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Community Structure of the Bivalve in Tidung Island Waters, Seribu Islands Regency, DKI Jakarta Province

Struktur Komunitas Bivalvia pada Perairan Pulau Tidung Kabupaten Kepulauan Seribu Provinsi DKI Jakarta

Anugrah Setiadari Harahap[1*], Syafruddin Nasution[1], Efriyeldi[1]
[1]*Department of Marine Science, Faculty of Fisheries and Marine, Universitas Riau, Pekanbaru 28293 Indonesia*
**email: anugrah.setiadari0036@student.unri.ac.id*

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Abstract

Community structure is a concept that studies the composition of species and abundance in a community. This research was conducted in April 2022 in the waters of Tidung Island, Seribu Islands Regency. The purpose by conducting this study was to determine the structure of the bivalve community which includes species, density, relative density, diversity, uniformity, dominance, distribution pattern and index of similarity. The research method used in this study is survey method, were carried out at 3 stations, station determination using purposive sampling method taking into account the anthropogenic conditions in the study area. Based on results, types of bivalves found consisted of 6 species of bivalve. The species most commonly found is *Atrina pectinata*. The abundance of bivalve obtained ranged from 2.67 – 5.47 ind/m^2. The results of the ANOVA test between observation stations obtained the value of sig. <0.05, so it can be concluded that the density of Bivalvia between stations was significantly different, except for stations I and III. The distribution pattern of bivalves in the waters of Tidung Island is in groups. The value of the Diversity Index in the study area is classified as moderate (2.06 – 2.12). The uniformity index value during ranged from 0.80 – 0.82 wich is included in the balanced category. The dominance index between stations is different with a value range of 0.25 – 0.28 which means that no species dominates at each station.

Keywords: Community Structure, Bivalve, Tidung Island Waters

Abstrak

Struktur komunitas adalah suatu konsep yang mempelajari komposisi spesies dan kelimpahan dalam suatu komunitas. Penelitian ini dilaksanakan pada bulan April 2022 di perairan Pulau Tidung Kabupaten Kepulauan Seribu. Tujuan dilakukannya penelitian ini adalah untuk mengetahui struktur komunitas bivalvia yang meliputi spesies, kerapatan, kerapatan relatif, keanekaragaman, keseragaman, dominasi, pola sebaran dan indeks kesamaan. Metode penelitian yang digunakan dalam penelitian ini adalah metode survei, dilakukan di 3 stasiun, penentuan stasiun menggunakan metode purposive sampling dengan mempertimbangkan kondisi antropogenik di daerah penelitian. Berdasarkan hasil penelitian, jenis bivalvia yang ditemukan terdiri dari 6 spesies bivalvia. Spesies yang paling banyak ditemukan adalah *Atrina pectinata*. Kelimpahan bivalvia yang diperoleh berkisar antara 2,67-5,47 individu/m^2. Hasil uji Anova antar stasiun pengamatan diperoleh nilai sig. < 0,05, sehingga dapat disimpulkan bahwa kepadatan Bivalvia antar stasiun berbeda nyata, kecuali stasiun I dan III. Pola sebaran bivalvia di perairan Pulau Tidung bersifat berkelompok. Nilai Indeks Keanekaragaman di daerah penelitian tergolong sedang (2,06 - 2,12). Nilai indeks keseragaman berkisar antara 0,80 - 0,82 yang termasuk dalam kategori seimbang.

Indeks dominasi antar stasiun berbeda dengan rentang nilai 0,25 – 0,28 yang berarti tidak ada spesies yang mendominasi pada setiap stasiun.

Kata kunci: Struktur Komunitas, Bivalvia, Perairan Pulau Tidung

1. Introduction

The ocean is a highly biodiverse ecosystem. Almost every animal species can be found in the sea. One of the natural resources in the ocean is molluscs. Molluscs are one of the essential animals in coastal ecosystems. This fauna is a group of biota that is strongly associated with seagrass and mangroves and plays a role in the food chain cycle in coastal ecosystems. One of the classes included in the mollusc species is bivalves. According to Litaay (2005), one of the critical marine biological resources is various types of bivalves (mussels), which are used as food sources and as biological indicators in determining the quality of the aquatic environment. Bivalves, as one of the ocean's natural resources, have been utilised to fulfil various human needs.

Bivalves (shellfish) are filter feeders, feeding on organic particles that are sucked up with the water. Living species are generally found at the bottom of muddy or sandy waters. The body and legs of Bivalves are generally flattened laterally. The whole body is covered by a mantle and two pieces of shell connected dorsally. Bivalves live by immersing themselves, digging and placing themselves on the substrate using adhesive tools on corals and rocks (Riniatsih & Wibowo, 2010). Bivalves are commonly used as bioindicators to estimate water quality and are a diverse community (Samiaji, 2012).

Coastal waters are areas vulnerable to change, so changes in water quality are thought to influence the survival of bivalves. Changes in environmental factors in an ecosystem will affect the abundance, diversity and even the distribution of bivalves. These organisms are found in almost all water areas, including Tidung Island Kepulauan Seribu Regency.

Tidung Island is a small island administratively located in the South Thousand Islands Regency. The people of Tidung Island have long utilised the marine resources available, including bivalves, for various purposes. The island has a beautiful white sandy beach. Around the coast of Tidung Island, there is vegetation in the form of coconut trees and mangroves. Many activities are found on this island, such as tourism and fishing is another activity that we can do here. Tourism activities on Tidung Island can impact the decline in the number of bivalves in the vicinity. Various activities found in coastal waters can seriously threaten the existence of bivalves.

Considering that the critical role of coastal sera bivalves can be used as one of the bioindicators of coastal damage, it is necessary to study the structure of the bivalve community in Tidung Island Waters. So far, studies or research related to bivalve community structure conducted in the Tidung Island area still need to be completed. Therefore, research on the structure of the bivalve community in the area is deemed necessary.

2. Material and Method

2.1. Time and Place

This research was conducted in April 2022. Sampling and water quality measurements were carried out in the waters of Tidung Island, Seribu Islands Regency (Figure 1). Sample analysis was conducted at the Marine Biology Laboratory of the Department and Marine Technology, Bogor Agricultural University.

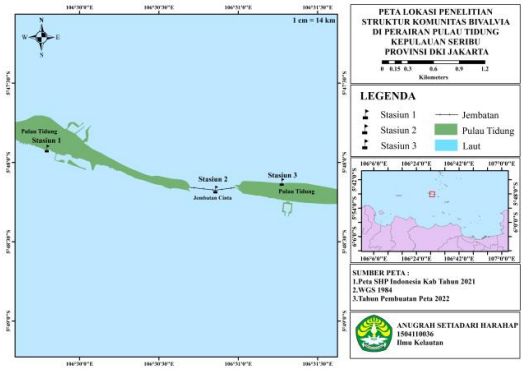

Figure 1. Research location

2.2. Methods

The method used in this research is the survey method, namely direct observation and sampling in the field and then the samples are analysed in the laboratory. Furthermore, the data obtained were processed and presented in tabular form and discussed descriptively by referring or referring to literature related to the study.

2.3. Procedure

The station was determined by purposive sampling, namely by determining the research location intentionally and considering and paying attention to the condition of the surrounding research area. The sampling location is divided into three stations: 1) West area of Tidung Island. This area is not only the ship reconstruction site but also the harbour area of Tidung Island, 2) The southern part of Tidung Island with minimum conditions of community activity, and 3) A tourist spot close to the settlement of Tidung Village community. Each station has 3 transect lines with a distance of 30m. Each transect line has 5 plots (with a plot area of 1x 1 m) sequenced from the lowest ebb to the highest tide with the same distance.

2.3.1. Bivalve Abundance

The Species Abundance Index was calculated using the formula (Oddum, 1993):

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

Description:

K = Species abundance (ind/m)^2
ni = Number of bivalve individuals found (ind)
A = L uas plot (m)^2

2.3.2. Bivalve Abundance

The relative abundance of bivalves can be calculated using the Shannon-Wiener formula (Odum, 1993), with the formula:

$$R = \frac{ni}{n}\ x\ 100\%$$

Description:

R = Relative abundance (ind)
n_i = Number of individuals of each species (ind)
N = Total number of individuals (ind)

2.3.3. Bivalve Diversity Index

The diversity of biota in water can be determined using the Shannon-Wiener formula (H'). Diversity is determined by the diversity index (Shannon-Wiener *in* Fachrul, 2007) with the formula:

$$H' = -\sum_{i=1}^{s} \frac{ni}{N} Log2\ \frac{ni}{N}$$

Description:

H' = Shannon-Wiener diversity index
Ni = number of individuals of species i (ind)
N = total number of individuals of all species (ind)
Log2= used for benthic animals/slow moving animals

Criteria H' < 1 = Biota community is unbalanced or water quality is heavily polluted; 1≤ H' ≤3 = Biota community balance is moderate and water quality is moderately polluted; H'>3 = Biota balance is in excellent condition and water quality is clean.

2.3.4. Bivalve Diversity Index

Uniformity is a balance, namely the composition of individuals of each species contained in a community. The uniformity index formula, according to Pilou *in* Krebs (1985):

$$E = \frac{H'}{Hmaks} = \frac{Hi}{Log2S}$$

Description:

Id : Morisita dispersion index
n : Number of Plots
N : Total number of individuals
$\sum x^2$: Number of individuals per plot squared

The criteria according to Pilou *in* Kasry and Fajri (2012) if the E value: Approaching 1 (≥ 0.5) means that organisms' uniformity is balanced and there is no competition for space or foo; Approaching zero (<0.5) means that the uniformity of organisms in the water is not balanced, and there is competition for food.

2.3.5. Bivalve Dominance Index

Dominance can be expressed in terms of Simpson's dominance index (Odum, 1993), namely:

$$C' = \sum_{i=1}^{s} \left(\frac{ni}{N}\right)^2$$

Description:

C' = Dominance index

Ni = Number of individuals of the i-th species (ind)
N = Total number of individuals of all species (ind)
s = Number of species

With criteria: D close to 0 (<0.5) = No dominating species; D close to 1 (≥ 0.5) = There is a dominating species.

2.3.6. Distribution Pattern (Id)

The distribution pattern of bivalves is known from the results of the Morisita index (Id) value (Brower & Zar, 1977). The dispersal index was calculated using the formula:

$$d = \frac{n(\Sigma x2 - 1)}{\Sigma x(\Sigma - 1)}$$

Description:
N = Number of plots
Σx = Total number of individuals in each quadrant = $x + x_{12}$
Σx^2 = Number of individuals in each quadrant squared = $x1^2 + x2^2$
x^2 = statistical test for the Morisita index (chi-square distribution).

2.3.7. Sediment Fraction

The procedure for determining the type of sediment is based on Rifardi (2008) as follows: Sediment samples were taken from the plastic bag, poured on aluminium foil, and weighed the wet weight, 100 g for each sample, using an analytical balance. They were then dried using an oven at a 95-105^{o}C temperature until dry. The dried samples were crushed and mixed with H_2O_2 3%.

Then, the sample was soaked in water and rinsed using a multistage sieve to obtain different sediment fractions according to their respective sizes. The sieve that passes the mesh size 6m m sieve and the water is collected in a container and then put in a 1000 ml cylindrical tube. Each sample of water taken is placed in a container (aluminium foil) and then in the oven for 24 hours. The weight of the sample and its container that has been dried is weighed in a dry state.

The data obtained was then described and classified using Shepard's triangle.

2.3.8. Total Organic Matter

The calculation of sediment organic matter content was carried out using the following formula:

$$\text{Total organic matter} = \frac{a - c}{a - b} x\ 100\%$$

Description:
a = weight of container and sediment sample after drying (g)
b = weight of container (g)
c = weight of container and sample after combustion (g)

2.3.9. Water Quality Measurement

Water quality measurements were taken at high tide. (Measurements were taken prior to bivalve sampling with 3 repetitions. Water quality parameters include temperature, pH, salinity, and brightness. Temperature measurement is done by dipping the thermometer into the water, and then the number shown is recorded (unit ^{0}C). Acidity is measured by dipping the pH indicator into the water and then recording the results shown. Salinity measurements using a hand refractometer that was first calibrated with distilled water. Seawater samples are dripped sufficiently using a drop pipette and see the number shown, then record the number in units of ‰. Brightness is measured using a Secchi disc that is lowered into the water slowly until it is not visible and measured for distance lost. The Secchi disc is pulled up to be visible and measured for distance.

2.4. Data Analysis

Data obtained from the field can be presented as graphical tables discussed descriptively. The ANOVA test was conducted using Microsoft Excel software application and Statistical Program for Social Science (SPSS) version 16.0 to compare the abundance of bivalves between stations.

3. Result and Discussion

3.1. Research Location

Tidung Island is one of the sub-districts in Seribu Selatan Islands Sub-district, Seribu Islands Regency, Jakarta, Indonesia, located at coordinates 106^o 19'30" to 106^o 44'50" East Longitude and 5^o 10'00" to 5^o 10'00" South Latitude.

3.2. Water Quality

Water quality parameters are supporting factors to show whether or not Water quality parameters are supporting factors to show whether or not the environment is still suitable to support the life of aquatic organisms. The measurement results of Tidung Island water quality parameters during the research can be seen in Table 1.

Table 1. Water quality parameters

Station	Parameters			
	pH	Temperature (^{0}C)	Salinity (ppt)	Brightness (cm)
I	7	28	28	13
II	8	28	30	7,5
III	7,5	33	30	20

From the table above, it can be seen that the pH value of the waters of the three stations has a value ranging from 7-8. The water temperature value ranges between 28-30 ^{0}C. The salinity ranged from 28-30 ppt. Current velocity at the three stations ranged from 8.7-10 m/s. At the same time, the brightness ranged from 7.5 to 20 cm.

3.3. Sediment Organic Matter Content

The results of the analysis of sediment organic matter content in Tidung Island waters can be seen in Table 2.

Table 2. Sediment organic matter content

Station	Organic matter content
I	3,00 ± 0,10
II	2,75 ± 0,15
III	2,24 ± 0,22

3.4. Sediment Type and Suspended Solids

The results of sediment fraction analysis obtained in Tidung Island Waters can be seen in Table 3.

Table 3. Sediment type

Station	**Average Sediment Fraction (%)**			**Sediment Type**
	Gravel	**Sand**	**Mud**	
I	66,37	26,15	7,48	Sandy Gravel
II	59,79	31,71	8,50	Sandy Gravel
III	60,87	32,08	7,05	Sandy Gravel

Based on the analysis conducted illustrates that the type of sediment that dominates at each station is sandy gravel. The average percentage of gravel fraction is highest at station I, which is 66.37%. The highest sand fraction is at station III, 32.08%, and the highest mud fraction is at station II, 8.50%, and the highest gravel fraction is obtained at station 1. Based on Shepard's triangle, it is obtained that the type of substrate in the waters of Tidung Island is dominated by sandy gravel.

Table 4. Suspended solids

Station	Suspended Solids (mg/L)
I	61,00
II	71,33
III	82,33

Based on Table 4, it can be seen that the suspended solids contained in the three stations are different. The highest suspended solids are found at station III, which is 82.33 mg/L, and the lowest at station I, which is 61.00 mg/L.

3.5. Bivalve Community Structure

The results of observations of bivalve species obtained in the waters of Tidung Island can be seen in Table 5.

Table 5. Species and distribution of bivalves

Family	**Genus**	**Species**	**Station**		
			I	**II**	**III**
Mytilidae	Perna	*Perna viridis*	+	+	+
Pinnidae	Atrina	*Atrina pectinita*	+	-	+
Veneridae	Paratapes	*Paratapes undulates*	+	+	+
	Meretrix	*Meretrix meretrix*	+	+	+
Arcidae	Anadara	*Tegillarca granosa*	+	+	-
		Anadara antiquate	-	+	+

The results of observations of bivalve species in the waters of Tidung Island during the study obtained 4 families from the three stations, namely Arcidae, Mytilidae, Veneridae, and Pinnidae, with the number of species found were 6 species. At stations I, II and III, the most common species found was Meretrix meretrix sp. According to Wahab et al. (2018), habitat factors and water substrate are thought to be the main factors related to the high composition of gastropod and bivalve species in a body of water. Bivalves are found in intertidal areas due to this species' ability to tolerate drought due to tides (Akhrianti et al., 2014).

Based on the analysis, the abundance value of bivalves at each station differs. The abundance of bivalves found in the waters of Tidung Island can be seen in Table 6.

Table 6. Abundance bivalves

Station	Bivalve abundance (Ind/m^2)
I	3,07 ± 0,70
II	5,47 ± 0,61
III	2,67 ± 0,12

Table 6 shows that the abundance of bivalves at each station in the waters of Tidung Island obtained the highest abundance at station II, with a value of 5.47 Ind/m^2. This can be seen from the condition of the location, which is far from human activity, so this station has a good substrate level for bivalve growth, as stated by Arisma (2017), which states that the type of substrate determines the abundance and composition of bivalves and is influenced by the aquatic environment and habitat conditions suitable for the life of these bivalves. Thus, a high substrate type can increase the abundance of bivalves because bivalve organisms highly favour a suitable substrate type. Susanti et al. (2019) added that differences in substrate texture can cause differences in the types of bivalves that live on the substrate.

The abundance of bivalves at this station is also because there are many human activities. Moreover, the organic matter content at station II, which is 2.75%, is categorised as low. The high abundance of bivalves is thought to be caused by the high organic matter content of the substrate and the type of substrate containing mud. This is the opinion of Suwondo et al. (2012), which states that bivalves are biota found in muddy substrates.

The low abundance of bivalves at Station III is influenced by human activities such as tourism and residential areas. This causes environmental pressure on bivalves at the station. The organic matter content at station III is also low, so the food sources needed by bivalves are very few. Based on the results of the ANOVA test on the abundance of bivalves between stations in the waters of Tidung Island, the sig. 0.01, which means sig. <0.05 indicates that the abundance of bivalves between stations is significantly different. The results of the LSD further test showed that the abundance between stations I and II and between stations II and III showed an asterisk (*) with a significant value <0.05, which means that there are significant between stations I and III are not significantly different. The relative abundance of bivalves in Tidung Island waters can be seen in Table 7.

Table 7. Relative abundance (%) of bivalve species

Species	Relative Abundance (%)		
	Station		
	I	II	III
Perna viridis	39,13	2,44	5,00
Atrina pectinata	8,70	0,00	17,50
Paratapes undulates	17,39	29,27	20,00
Meretrix meretrix	23,91	20,73	42,50
Tegillarca granosa	10,90	28,05	0,00
Anadara antiquate	0,00	19,51	15,00

The availability of organic matter influences abundance. Organic matter is a food source for marine biota, which is generally found in the substrate, so the dependence of marine biota on organic matter is vast. This is reinforced by Abrianti et al. (2017), benthic animals are closely related to the availability of total organic matter contained in the substrate because organic matter is a source of nutrients for marine biota, which is generally found in the substrate so that its dependence on organic matter is vast. The availability of organic matter can significantly vary the density of organisms present. The distribution pattern of bivalves in Tidung Island waters can be seen in Table 8.

Table 8. Distribution pattern of bivalves

Station	Value	Criteria
I	3,65	Clustered
III	3,55	Clustered
III	3,87	Clustered

Table 8 shows the results of calculating bivalve distribution patterns in Tidung Island waters with clustering criteria. According to Morisita *in* Wilhm (1975), it is stated that if the value of Id = 1, it means that the distribution of bivalves is

randomly distributed. If the value of Id < 1, the distribution of bivalves is evenly distributed. If the value of Id>1 means that the distribution of bivalves is clustered. The results of the calculation of the index value of bivalve distribution in the waters of Tidung Island ranged from 3.550-3.865, This suggests that bivalve dispersal occurs in clusters.

The clustering of bivalves is thought to be influenced by environmental factors that experience changes, such as unevenly distributed organic matter content. The cause of clustering distribution patterns can be influenced by resource grouping, mating behaviour and shelter to prevent predator attacks (Supratman et al., 2019). The research results by Supratman et al. (2019) showed that the clustering distribution pattern was caused by suitable habitat conditions as a place to shelter and find food, in addition to the interaction of male and female individuals to carry out the reproduction process. According to Akhrianti et al. (2014), the species *G.tumidum* found a clustered distribution pattern because the species gathered in an area with a high density.

3.6. Index of Diversity (H'), Uniformity (E), and Dominance (C)

Based on the analysis, we obtained the average value of the diversity index, uniformity and dominance of bivalves. More details can be seen in Table 9

Table 9. Diversity index, uniformity and dominance bivalves

Station	Diversity Index (H')	Index of Uniformity (E)	Dominance Index (C)
I	2,18	0,82	0,30
II	2,10	0,81	0,25
III	2,06	0,80	0,28

Based on Table 8, the highest value for the bivalve diversity index in Tidung Island waters ranges from 2.06 - 2.18, which means that Tidung Island waters are in a moderately polluted condition. The uniformity index of bivalves in Tidung Island waters ranges from 0.80 - 0.82, which means that the uniformity of organisms in Tidung Island waters is balanced, and there is no competition for either place or particular food. The Dominance Index of bivalves in Tidung Island waters ranges from 0.25 - 0.30, meaning there are no dominant bivalve species in Tidung Island waters.

Diversity, uniformity and dominance indices are often used to evaluate an aquatic environment based on biological conditions. This relationship is based on the fact that unbalanced environmental conditions will also affect an organism that lives in a water body (Odum, 1993).

According to the Shannon-Wiener assessment criteria, the species diversity index is H'< 1: low diversity, meaning the aquatic environment has been heavily polluted. If $1 \leq H' \leq 3$: medium diversity, the aquatic environment is half polluted (moderate pollution). If H'>3: high diversity, the aquatic environment has not been polluted (Wilhm *in* Fachrul 2007).

The diversity index (H') obtained from the study's results ranged from 2.06 - 2.18. the index value indicates a semi-polluted aquatic environment (moderate pollution).

The high diversity of bivalves at the station is likely due to organic matter and lack of anthropogenic activities. Sediments that are rich in nutrients are a good place for bivalve survival. Yuniarti (2012) shows low diversity because the ecosystem is under pressure or its condition decreases due to natural disturbances and human activities.

According to Fachrul (2017), if the value of E is close to 1 (>0,5), it means the uniformity of organisms in a water body is in a state of balance. If the value of E is <0.5 or close to 0, the diversity of species in these waters is not balanced. The results of calculating the uniformity index value in the waters of Tidung Island ranged from 0.80 - 0.82, indicating that the diversity of species in these waters is in the balanced category. The uniformity index's moderate value shows that each species' individual richness is different. It can be concluded that the uniformity index (E) in Tidung Island waters is balanced, meaning that there is no competition between bivalve species, both competition for living space and food. Uniformity in the high category is found at stations I and II—the more similar the number of individuals between species, the greater the degree of balance. The uniformity of biota in a body of water highly depends on the number of species in the community. The more species found, the greater the diversity, although this value highly depends on the number of individuals of each species (Yuliana *et al*., 2020).

Odum (1993) states that the species' dominance index (C) value is 0-1. If the C value is close to zero, it means that there is no dominating species; if the C value is close to 1, it means that a dominant species appears in these waters. The dominance index value found in Tidung Island waters is 0.25 - 0.30. According to Kinsman et al. (2016), the dominance index determines the type of bivalve that dominates in a community and the effect of environmental quality on an individual community. Based on the data obtained, there is no dominant species.

4. Conclusions

The bivalve species found in the waters of Tidung Island come from 4 families: Arcidae, Mytilidae, Veneridae, and Pinnidae. The types of bivalves found are *Anadara antiquata*, *Atrina pectinata*, *Meretrix meretrix*, *Paratapes undulatus, Perna viridis, and Tegillarca granosa*. The highest abundance of bivalves is found in areas where human activity is rare (station II), and the lowest abundance is found in tourist areas and close to residential areas (station III). The distribution pattern of bivalves in these waters is clustered. The diversity index obtained is classified as moderate, which means that these waters experience moderate pressure (disturbance) in these waters. The uniformity index value obtained is in the high category, where the distribution of individuals in these waters is balanced. The dominance index value obtained states that no dominating species exist in these waters. It is recommended that further research be carried out sampling at high tide, and sampling is carried out regularly.

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