fluctuations, temperature, salinity, and humidity. These conditions support a wide variety of faunal communities. However, the occurrence and distribution of fauna in coastal environments are

strongly influenced by habitat conditions and human activities. Environmental degradation can lead to declines in both species abundance and diversity (Rahmawati et al., 2021).

Belakang Padang District, including Rumut Island and its surrounding islands, constitutes part of the Batam hinterland region, which consists of hundreds of small islands and possesses significant potential for faunal diversity. Rumut Island is not only utilized as a temporary stopover for local fishermen but also holds considerable potential for marine tourism development. Its ecosystems, including mangrove forests, sandy beaches, and shallow coastal waters, provide habitats that support various faunal groups, particularly marine invertebrates (Sari et al., 2021; He & Silliman, 2019). Nevertheless, information regarding the faunal species inhabiting this area remains limited. Therefore, faunal inventory studies are needed to provide scientific data and environmental information. Such inventories are essential for assessing species diversity and understanding the ecological conditions of a region (Rahmawati et al., 2021).

Faunal inventory and analysis involve the observation and documentation of animal species within a particular habitat. These activities are important because they provide information on species occurrence, biodiversity levels, and environmental conditions (Asaad et al., 2019). Furthermore, faunal inventories can serve as an initial step toward conservation and sustainable natural resource management. The availability of biodiversity data enables early detection of environmental changes and supports the implementation of appropriate conservation measures (Sari et al., 2022). Studies on fauna also contribute significantly to education and scientific advancement, particularly in the fields of biology and ecology (Haumahu et al., 2022).

This study aimed to inventory Mollusca and Arthropoda species inhabiting the waters of Rumut Island, Batam City. The findings are expected to provide scientific information useful for environmental conservation efforts in the small islands surrounding Batam and to enhance knowledge regarding regional biodiversity in the Riau Islands. Systematic biodiversity data collection is also expected to support ecosystem-based conservation strategies and sustainable coastal zone management.

2. MATERIALS AND METHODS

2.1 Study Area and Time

This study was conducted in the waters surrounding Rumut Island, Batam City, in April 2026. The study area is a coastal environment characterized by a tropical beach

ecosystem influenced by tidal fluctuations and relatively high humidity, conditions that support the presence of Mollusca and Arthropoda. In addition, sandy and muddy substrates play important roles in determining the distribution and survival of these organisms. Species identification and data analysis were conducted in the Microbiology Laboratory of the Biology Study Program, Universitas Internasional Batam. The study area is presented in **Figure 1**.

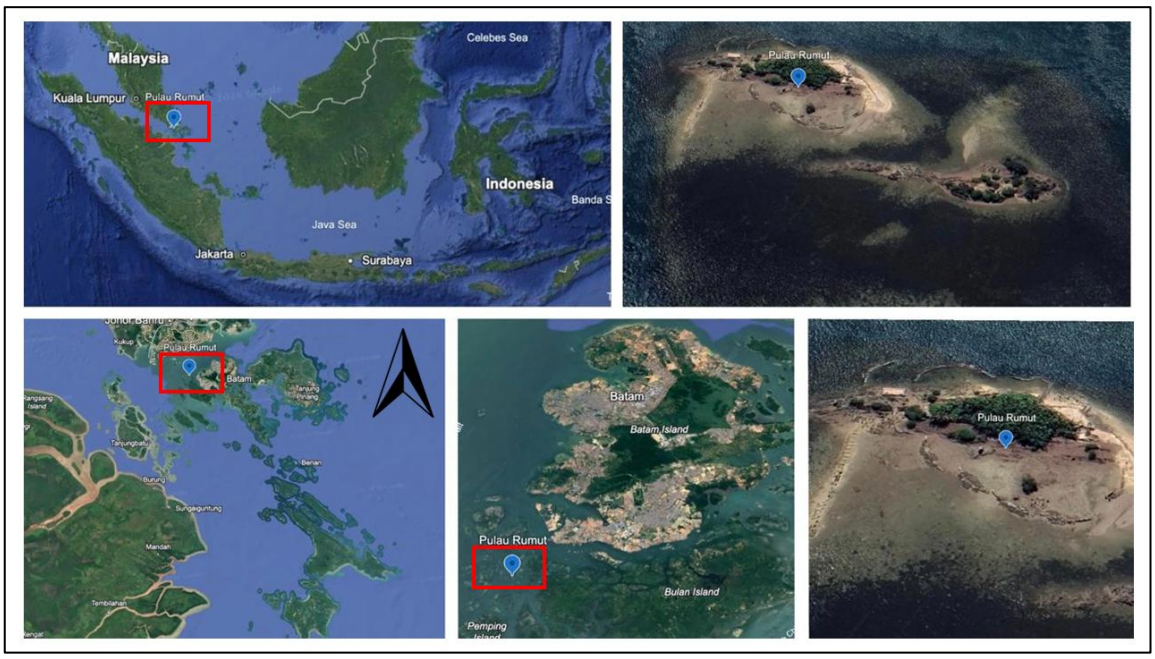

Figure 1. Map of the Study Area on Rumut Island, Batam

2.2 Tools and Materials

The equipment used in this study included a measuring tape, raffia rope for plot boundaries, a 50 cm × 50 cm PVC frame used as a quadrat marker, a shovel for digging sediment, a GPS device or mapping application for recording coordinates, forceps for specimen collection, and a camera or smartphone for documentation. Field data were recorded using field notebooks and writing instruments. Materials included recording sheets, specimen data forms, and plastic or zip-lock bags for temporary specimen storage. The research objects consisted of all Mollusca and Arthropoda species encountered within the observation plots at predetermined sampling point.

2.3 Research Procedure

This study employed the quadrat transect method, which was conducted directly in the field. The method was used to determine the species composition and abundance of Mollusca and Arthropoda within the study area. Prior to data collection, several observation stations

were selected based on habitat conditions and substrate types (Mulawarman et al., 2025). At each station, a 50-meter transect line was established as the observation pathway. Quadrat plots measuring 50 cm × 50 cm were then placed at several points along the transect at 5-meter intervals. All fauna found within each quadrant were identified and counted. In addition to faunal observations, environmental parameters including temperature, pH, water depth, and substrate type were measured directly in the field to assess their influence on organism distribution.

Observations were conducted from morning until midday to maximize visibility and improve the detection of intertidal fauna. Weather conditions during the study ranged from light drizzle to mild rainfall; however, observations were successfully completed. These conditions increased substrate moisture and caused partial inundation of some areas, potentially influencing the activity of certain intertidal species observed during sampling.

All observation data were compiled into inventory tables for further analysis based on species occurrence and abundance within each sampling plot. Field observations were documented using smartphones as supporting evidence. Collected specimens were cleaned of mud, sand, and other debris before being placed in labeled containers and transported to the laboratory for further identification. Organisms were identified based on morphological characteristics and classified according to phylum, class, and genus using identification guides, supporting references, and the World Register of Marine Species (WoRMS) database (Lumowa et al., 2024).

2.4 Data Analysis

The collected data were analyzed using ecological parameters to determine the community structure of fauna in the study area. Analyses included species composition based on phylum and class, organism density, relative density, dominance index, Shannon–Wiener diversity index, water quality assessment, and correlations between environmental parameters and faunal diversity.

Density was calculated to determine the number of individuals of a species per unit area. This parameter reflects organism abundance and distribution patterns within the habitat (Wahab et al., 2019).

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

Where:
K = Density (ind/m²)
Ni = Number of individuals of a species
A = Observation area

Relative density was used to determine the percentage contribution of a species relative to the total number of individuals observed in the study area (Sastra et al., 2022). rumus:

$$KR = \frac{Ni}{N} \times 100\%$$

Where:
KR = Relative Density (%)
Ni = Number of Individuals of a Species
N = Total number of individuals of all species

The diversity index was calculated using the Shannon–Wiener formula (Wahab et al., 2019).

$$\mathbf{H'= -\Sigma Pi \ln Pi}, \boldsymbol{Pi}$$

Where:
H' = Diversity index
Pi = Relative abundance of species
Ni = Number of individuals of a species
N = Total number of individuals

Criteria:
H' ≤ 1 = Low diversity
1 < H' ≤ 3 = Moderate diversity
H' > 3 = High diversity

Species evenness was calculated using the following equation (Sastra et al., 2022).

$$E = \frac{H'}{LnS}$$

Where:
E = Evenness index
H' = Diversity index
Ln S = Natural logarithm of the total number of species

The value of E ranges from 0 to 1 and can be interpreted as follows:
E ≤ 0,4 = Low population evenness
0,4 < E ≤ 0,6 = Moderate population evenness
E > 0,6 = High population evenness

Species dominance was calculated using Simpson's Dominance Index (Sastra et al., 2022).

$$\boldsymbol{D} = \frac{\Sigma[ni]^2 N}{N}$$

Where:
D = Dominance Index

ni = Number of individuals of each species
N = Total number of individuals

Interpretation of the Dominance Index (D):
$0 < D \leq 0,50$ = Low dominance
$0,50 < D \leq 0,75$ = Moderate dominance
$0,75 < D \leq 1,00$ = High dominance

3. RESULTS AND DISCUSSION

3.1 Species Composition

The inventory of Mollusca and Arthropoda conducted in the intertidal zone of Rumut Island revealed a diverse assemblage of organisms belonging to two major phyla: Mollusca and Arthropoda. A total of 15 species were identified, representing 17 families, 12 orders, and 3 major classes, with 53 individuals recorded during the study. Mollusca was the dominant phylum in terms of species richness and abundance, indicating that the coastal habitat of Rumut Island remains suitable for supporting a variety of benthic invertebrates. The taxonomic composition of the recorded fauna is presented in **Table 1**.

The inventory results showed that the phylum Mollusca dominated the faunal community in the intertidal zone of Rumut Island, particularly the class Gastropoda, which exhibited the highest species richness among all groups recorded. The dominance of Gastropoda in intertidal habitats has also been reported by Abdillah et al. (2019) along the coast of Poton Bako, East Lombok, where they recorded 9 gastropod species and 6 bivalvia species, with Gastropoda representing the most diverse group within the Mollusca community. This finding suggests that intertidal habitats generally provide suitable substrates and food resources that optimally support gastropod populations. The composition of Mollusca and Arthropoda by class was also illustrated graphically to show the proportion of species richness and individual abundance within each taxonomic group recorded in the intertidal zone of Rumut Island. The data are presented in **Figure 2**.

Based on observations conducted in the intertidal zone of Rumut Island, the recorded Mollusca and Arthropoda were classified into three major classes: Bivalvia, Gastropoda, and Malacostraca. Gastropoda exhibited the highest species richness, comprising approximately seven species and 22 individuals, accounting for 41.51% of the total individuals recorded. Malacostraca consisted of approximately four species with 26 individuals (49.06%), whereas Bivalvia comprised approximately four species represented by only five individuals (9.43%).

Table 1. Species Composition of Mollusca and Arthropoda in the Intertidal Zone of Rumut Island, Batam

Phylum	Class	Order	Family	Species
Mollusca	Bivalvia	Ostreida	Pinnidae	*Pinna bicolor*
			Malleidae	*Malleus regula*
		Pectinida	Pectinidae	*Mimachlamys senatoria*
		Venerida	Veneridae	*Dosinia abyssicola*
	Gastropoda	Littorinimorpha	Naticidae	*Polinice sp*
			Strombidae	*Canarium urceus*
		Caenogastropoda	Cerithioidea	*Cerithium coralium*
			Cerithiidae	*Cerithium lutosum*
				Cerithium zonatum
		Neogastropoda	Nassariidae	*Nassarius livescens*
			Muricidae	*Reishia clavigera*
Arthropoda	Malacostraca	Decapoda	Diogenidae	*Clibanarius infraspinatus*
				Clibanarius inaequalis
				Clibanarius sp
			Portunidae	*Thalamita crenata*

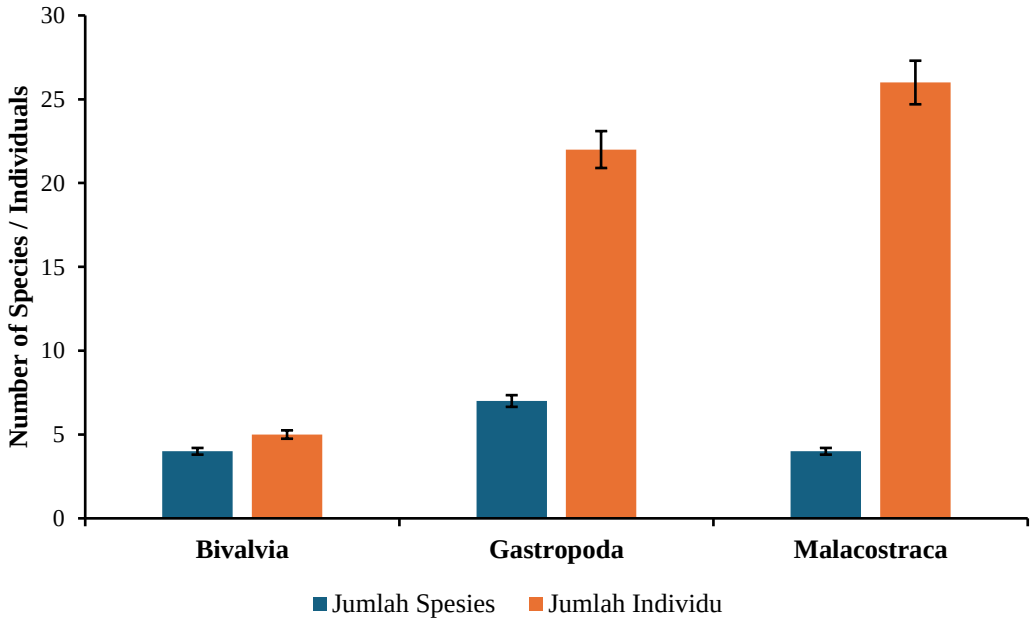

Figure 2. Composition of Species Richness and Individual Abundance by Class in the Intertidal Zone of Rumut Island, Batam

These findings are consistent with those reported by Susintowati et al. (2019) in Alas Purwo National Park, who documented a high diversity and broad distribution of gastropods within intertidal habitats. According to their study, gastropods possess a strong capacity to adapt to variations in substrate characteristics and coastal environmental conditions, which often makes them one of the dominant faunal groups in intertidal ecosystems.

3.2 Density and Relative Density of Mollusca and Arthropoda

Density and relative density are ecological parameters used to describe the level of organism abundance within a community. Density reflects the number of individuals recorded per unit area of observation, whereas relative density indicates the contribution of a particular species to the total number of individuals recorded. The results of the density and relative density analysis of Mollusca and Arthropoda at each sampling station are presented in **Figure 3**.

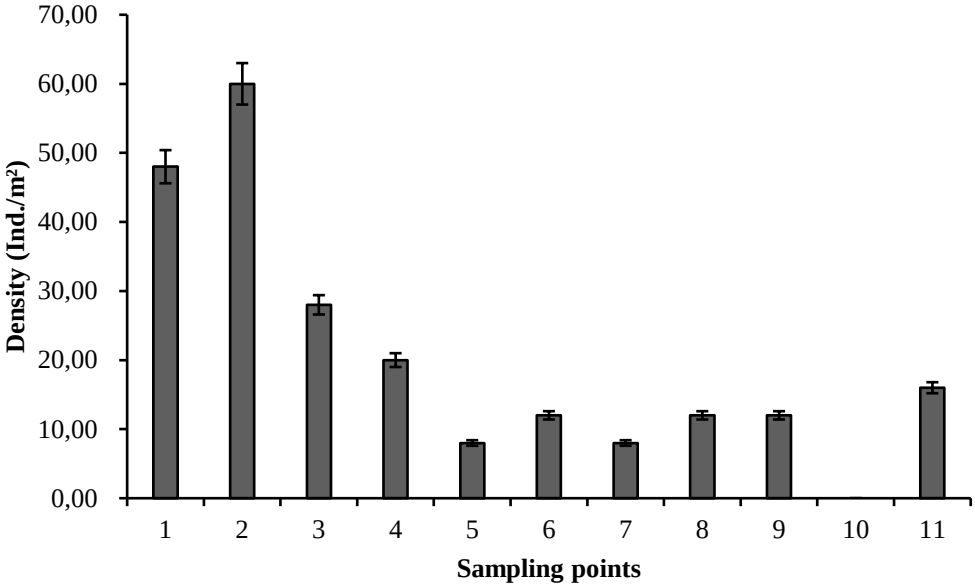

Figure 3. Density of Mollusca and Arthropoda in the Intertidal Zone of Rumut Island, Batam

Based on **Figure 3**, the density of Mollusca and Arthropoda at the study site exhibited variation among sampling stations. The highest density was recorded at Station 2, with a value of 60 ind./m², followed by Station 1 with 48 ind./cm² and Station 3 with 28 ind./m². In contrast, no organisms were recorded at Station 10, resulting in a density value of 0 ind./m², while Stations 5 and 7 exhibited the lowest densities, each with a value of 8 ind./m².

The high density observed at Stations 1 and 2 indicates that these locations provide favorable environmental conditions for Mollusca and Arthropoda, enabling them to support a greater number of individuals compared to other sampling stations. Conversely, the low density recorded at several stations suggests that the distribution of organisms was not uniform throughout the study area. Variations in density may be influenced by substrate characteristics, food availability, and the ability of organisms to adapt to local environmental conditions. These findings are consistent with those reported by Abdillah et al. (2019), who

observed that molluscan density within intertidal zones varied among sampling locations due to differences in habitat conditions and substrate characteristics.

Based on the relative density data, the distribution of Mollusca and Arthropoda fauna within the intertidal zone of Rumut Island exhibited an uneven pattern across sampling stations (Table 2). Several species were recorded only at specific locations with relatively density values, including *Polinice* sp. (100%), *Canarium urceus* (100%), and *Cerithium lutosum* (100%). Other species, such as Pinna bicolor, also demonstrated a relatively density value of 50%. Among the Arthropoda, *Clibanarius* sp. exhibited a relatively broad distribution, reaching a relative density of 75%, whereas *Clibanarius inaequalis* and *Clibanarius infraspinatus* showed dominance at particular sampling stations. Meanwhile, species such as Malleus regula were not recorded during the survey. This pattern indicates the presence of habitat variation that may influence the occurrence and distribution of certain species within the intertidal ecosystem.

Table 2. Relative Density of Mollusca and Arthropoda Species on Rumut Island, Batam

Species	Sampling Points / Relative Density (%)										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Pinna bicolor	-	-	-	-	-	-	-	50.00	50.00	-	-
Malleus regula	-	-	-	-	-	-	-	-	-	-	-
Mimachlamys senatoria	-	-	-	-	-	-	50.00	-	-	-	-
Dosinia abyssicola	-	-	-	-	50.00	-	-	-	-	-	-
Polinice sp	-	-	-	-	-	-	-	100.00	-	-	-
Canarium urceus	-	-	-	-	-	100.00	-	-	-	-	-
Cerithium coralium	41.67	16.67	-	-	-	-	-	-	-	-	-
Cerithium lutosum	16.67	-	-	-	-	-	-	-	100.00	-	-
Cerithium zonatum	-	16.67	-	-	-	-	-	-	-	-	-
Nassarius livescens	-	25.00	-	-	-	-	-	-	-	-	-
Reishia clavigera	-	-	-	8.33	-	-	-	-	-	-	25.00
Clibanarius infraspinatus	-	-	-	-	-	-	50.00	-	-	-	-
Clibanarius inaequalis	-	-	25.00	-	-	50.00	-	-	-	-	-
Clibanarius sp	-	-	33.33	25.00	-	-	-	-	-	-	75.00
Thalamita crenata	-	-	-	-	50.00	-	-	-	-	-	-

Differences in relative density among species are influenced by various environmental factors, including substrate type, water depth, and food availability. Gastropod species such as *Cerithium coralium* and *Cerithium lutosum* were commonly associated with sandy substrates that are relatively stable and rich in organic matter, conditions that provide suitable habitats for their survival and growth. In contrast, arthropods belonging to the genus *Clibanarius* exhibited a high capacity for adaptation to a wide range of environmental conditions, allowing them to occur at several sampling stations with varying levels of dominance. The high relative density observed at certain stations also suggests the presence of specific habitat preferences, as well as potentially low levels of interspecific competition

within those areas. These findings indicate that species distribution patterns within the intertidal zone are closely linked to local environmental conditions. Therefore, the variation in relative density recorded among species reflects the complex interaction between environmental factors and the ecological characteristics of each species inhabiting the intertidal zone of Rumut Island.

3.3 Community Structure of Mollusca and Arthropoda

Diversity (H′), evenness (E), and dominance (C) are ecological parameters commonly used to describe the community structure of organisms within an ecosystem. The diversity index reflects the level of species variation within a habitat, the evenness index describes the distribution of individuals among species, whereas the dominance index indicates the extent to which a particular species dominates the community. The results of the diversity, evenness, and dominance index calculations for Mollusca and Arthropoda at each sampling station are presented in **Figure 4**.

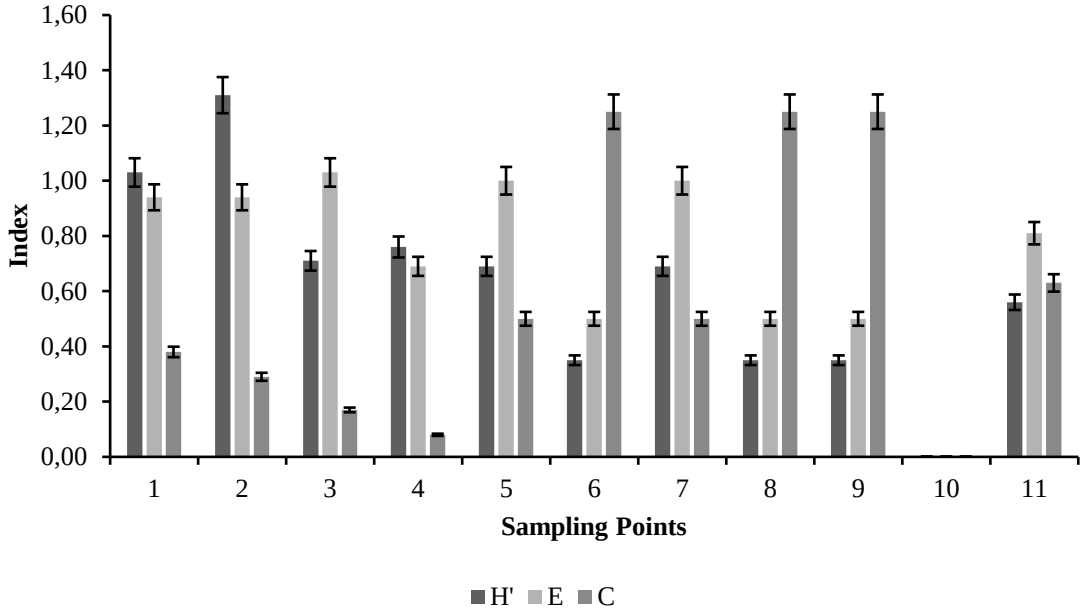

Figure 4. Diversity, Evenness, and Dominance Indices in the Intertidal Zone of Rumut Island, Batam

Based on the results of the analysis, the diversity index (H′) of Mollusca and Arthropoda within the study area generally ranged from low to moderate, indicating that the number of species recorded was relatively limited and that their distribution varied among sampling stations. The evenness index (E) was predominantly classified as moderate to high, suggesting that individuals were relatively evenly distributed among species without substantial imbalance. Meanwhile, the dominance index (C) ranged from low to high at

several sampling stations, indicating that certain locations were characterized by the dominance of particular species over others. Overall, the combination of diversity, evenness, and dominance values suggests that the Mollusca and Arthropoda community in the waters of Rumut Island exhibits a relatively stable community structure, with varying degrees of species dominance across sampling stations. These findings are consistent with those reported by Susintowati et al. (2019), who observed that gastropod communities within intertidal zones generally exhibit low to moderate diversity levels accompanied by relatively high evenness.

3.4 Water Quality and Habitat Conditions

Water quality and habitat conditions are important environmental factors that influence the occurrence, abundance, and distribution of organisms within an aquatic ecosystem. The environmental parameters measured in this study included temperature, pH, water depth, and substrate type at each sampling station. The results of the water quality measurements and habitat condition assessments conducted within the intertidal zone of Rumut Island are presented in **Table 3**.

Table 3. Water Quality and Habitat Conditions in the Intertidal Zone of Rumut Island, Batam

Sampling points	Temperature (°C)	pH	Depth (m)	Substrate
1	29.5	8.1	0.00	Coral Rock and Sand
2	29.5	8.1	0.00	Sand
3	29.5	8.1	0.11	Coral Rock and Sand
4	29.5	8.1	0.15	Mud
5	29.5	8.1	0.16	Mud
6	29.5	8.1	0.24	Mud
7	29.5	8.1	0.33	Mud
8	29.5	8.1	0.36	Mud
9	29.5	8.1	0.41	Mud
10	29.5	8.1	0.42	Mud
11	29.5	8.1	0.42	Mud

Based on the measurement results, the water quality conditions within the waters of Rumut Island were relatively uniform across all sampling stations. Water temperature remained within a stable range, while pH values indicated slightly alkaline conditions that are still suitable for supporting the survival of Mollusca and Arthropoda. Meanwhile, water depth varied from very shallow intertidal areas to relatively deeper zones. Substrate conditions also exhibited variation, consisting of sand, mixed coral rock and sand, and predominantly muddy substrates at most sampling stations. According to Gimenez et al. (2024), substrate characteristics are important factors influencing the distribution of benthic organisms, as different species exhibit distinct habitat preferences. Furthermore, Hou et al. (2020) reported that the stability of physicochemical parameters, such as temperature and

pH, plays a significant role in maintaining the balance of aquatic communities. Therefore, the overall water quality and habitat conditions within the study area can be considered favorable for supporting the occurrence and persistence of Mollusca and Arthropoda populations.

4. CONCLUSION

The diversity of Mollusca and Arthropoda within the waters of Rumut Island can be classified as moderate, with Gastropoda representing the group with the highest species richness and Malacostraca constituting the most abundant group in terms of individual abundance. The variation in the distribution and density of organisms among sampling stations was influenced by environmental factors such as substrate type, water depth, temperature, and pH, all of which remained within ranges suitable for supporting intertidal fauna. These findings suggest that the aquatic ecosystem of Rumut Island is still in relatively good condition and possesses the potential to support the continued persistence and diversity of benthic invertebrate communities.

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