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STUDY OF BIVALVIAN COMMUNITY STRUCTURE BASED ON ECOLOGICAL INDEX IN THE COASTAL AREA OF PALOPO CITY

Kajian Struktur Komunitas Bivalvia Berdasarkan Indeks Ekologi di Wilayah Pesisir Kota Palopo

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ABSTRACT

The coastal area of Palopo City has a high potential for bivalve ecosystems, but few studies have examined their community structure in detail. This issue was the primary reason for conducting this study, which aimed to determine the abundance, diversity, dominance, and evenness of bivalves in three locations with distinct characteristics: a mangrove area, a residential area, and the Toponggoli River estuary. The study was conducted in June 2025 using a quantitative descriptive survey approach. The sampling technique used a quadrat transect method at three observation stations, each consisting of three plots. Bivalve identification results were analyzed using the abundance index, Shannon-Wiener index (H′), Simpson index (C), and evenness index (E). The analysis showed that the abundance of bivalves found was 118 individuals. Station 2 recorded the highest abundance, followed by Stations 3 and 1. Polymesoda sp. dominated at Stations 1 and 3, while Anadara sp. was more abundant at Station 2, while Sinonovacula constricta was only found at Station 1. Station 2 (the settlement) had the most balanced community structure, with a diversity value of H′ = 1.012 and evenness of E = 0.921. Meanwhile, Stations 1 and 3 tended to be dominated by a single species, Polymesoda sp., as evidenced by their low H′ values and high dominance. The output of this study is baseline data on the bivalve community structure that can be used in ecologically based coastal management efforts.

Keywords: Bivalves; Community structure; Ecological index; Coast; Palopo City

ABSTRAK

Wilayah pesisir kota palopo memiliki potensi ekosistem bivalvia yang cukup tinggi, namun belum banyak penelitian yang mengkaji struktur komunitasnya secara detail. Masalah ini menjadi alasan utama dilakukannya penelitian dengan tujuan untuk mengetahui tingkat kelimpahan, keanekaragaman, dominansi, dan keseragaman bivalvia pada tiga lokasi yang memiliki karakteristik berbeda yaitu kawasan mangrove, kawasan pemukiman, dan muara

sungai toponggoli. Penelitian dilakukan pada bulan juni 2025 dengan pendekatan survei deskriptif kuantitatif. Teknik pengambilan sampel menggunakan metode transek kuadrat di tiga stasiun pengamatan, yang masing-masing terdiri dari tiga plot. Hasil identifikasi bivalvia dianalisis menggunakan index kelimpahan, indeks shannon-wiener (h′), simpson (c), dan indeks keseragaman (e). Hasil analisis menunjukkan bahwa kelimpahan bivalvia yang ditemukan sebanyak 118 individu. Stasiun 2 mencatat kelimpahan tertinggi, diikuti stasiun 3 dan stasiun 1. *Polymesoda* sp. Mendominasi di stasiun 1 dan 3, *anadara* sp. Lebih banyak di stasiun 2, sedangkan *sinonovacula constricta* hanya ditemukan di stasiun 1. Keanekaragaman di stasiun 2 (pemukiman) memiliki struktur komunitas yang paling seimbang, dengan nilai keanekaragaman h′ = 1.012 dan keseragaman e = 0.921. Sementara itu, stasiun 1 dan stasiun 3 cenderung didominasi oleh satu spesies, yaitu polymesoda sp, yang terlihat dari rendahnya nilai h′ dan tingginya dominansi.

Kata Kunci: Bivalvia; Struktur komunitas; Indeks ekologi; Pesisir;

INTRODUCTION

Coastal areas are complex and crucial ecosystems supporting marine life, including benthic groups such as Bivalves. Bivalves are a class of mollusks that play a crucial role in maintaining ecosystem stability, serving as filter feeders, indicators of water quality, and as a food and economic resource for coastal communities. They live attached to or hidden in soft substrates such as mud, sand, and mixtures of both, with habitat preferences influenced by environmental factors such as salinity, pH, temperature, and organic matter content. The diversity and structure of Bivalve communities can reflect the ecological conditions of a body of water, making them crucial for in-depth study (Mawardi et al., 2024).

Differences in coastal habitat characteristics lead to variations in Bivalve community structure. In estuarine areas, Bivalve communities tend to be limited due to the influence of salinity fluctuations and high land runoff. Conversely, coastal habitats around residential areas often experience anthropogenic pressures such as domestic waste pollution, which can lead to a decline in species abundance and diversity. Meanwhile, mangrove areas generally provide a substrate rich in organic matter that supports the abundance of certain Bivalves. These differences indicate that habitat significantly determines the structure of the bivalve community in a region (Ashif, 2019).

Palopo City, as one of the coastal areas in South Sulawesi, boasts diverse habitats, including estuaries, coastal settlements, and mangrove forests. However, few studies have comprehensively examined the structure of the bivalve community in this area, particularly using ecological indices such as the abundance index, Shannon-Wiener diversity index (H'), dominance index (C), and evenness index (E). This presents a fundamental problem because the lack of information on the ecological conditions of the bivalve community could impact the sustainability of coastal biological resources in Palopo. Although the coastal area of Palopo City has high benthic ecosystem potential, information on the structure of the bivalve community in the region remains very limited. The lack of systematic baseline data on the species, dominance, and distribution of bivalves poses a barrier to sustainable coastal resource management. Furthermore, environmental pressures resulting from human activities around the coast, such as settlements, mangrove clearing, and waste discharge into river estuaries, are suspected to influence the presence and diversity of bivalve species. Therefore, this research is important to provide an ecological picture of the structure of the Bivalvia community through the diversity, dominance, and uniformity index approaches.

In the coastal waters of the Makassar Strait, bivalves dominate the benthic community due to their ability to survive highly fluctuating conditions. Beyond their physiological importance, bivalves also play a crucial ecological role as filter feeders, helping maintain water clarity and

nutrient cycling. Healthy, nutrient-rich habitats enable bivalves to thrive. For example, research on the southern coast of East Java shows that mangrove areas provide ideal habitats for bivalves, with their soft substrates and high organic matter content. Consequently, bivalve diversity in these areas is higher than in other areas, such as river estuaries and residential areas (Sedana Putra et al., 2021). Studies on the northern coast of East Java indicate that heavily polluted areas have significantly lower bivalve diversity than protected natural areas, such as mangroves. This confirms that anthropogenic pressures can significantly reduce bivalve biodiversity (Jannah and Restu, 2023).

Bivalve community structure describes the pattern of species composition within a habitat, including diversity, abundance, and dominance. According to Annisa et al. (2024), the diversity and structure of bivalve communities are strongly influenced by the physical conditions of the habitat, such as substrate type and food availability. Healthy communities exhibit a balance between dominant and other species, reflecting the stability of coastal ecosystems. Various studies on bivalve communities in coastal areas of Indonesia have been conducted to understand their distribution, diversity, and the environmental factors that influence them. Research conducted by Sundari et al. (2023) in the mangrove area of Sungai Nibung Village showed that the presence of mangrove vegetation significantly contributes to the high diversity of bivalves. The muddy environment and high organic matter content support the growth of several species, such as Anadara granosa and Meretrix meretrix. The diversity index (H') at the location was categorized as moderate to high, reflecting relatively good ecosystem quality. This finding underscores the important role of mangrove vegetation as the primary habitat for bivalve communities.

Another study was conducted on the coast of Nepa Mekar Village, Southeast Sulawesi, an intertidal area with moderate anthropogenic pressure. Researchers found that the intertidal zone has a relatively high diversity of bivalves, dominated by species from the genera Tellina and Solen. The sandy habitat at this location provides stable conditions for bivalves to reproduce. A high level of evenness (E) indicates a relatively even distribution of individuals among species, indicating the absence of strong specific dominance. This study serves as a reference for observing community structure in the intertidal zone (Tala et al., 2022).

Research conducted by Bahri et al. (2020) at Bama Beach in Baluran National Park highlights the impact of human activities, such as fishing and boat traffic, on the bivalve community. A decrease in diversity index values was found in areas of high pressure, along with an increase in the dominance of species tolerant of environmental disturbances. The substrate in this area is coarser sandy, making it difficult for some bivalve species to adapt. This indicates that anthropogenic pressure can significantly alter community composition in a relatively short time.

This study aims to determine the structure of bivalve communities in three types of coastal habitats in Palopo City: river estuaries, coastal residential areas, and mangrove areas. By comparing community structures between habitats, the results are expected to provide useful scientific information for the sustainable management and conservation of coastal resources. This study also supports the marine laboratory research roadmap which focuses on coastal biodiversity and ecology studies as a basis for scientific data-based policy making.

Benefits of research

The benefits of this research are expected to increase insight and knowledge regarding the distribution and types of Bivalves in the city of Palopo, South Sulawesi.

Specific Research Objectives

1. Identifying the types of Bivalves found in three different habitats, namely river estuaries, residential areas and mangrove areas in Palopo City.

2. Analyzing the abundance and distribution of Bivalves at each observation station.
3. Calculating the ecological index values, namely the diversity index (Shannon-Wiener, H′), dominance index (Simpson, C), and evenness index (E).

Urgency (Priority) of Research

This research is crucial because data on the structure of bivalve communities along the coast of Palopo City is currently unavailable, particularly in three different habitat types. The resulting data is expected to provide useful baseline information for coastal ecological studies in this region.

RESEARCH METHODS

The research method used was descriptive quantitative with an ecological survey approach to analyze the structure of the Bivalvia community in three coastal habitats in Palopo City, namely river estuaries, residential areas, and mangroves. Sampling was carried out using an effective quadrat transect to determine the distribution and abundance of Bivalves. The samples obtained were identified in the laboratory, then analyzed using ecological indices, namely the abundance index, diversity index, dominance, and evenness to describe the condition of the community at each station. The research stages included location surveys, sampling, identification, data analysis, and reporting of results.

Place and Time

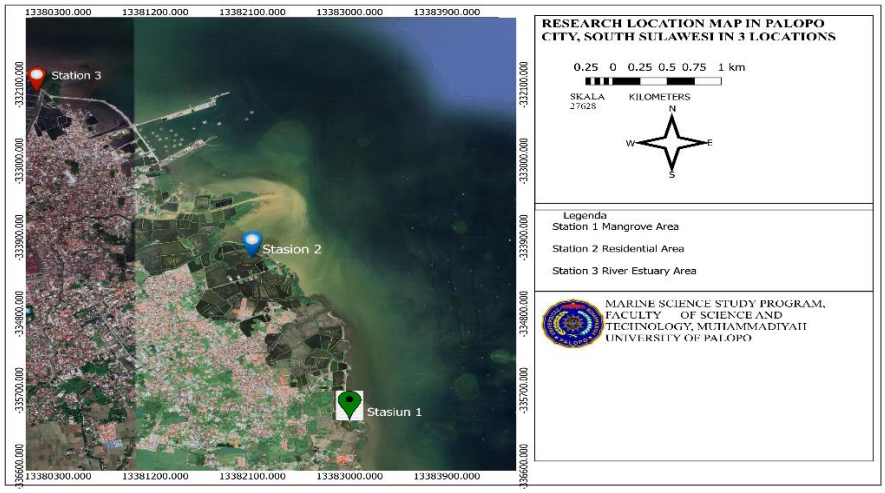


Figure 1. The research location is in 3 sub-districts, namely Bara Selatan, Wara Timur, and Wara Selatan sub-districts.

This research was conducted in the coastal area of Palopo City, South Sulawesi, consisting of three observation stations representing three different habitat types. The first station is located in the estuary area, which is a meeting point for freshwater and seawater, characterized by soft substrates and fluctuating salinity. The second station is located in a coastal residential area, which is influenced by human activity and relatively stable environmental conditions. Meanwhile, the third station is located in a mangrove forest area, which has a muddy substrate with dominant mangrove vegetation and plays an important role as a habitat for coastal biota. The research period took place from June 10, 2025, adjusting to tidal and weather conditions to ensure optimal and representative sampling at all three stations.

Tools and Materials

The tools and materials used in data collection are shown in Table 1 including:

Table 1. Tools and Materials

No	Name	Utility
1.	A sieve	To filter macrobenthos from sediment
2.	A shovel	To excavate sediment
3.	A camera or cell phone	For photo documentation
4.	Stationery	To record data in the field
5.	A plastic bag	Measurement: 10x10 cm, 50 pieces for storing samples
6.	Ravia cord	10 meters long to mark the sampling location
7.	Quadrant	Three 50x50 cm strips were used to determine the observation area.

Sampling Method

Sampling Preparation Stage

The activity in this sampling begins with pulling the rope at each station, the rope is then pulled from the predetermined point towards the sea along 50 meters from each (research station). At each research station there are three plots and the distance between one plot and another is 50 meters, each plot has five subplots where the distance between subplots is 10 meters so that the total number of subplots in each station is 15 subplots then the quadrant is placed on the subplot to carry out the excavation process and the diameter of the quadrant to be used is 1m x 1m (see figure 2).

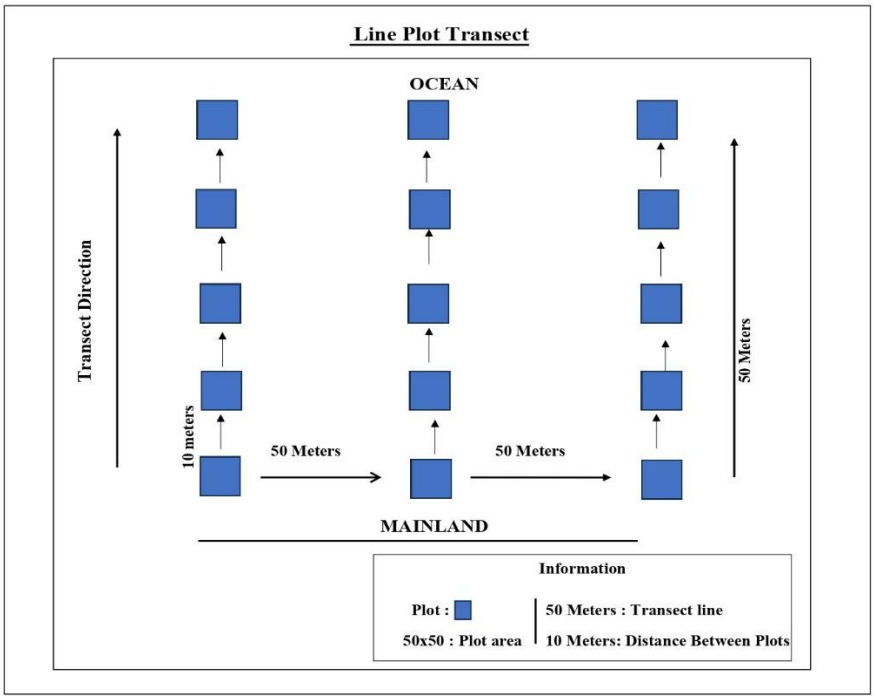


Figure 2. Transect line plot

Bivalvia Sampling Process

Bivalve sampling was carried out by taking sediment using a shovel in each plot that had been marked with a quadrant, in this sampling process it was done carefully and did not step foot into the area to be excavated. The excavated sediment was then placed on a prepared sieve,

then the sieve was shaken so that the bivalve sample would be separated from the sediment. After the sediment dredging process was completed, it was continued to the next subplot, for the excavation depth in each subplot was around 25 cm. Samples found in each subplot were then put into a labeled plastic bag, samples found at each station were then taken home for identification.

Research Sample Identification

Samples taken at each station were then identified. The identification process was carried out in the marine laboratory of Muhammadiyah University of Palopo on June 10, 2025. To determine the types and morphological characteristics of bivalves using an identification book sourced from Isnaningsih, et al., (2021).

Data Analysis

The collected data were then analyzed using ecological indices, namely the abundance index, the Shannon-Wiener diversity index (H'), the dominance index (C), and the evenness index (E). The recorded data included the type of bivalve, the number of individuals found, and the sampling location. The data was then compiled in a table to determine the number and types found at each station. Comparisons were made to determine differences in abundance, diversity, and dominance between research locations.

Abundance Index

In bivalve sampling, abundance indicates the number of bivalve individuals of a species found in a given observation area, and can therefore be used to describe population density in its habitat. This value helps compare population conditions across locations or time periods and identifies the influence of environmental factors on bivalve communities.

Shannon-Wiener Diversity Index (H')

The following formula is used to calculate community diversity based on the relative distribution of individuals found.

$$H = -\sum_{i=1}^{s} Pi \,.\, \mathrm{Ln(Pi)}$$

$$\text{with: } Pi = \frac{ni}{N}$$

Information:
H′: diversity index
pi: proportion of individuals of species i
ni: number of individuals of species i
N: total number of individuals
ln: natural logarithm
s: number of species found

According to research by Shannon & Wiener (1963), an H' value (H' < 1) is interpreted as indicating a low level of diversity, typically occurring in environments with high ecological pressure, such as pollution or anthropogenic disturbances that support only a few species. An H' value (1 ≤ H' ≤ 3) indicates moderate to high diversity, where the macrozoobenthos community is quite stable and supported by a relatively healthy and varied environment. However, an H' value > 3 indicates very high diversity, reflecting a healthy environment with

heterogeneous substrates, minimal ecological pressure, and supporting many species. The following table shows the interpretation of diversity index values:

Table 2. Interpretation of Diversity Index Values

No	H' value	Interpretation
1.	H' < 1	Low diversity
2.	1 ≤ H' ≤ 3	Moderate to high diversity
3.	H' > 3	Very high diversity

Dominance Index (C)

The following formula is used to calculate the dominance index which describes the dominance of one species in a community.

$$C = \sum_{i=1}^{s} P^2 i$$

Information**:**
C: dominance index
pi: proportion of individuals of species i
The C value approaches 1 → there is a dominant species
The C value approaches 0 → the community is balanced

Simpson's (1949) research demonstrated the interpretation of Simpson's Dominance Index (C) values. A C value close to 0 indicates that no species dominates the community, reflecting a more balanced ecosystem with relatively high species diversity. Conversely, a C value close to 1 indicates strong dominance by one species, which is often an indication of ecosystem imbalance, such as due to environmental disturbance or pressure from dominant species. The following interpretations of the dominance index are shown in Table 3.1.3.

Table 3. Interpretation of Dominance Index Values

No	C Value	Interpretation
1.	C approaches 0	There is no dominance of a particular species
2.	C approaches 1	One species dominates the community

Uniformity Index (E)

The following is the formula for the Evenness Index which will be used to assess whether the distribution of individuals among species in the community is even or not..

$$E = \frac{H}{Ln(S)}$$

Information:
E: uniformity index
H′: Shannon index value
S: number of species
The E value is close to 1 → the distribution of individuals is very even

According to research conducted by Pielou (1966), the interpretation values shown in Table 3.1.4 indicate that an E value approaching 0 indicates an uneven distribution of individuals among species, with one or more species significantly dominating the community.

This indicates an imbalance in population distribution, making the community less stable. However, an E value approaching 1 indicates a very even distribution of individuals among species, meaning no species dominates and the community has a high balance in the distribution of individuals among species, reflecting a more stable and healthy ecosystem.

Table 4. Interpretation of Evenness Index Values

No	Nilai E	Interpretation
1.	E approaches 0	Uneven distribution, with very dominant species.
2.	E approaches 1	Very even distribution

RESULT

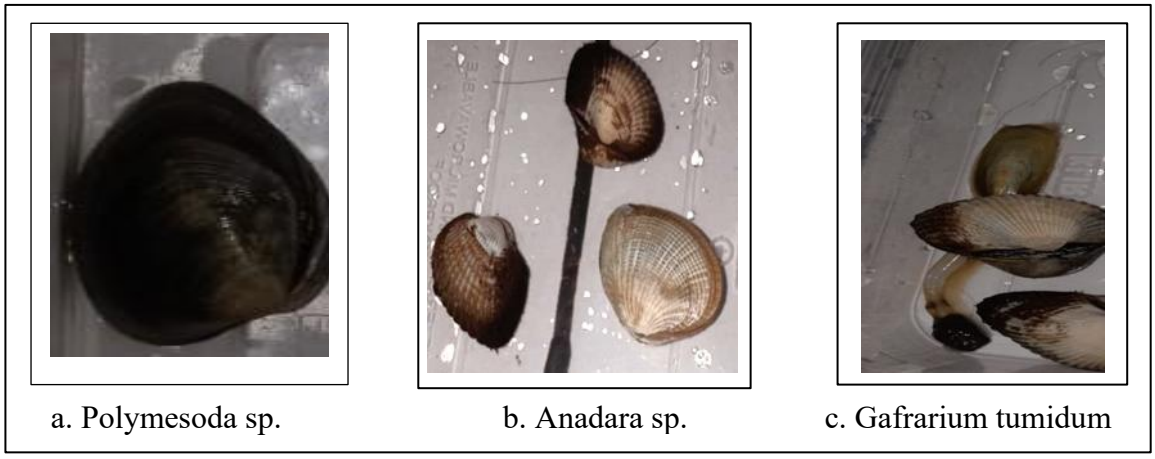
Research result

Abundance

Table 5. Abundance data between stations

No	Type	Abundance data		
		S1/Mangrove	S1/Settlements	S1/Estuari
1.	Gafrarium tumindum Clas: Bivalvia		21	
2.	Anadara sp. Clas: Bivalvia	8	20	7
3.	Polymesoda sp. Clas: Bivalvia	22	7	33
Total/station		30	48	40
Total		118		

Image of the Types of Bivalves Found



a. Polymesoda sp. b. Anadara sp. c. Gafrarium tumidum

Diversity Index (H′)

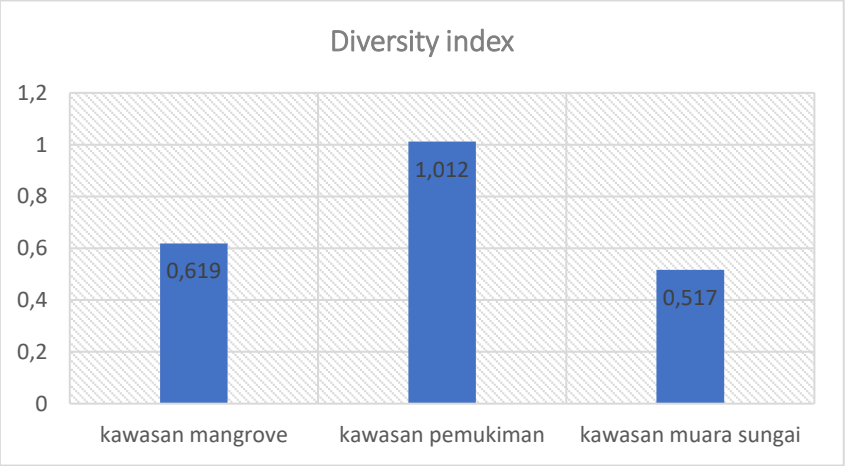


Figure 4. Results of Diversity Index Calculation at Each Station

Dominance Index (C)

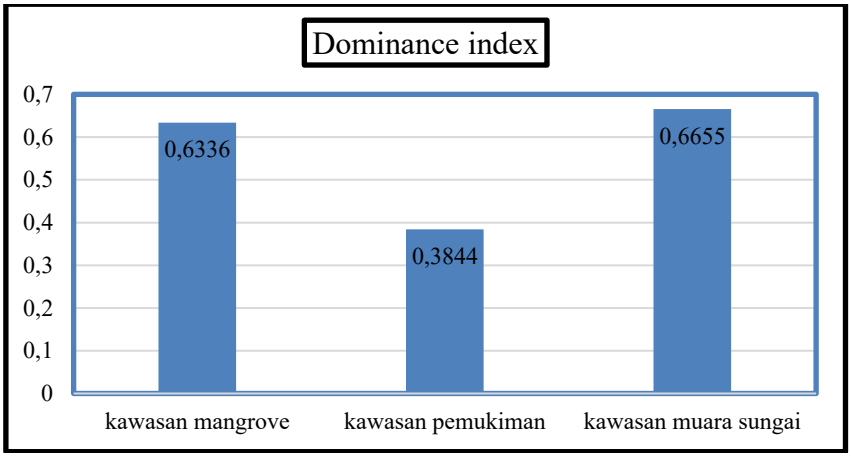


Figure 5. Results of Dominance Index Calculation at Each Station

Uniformity Index (E)

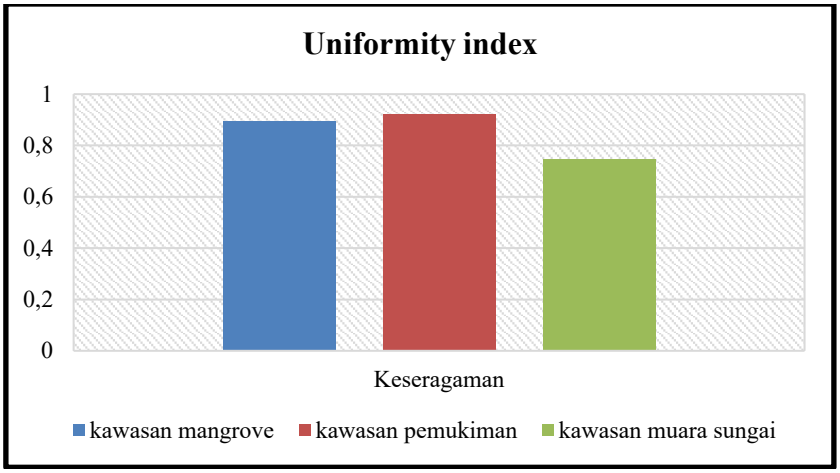


Figure 6. Results of Uniformity Index Calculation

Comparison of Ecological Index of Bivalve Community Structure in Palopo City

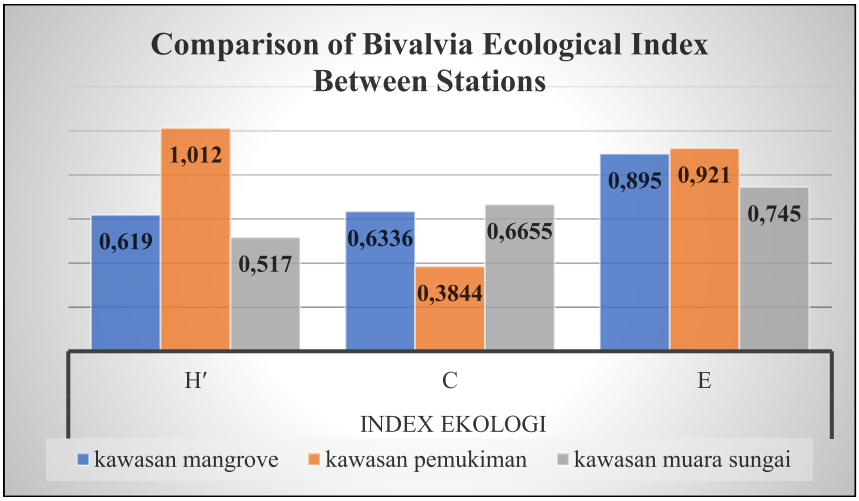


Figure 7. Results of Calculation of Ecological Index of Diversity, Dominance, and Uniformity

Table 6. Data on the types and number of individuals found at each station and plot

No	Station	Plot		Type			
				Sinonovacula constricta	Anadara sp.	Polymesoda sp.	Total
1.		1	1			1	1
2.			2		1		1
3.	ST1		3			3	3
4.			4		1	2	
5.			5			4	3
6.		2	1			1	1
7.			2		1		1
8.			3			1	1
9.							
10.			4				
11.			5		4	4	8
12.		3	1				
13.			2			2	2
14.			3		1		1
15.			4			1	1
16.			5			3	3
	Total				8	22	30
17.		1	1	3		1	4
18.			2	6			6
19.			3	4	2		6
20.			4	2	3	1	6
21.	ST2		5	1	2	1	4
22.		2	1	4			4
23.			2			1	1
24.			3			1	1
25.			4		2		2

26.			5			1	1
27.		3	1	4			4
28.			2		4		4
29.			3		3		3
30.			4		1		1
31.			5		3	1	4
Total				24	20	7	51
32.		1	1			2	2
33.			2		2	1	3
34.	ST3		3			1	1
35.			4		1	3	4
36.			5			1	1
37.		2	1				
38.			2			2	2
39.			3			4	4
40.			4		1	2	3
41.			5				
42.		3	1			3	3
43.			2			1	1
44.			3		2	1	3
45.			4			2	2
46.			5		1	3	4
Total					7	26	33
Total overall /station						114 individu	

DISCUSSION

This research was conducted at three observation stations with different environmental characteristics. Each station consisted of three plots, each with five quadrants. Observations were made on the types and number of bivalve individuals found in each quadrant. The results showed variations in the number of individuals and species at each station, which were then analyzed using the abundance index (H′), dominance index (C), and evenness index (E).

Abundance Index

The results of the study showed that the abundance of Bivalves differed at each observation station, at Station 2 the residential area had the highest number of individuals, namely 48 individuals, followed by Station 3 the river estuary with 40 individuals, while the lowest abundance was found at Station 1 the mangrove area with 30 individuals. This abundance indicates differences in environmental conditions that affect the distribution and number of organisms at each study location, the high abundance at the residential station is thought to be caused by the large number of organic material sources from the community's domestic activities. Organic material carried by water flow into the waters serves as a source of nutrients that support food availability for Bivalves. Meanwhile, the low abundance at the mangrove station is likely influenced by the characteristics of the substrate which is thick muddy and higher litter accumulation, so that only certain species are able to adapt and dominate. This finding is in line with the results of research by Suryana et al., (2024) which

states that the abundance of macrozoobenthos, including bivalves, is influenced by sediment characteristics and organic material content. Likewise, research from Sari et al., (2024) reported that the abundance of Bivalves in coastal waters is strongly influenced by environmental factors, especially the availability of organic material and substrate type. Thus, the differences in abundance between stations can be interpreted as the ecological response of Bivalves to variations in environmental conditions at the research site.

Diversity Index (H′)

Bivalvia diversity at the research location showed differences between stations, station 1 mangrove area has low diversity with Shannon-Wiener index (H′) value of 0.619. At this station only two species were found, namely Polymesoda sp. (22 individuals) and Anadara sp. (8 individuals) with a total of 30 individuals. The low diversity value is caused by the dominance of Polymesoda sp which is higher in number than other species as also found by Ashif, (2019) that the dominance of certain species can reduce the value of community diversity. Station 2 (residential area) has moderate diversity with H′ value of 1.012, there are three types of Bivalves namely Gafrarium tumidum (24 individuals), Anadara sp (20 individuals) and Polymesoda sp (7 individuals) with a total of 51 individuals. This condition shows that the environment around the settlement still supports the existence of several species, despite pressure from human activities such as waste disposal and substrate changes. Station 3 (Toponggoli River estuary) has low diversity with H′ value of 0.517. At this station, only two species were found, namely Polymesoda sp (26 individuals) and Anadara sp (7 individuals), with a total of 33 individuals. The low diversity at this location is related to the environmental conditions of the estuary which are influenced by dynamic currents, salinity, and sediments, so that only certain species are able to survive. The results of this study indicate that the level of Bivalvia diversity in the study area varies according to the environmental conditions of each station. These results are in line with research conducted by (Wuryantoro et al., (2024) conducted in the Coastal Waters of Kendari Bay which shows that areas with high environmental pressure and tend to increase in habitats with more stable conditions. Thus, differences in diversity values at each station can be explained by ecological factors that influence species distribution.

Dominance Index (C)

Bivalvia dominance varied between research stations, with Station 3 having the highest dominance value of C = 0.6655, and Station 1 having a dominance value of 0.6336, indicating strong dominance by Polymesoda sp. These two locations contained only two species and indicated community imbalance due to the dominance of one species. In contrast, Station 2 recorded the lowest dominance value (C = 0.3844), indicating that no single species was truly dominant. Although Gafrarium tumidum had the highest number of individuals, the difference with Anadara sp. and Polymesoda sp. was not significant, reflecting a more balanced community structure. This finding is supported by research by Kurniawan et al., (2024) in the Senggarang Besar Waters of Tanjungpinang City, which showed a low dominance index across all research stations indicating that no single Bivalvia species was absolutely dominant in the community.

Uniformity Index (E)

The species evenness index value shows the pattern of individual distribution between species that varies at each station, station 2 has the highest E value of 0.921 which indicates that the three types of Bivalvia Gafrarium tumidum, Anadara sp., and Polymesoda sp.) are evenly distributed. The relatively balanced distribution of individuals indicates that the ecological community is more stable even though it is in an area influenced by human activities.

This result is in line with research at Kerang Mas Beach, Lampung which reported an E value between 0.85 and 0.94, the community is categorized as stable and relatively even Wijayanti, (2021). Station 1 also shows high evenness with an E value of 0.895, although there are only two species, the ratio of the number of individuals between the two is quite proportional so that the community remains stable and evenly distributed. In contrast, Station 3 has a moderate evenness value of 0.745 which indicates a difference in the number of individual distributions. At this station, Polymesoda sp is much more numerous than Anadara sp, most likely due to physical environmental conditions such as salinity, and organic matter content in the substrate that favors one particular species. The same thing was also said by Erika et al., (2022) in the Pangkal Pinang mangrove ecosystem, who stated that physical environmental conditions such as current speed, salinity, and organic material content in the substrate can influence the number of species in the mangrove ecosystem.

CONCLUSION

The conclusion of this study shows that the structure of the Bivalvia community in the coastal area of Palopo City differs at each observation station, according to the characteristics of each environment. Station 2, located in a residential area, has the highest diversity value (H′ = 1.012), the highest evenness (E = 0.921), and the lowest dominance (C = 0.3844), indicating a stable and balanced community. In contrast, Station 1 (mangrove area) and Station 3 (Toponggoli river estuary) show low diversity values and high dominance, indicating the dominance of certain species (Polymesoda sp.) and more limited environmental conditions. These differences in community structure indicate that habitat conditions, such as substrate, human activities, and abiotic factors, greatly influence the distribution and dominance of Bivalvia species.

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