Journal of Coastal and Ocean Sciences *e-issn: 2746-4512*
Volume 5 No. 2, May 2024: 135-142 *p-issn: 2745-4355*

Bivalve Abundance and Distribution in the Seaweed Ecosystem in the Waters of Jago-Jago Village, Tapanuli Tengah, North Sumatra Province

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Received: 25 February 2024; Accepted: 25 April 2024

ABSTRACT

This research was conducted in May 2022. This research was conducted in Jago-jago Village, Tapanuli Tengah, North Sumatra Province. The aim was to determine the abundance and distribution pattern of bivalves in the study area. The method used in this study is a survey method, namely direct observation, taking samples in the field, and then analyzing them in the laboratory. Determining observation stations and data collection using the purposive sampling method is done by considering various conditions at the research location. Sampling was carried out at three stations that were considered representative of the research area. Each station consists of 3 transects with a length of 50 m each, where each transect has three plots measuring 1x1m^2. From the research results of the types of bivalves found in the coastal waters of Jago-Jago Village during the study, there were six types of families, namely Arcidae, Cardiidae, Mesodesmatidae, Ostreidae, Donacidae, and Corbiculidae. At the same time, there were as many as six species: *Anadara antiquata*, *Trachycardium subrugosum*, *Atactodea* sp, *Crassostrea* sp, *Donax* sp, and *Polymesoda erosa*. Based on the results of the ANOVA test, it was known that the abundance of bivalves in the coastal waters of Jago-Jago Village showed a significant value obtained <0.05, namely 0.016. This indicates that the difference in abundance between stations is significantly different. The average organic matter content at station 1 is 4.59%. The substrate is muddy sand with an abundance value of 4.33 ind/m^2. At station 2, the organic matter content is 4.05% with sand substrate, and the abundance value is 3.11 ind/m^2. The organic matter content at station 3 is a 6.39% sandy mud substrate with an abundance value of 6.11 ind/m^2. The highest relative abundance of bivalves found at station 3 was *Donax* sp, which is 32.72%.

Keywords: Bivalves, Abundance, Distribution, Jago-Jago

1. INTRODUCTION

The waters of Jago-Jago Village have the potential for seagrass growth because the marine environment is favorable for seagrasses to grow well. David's (2011), seagrass species found in the waters of Jago-Jago Village are *Enhalus acoroides*, *Cymodoceae rotundata* and *C.serulata*, but the dominant species is *E. acoroides*. The substrate type in these waters is sandy mud and muddy sand. Bivalves are one of the classes of mollusks that are well-associated with seagrass ecosystems, have an essential role in the seas, and live in intertidal areas. Bivalves are often known as shellfish and can be found in coastal regions of the bottom substrate of waters in seagrass ecosystems. The diversity of bivalves in seagrass ecosystems can be a picture of water conditions (Irawan, 2015).

The Seagrass ecosystem is one of the most productive shallow marine ecosystems. In addition, seagrass ecosystems have an important role in supporting the life and development of living organisms in shallow seas, namely as primary producers, biota habitats, sediment traps, and nutrient traps (Romimohtarto & Juwana, 2009).

Bivalves are one of the classes of mollusks that are well-associated with seagrass ecosystems, have an important role in the waters, and live in intertidal areas. Bivalves are often known as shellfish and can be found in coastal regions of seagrass ecosystems' bottom substrate of waters. The diversity of bivalves in seagrass ecosystems can be a picture of water conditions (Irawan, 2015).

Given the importance of seagrass habitat for the survival of various associated organisms, especially bivalves. Therefore, it is necessary to research "Abundance and Distribution of Bivalves in Seagrass Ecosystems in the Waters of Jago Jago Village, Tapanuli Tengah, North Sumatra Province" so that later it can be used as

a reference and information in coastal area management planning in the waters of Jago Jago Village, Tapanuli Tengah, North Sumatra Province.

2. RESEARCH METHOD

Time and Place

This research was conducted from May 2022 to June 2022 in Jago-Jago Village, Tapanuli Tengah, North Sumatra Province. Species identification activities were carried out at the Marine Biology Laboratory, and sediment analysis was performed at the Marine Chemistry Laboratory, Faculty of Fisheries and Marine Sciences, Universitas Riau.

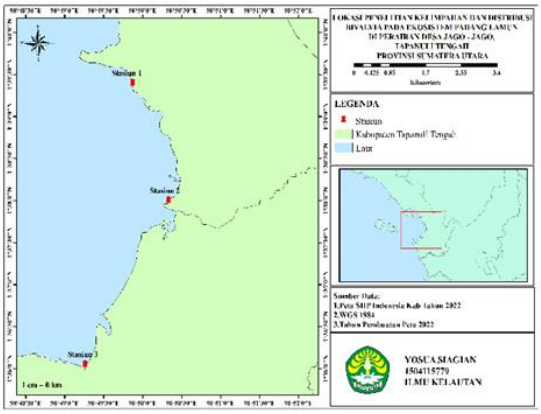

Figure 1. Research Location

Method

The method used in this research is a survey method, namely direct observation of the research area and sampling and measurement of quality parameters of the water environment in the field. Parameters include bivalve species abundance, bivalve distribution patterns, water temperature, salinity, acidity, total organic matter, and sediment type. Furthermore, the samples were identified and analyzed at the Marine Biology Laboratory of the Department of Marine Science, Faculty of Fisheries and Marine Sciences, Universitas Riau.

Procedures

The research location was determined using purposive sampling, which was carried out by paying attention to various conditions of the research area, which was divided into three stations that could represent the research area. The research location was determined using purposive sampling, which was carried out by taking into account various considerations of the conditions and circumstances of the research area. The research area was divided into three stations that could represent the research area.

Data Analysis

Bivalve samples brought to the laboratory were washed with fresh water, and then the Bivalves were identified and grouped into trays labeled according to the station point. Samples were determined based on the shape obtained using the Guide to Identification of Marine and Estuarine Invertebrates book by Gosner (1971). Furthermore, the number of species obtained was calculated.

Bivalve Abundance

Bivalve calculations Fachrul (2007) can be formulated as follows:

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

Description:

Di = abundance of the i-th individual species (ind/m^2)
ni = number of individuals of the i-th species obtained
A = Plot area of the i-th species found (m^2)

Relative Abundance of Bivalves

The determination of relative abundance was calculated using the formula according to Dahuri (2003) as follows:

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

Description:

R = Relative abundance (%)
n = number of individuals of each species (ind)
N = Total number of individuals (ind)

Bivalve Distribution Pattern

To see the distribution pattern at each station, the Morisita Scatter Index (Krebs, 1985) was used as follows:

$$\text{Id} = \text{N}\ \frac{\sum X^2 - \sum X}{(\sum X)^2 - \sum X}$$

Description:

Id = Morisita Spread Index
N = number of sampling plots
Σx = number of individuals per plot
Σx^2 = Sum of squares of individual plots

These results were grouped into three criteria, namely: IsM < 1: the distribution of individuals is even; IsM = 1: the distribution of individuals is random; IsM > 1: the distribution of individuals is clustered

Sediment Organic Matter Analysis

BOT content was analyzed using the Loss On Ignition (LOI) method (Prasetia, 2013). The LOI method aims to determine the total organic matter (organic carbon) content in sediments so that the deposition environment is known for the process of sediment occurrence based on the organic carbon content of sediment samples. The formula calculates organic matter content:

$$BOT = \frac{(Wt-C)-(Wa-C)}{Wt-C} \times 100\%$$

Description:

Wt = total weight (crucible + sample) before burning,
Wa = total weight (crucible + sample) after burning
C = weight of the empty crucible

Data obtained during the research will then be compiled, presented in tables and graphs, and discussed descriptively. To compare the abundance of bivalves between stations, the ANOVA test was conducted with the help of Microsoft Excel software application and Statistical Program For Social Science (SPSS) version 16.0.

3. RESULT AND DISCUSSION

General Situation of the Research Location

Jago-Jago Village is one of the coastal villages in the region of Badiri District, Central Tapanuli Regency, North Sumatra Province. The area of Jago-Jago Village is ±22.83 km² or 11% of the Badiri Sub-district area. Jago-Jago Villagejago is located at 1º 32' 0"- 1º37' 0" N and 98º47'30" - 98º53'06" E. The land boundaries of Jago-Jago Village are as follows: Aek Horsik borders the north, Hutabalang Village borders the east, Lumut Village and Sitardas Village borders the south, and Tapanuli Bay borders the west.

The area of Jago-jago Village is approximately 22.8 km^2, or about 11% of the total area of Kecamatan Badiri. Jago-jago Village is partly along Sibolga Beach and partly in an island area at the front of Sibolga Beach. The coastal region of Jago-jago Village has a coastline length of approximately ±1.5 km, and the sea wave height ranges from 0.6-2.5 m. The water depth is 1-10 m, and the type of water is 1.5 m. Water depth is 1-10 m, and the type of sandy and muddy beach substrates is (Dhewani & Kusumawati 2009).

Water Quality Parameters

Water quality parameters are supporting factors to show whether or not the environment is still feasible to support the life of aquatic organisms. The average measurement results of the water quality parameters of Jago-Jago Village beach when the research was carried out can be seen in Table 1.

Table 1. Average Calculation of Water Quality at Each Station

	pH	Temperature (^{0}C)	Salinity (ppt)	Brightness (cm)	Current Speed (m/s)
I	8,06	32,76	22	100	0,046
II	7.92	33,15	20,3	100	0,034
III	8,23	33,56	25,87	100	0,042

Based on pH measurements in the Jago-Jago Village water area, the pH value ranges from 7.92-8.23. According to Kuncoro (2008), the acidity of water in the waters ranges from 1-14, where if the waters are more acidic, the pH value becomes smaller. But if the waters are alkaline, the pH value is getting bigger. Meanwhile, if the pH value is 7, the water condition is neutral. According to Winanto (2004), the degree of water acidity suitable for bivalve life ranges from 7.8 to 8.6. Natural waters have a pH ranging from 4-9. The water's pH affects the water's fertility, affecting the life of microorganisms. Dissolved oxygen content decreases at low pH conditions (high acidity). As a result, oxygen consumption decreases, respiratory activity increases, and appetite decreases. Under normal pH conditions, most aquatic biota are sensitive to changes in pH and favor pH values around 7-8.5. pH plays a role in aquatic biochemical processes (Kordi, 2008).

The temperature measurements at the three stations show an average temperature value ranging from 32.76 to 33.56°C. According to Gosling (2004), it is stated that most marine bivalves live in a temperature range of -3 to 44^{0}C. Within this range, temperature tolerance levels are species-specific, and within individual species, early embryos and larvae have limited temperature tolerance than adults. In addition, the temperature required for spawning is always higher than the minimum temperature required

for growth. All these factors limit species' natural distribution at regional and local scales.

The salinity measurements in the Jago-Jago Village Waters area show that the average salinity ranges from 22-25.87 ppt. Station II have the lowest salinity. Station II is far from the river, so the salinity is lower than other stations. In contrast, stations II and III are coastal areas already a little far from the mouth of the river, and the salinity is not too different. Because bivalves are biota with a high tolerance to changes in salt concentration, according to Kim et al. (2001), bivalves can survive when there is a change in salinity characterized by the closure of the shell valve for several days. Bivalves are known to be able to become anaerobic organisms when their body tissues are severely deprived of oxygen as a result of shell closure.

Based on the brightness measurements taken by inserting the Secchi disk into the water as deep as 100 cm, the Secchi disk is still clearly visible above the water surface. This is done at all three stations with the same results, which are still clearly visible at a distance of 100 cm.

The type of current is differentiated based on its speed. The types of currents that exist are very fast currents (>1 m/s), fast currents (0.5-1 m/s), moderate currents (0.2-0.5 m/s), slow currents (0.1-0.2 m/s) and very slow currents (<0.1 m/s) (Welch, 1980). The waters of Jago-jago Village have a current speed ranging from 0.034-0.046 m/sec, which means the type of current in this location is very slow.

Bivalve Species and Abundance

The results of observations of bivalve species obtained in the coastal waters of Jago-Jago Village can be seen in Table 2.

Table 2. Bivalve Species found in the Coastal Waters of Jago-Jago Village

Station	Family	Genus	Species
	Arcidae	*Anadara*	*Anadara antiquata*
	Cardiidae	*Trachycardium*	*Trachycardium subrugosum*
I	Mesodesmatidae	*Atactodea*	*Atactodea* sp
	Ostreidae	*Crassostrea*	*Crassostrea* sp
	Donacidae	*Donax*	*Donax* sp.
	Corbiculidae	*Polymesoda*	*Polymesoda erosa*
	Arcidae	*Anadara*	*A. antiquata*
	Cardiidae	*Trachycardium*	*T.subrugosum*
II	Mesodesmatidae	*Atactodea*	*Atactodea* sp.
	Donacidae	*Donax*	*Donax* sp.
	Corbiculidae	*Polymesoda*	*P.erosa*
	Arcidae	*Anadara*	*A.antiquata*
	Cardiidae	*Trachycardium*	*T. subrugosum*
	Mesodesmatidae	*Atactodea*	*Atactodea* sp.
III	Ostreidae	*Crassostrea*	*Crassostrea* sp.
	Donacidae	*Donax*	*Donax* sp.
	Corbiculidae	*Polymesoda*	*P.erosa*

Table 2, bivalve observations in the coastal waters of Jago-Jago Village obtained six families: Arcidae, Cardiidae, Mesodesmatidae, Ostreidae, Donacidae and Corbiculidae. The bivalve species found were *A.antiquata*, *T. subrugosum*, *Atactodea* sp, *Crassostrea* sp, *Donax* sp, and *P.erosa*. The most common species found at all stations is *Donax* sp. The dominating species of all stations are from the Donacidae family. Irawan (2015) states that a high abundance value indicates many organisms. Bivalves are found in intertidal areas, and this is due to the ability of this species to tolerate drought due to tides (Dewiyanti, 2004).

According to Oemardjati & Wardhana (1990), bivalves are generally found in littoral water habitats until they survive at less than 500m depth. These animals mostly immerse themselves in sand or mud. The diversity of mussels in areas inhabiting sandy and muddy coastal habitats is a constituent of the macrozoobenthos community. These mussels are also one of the main components of soft sediment communities in coastal areas. Mussels have a variety of shell shapes and sizes. This variation in shell shape is significant in determining the types of bivalves.

Romimohtarto & Juwana (2001) suggest that in terms of their way of life, the types of clams or bivalves have different habitats even though they belong to one tribe and live in one ecosystem. Clams or bivalves generally live immersed in sand or muddy sand. Some of them are attached to complex objects with a kind called byssus.

Based on the analysis, the abundance value of bivalves at each station differs. The abundance of bivalves found in the waters of Jago-jago Village can be seen in Table 3.

Table 3. Average Abundance of Bivalves

Station	Bivalve abundance (ind/m^2) (Mean ± SD)
I	4,33 ± 0,34
II	3,11 ± 0,26
III	6,11 ± 0,55

In Table 3, it can be seen that the abundance of bivalves ind/m^2 at each station in the coastal waters of Jago-Jago Village obtained the highest abundance at station III with a value of 6.11 ind/m^2 and the lowest was at station II with a value of 3.11 ind/m^2.

The abundance of bivalves in the waters of Jago-Jago Village ranged from 3.11-6.11 ind/m^2. Station III has the highest abundance of bivalves, 6.11 ind/m^2. The abundance of bivalves at this station is due to minimal human activity and high organic matter content at station III, which is 6.39%. The high organic matter comes from organic materials carried from the river flow. The high organic matter affects the abundance of bivalves at the station. This station has a sandy mud sediment type. Bivalves are optimized to live in waters with high organic matter content. According to Widianingsih & Ritniasih (2007), the high abundance value is supported by the percentage of organic matter content in the waters. This is because organic matter is important in providing food sources for bivalve organisms.

The low abundance at station II is thought to be due to the presence of many human activities, such as tourist areas and the activity of fishing boats. This causes environmental pressure on bivalves at the station. The organic matter content at station II is also low, so the food sources needed by bivalves are also insufficient. Based on previous research on the structure of the bivalve community in the Mangrove area of Bontolebang Waters of Selayar Islands Regency, South Sulawesi, by Litaay (2014), an abundance of about 15.25 ind/m^2 was obtained. Also, a study entitled Bivalve Community Structure in Seagrass Areas in Inner Bay Waters by Alfiansyah (2014) obtained an abundance of 0.01-0.29 ind/m^2. Based on these data, it can be seen that the abundance value of Bivalves in the Waters of Jago-Jago Village is higher than the abundance of the Inner Bay Waters, Nias, and lower than the abundance found in the Waters of Bontolebang, Selayar Islands Regency, South Sulawesi.

Relative Abundance of Bivalves

The relative abundance of bivalves in the coastal waters of Jago-jago Village can be seen in Table 4.

Table 4. Relative Abundance of Bivalves

Species	Station I	Station II	Station III
A. antiquata	15,38	7,14	7,28
T. subrugosum	12,82	14,28	12,72
Atactodea sp.	17,94	21,42	23,63
Crassostrea sp	2,56	28,58	7,28
Donax sp	25,65	28,58	32,72
P.erosa	25,65	0	16,36

Table 4 shows that the lowest relative abundance at all stations is at station II with *A.antiquata* species, which is 7.14%. Meanwhile, the highest relative abundance at all stations is station III with *Donax* sp. species, which is 32.72%. The relative abundance of bivalves in the waters of Jago-jago Village is dominated by the Donaciidae family, namely the *Donax* sp. species. The relative abundance value at each station is highest at station III with *Donax* sp. species, which is 32.72%. This is thought to be caused by the type of sandy mud sediment fraction owned by station III, making it easier for Donax sp. to move and get food from organic matter.

Clark & Deswarte (2008) explain that sandy sediments have less organic matter than muddy sediments. This is because muddy bottom waters tend to accumulate organic matter carried by water flow, where the texture and particle size are finer, making it easier for organic matter to be absorbed.

Bivalve Distribution Pattern

The distribution pattern of bivalves in the

coastal waters of Jago-Jago Village can be seen in Table 5. Bivalve distribution pattern

Table 5. Distribution Pattern of Bivalves in the Coastal Waters of Jago-jago Village

Observation Station	Id	Distribution Pattern
I	1,65	Clustering
II	1,86	Clustering
III	1,82	Clustering

Table 5 shows that the results of calculating bivalve distribution patterns in the waters of Jago-Jago Village from the three stations have clustering criteria. According to Wilhlm (1975), it is said that the value of Id = 1 indicates that the distribution of bivalves is randomly distributed; if the value of Id < 1, it means that the distribution of bivalves is evenly distributed, and if the value of Id> 1 implies that the distribution of bivalves is clustered. The clustering of bivalves is due to environmental factors that have changed, such as the content of organic matter being distributed unevenly.

Based on the analysis, the sediment organic matter content in the study area obtained an average value at station I of 4.59%, station II of 4.05%, and station III of 6.39%. The highest organic matter content is found at station III, 6.39%, while the lowest is at station II, 4.05%. The comparison of organic matter content between stations can be seen in Table 6.

Table 6. Sediment Organic Matter Content.

St	Transect			Average
	I	II	III	
I	5,93	4,23	3,62	4,59
II	4,16	3,99	4,00	4,05
III	8,32	6,48	4,36	6,39

The basic substrate is one factor that can affect macrozoobenthos animals' distribution pattern. The substrate also affects the distribution of bivalves because, in addition to acting as a place to live, it also functions as a hoarder of nutrients, a gathering place for organic matter, and a place to protect organisms from predators. Tides, waves, water discharge, and the interaction of other marine biophysical factors usually determine sediment distribution.

Tanjung et al. (2013) stated that organisms that live on sandy beaches usually have more ability to make holes, immerse themselves, and attach themselves to dunes. This is because the waves always occur with a certain rhythm (defined rhythm), so organisms have the time/opportunity to save themselves (survival acts).

The substrate is an important component that determines the life, diversity, and composition of mollusk species that live in it. Observations from this study show that the substrate in the waters of Jago-Jago Village is muddy sand, sand, and sandy mud, following Nybakken's (1992) statement that the sandy substrate type makes it easier for mollusks to get the supply of nutrients and water needed for their survival. Unlike muddy substrate types, sandy and muddy sand substrate types are suitable for mollusk life, especially the Gastropoda and Bivalve classes.

Based on the analysis of sediment fractions obtained in the coastal waters of Jago-Jago Village, the following sediment fraction results can be seen in Table 7.

Table 7. Types of Sediment Fractions

Station	Sediment fraction (%)			Sediment Type
	Gravel	Sand	Mud	
I	5,37	64,31	30,33	Silty sand
II	7,58	86,89	5,53	Sand
III	4,06	37,23	58,71	Sandy mud

Based on the analysis conducted it illustrates that the sediment fraction that dominates at each station is sand. The highest sand fraction is found at station II, 86.89%. The highest mud fraction is found at station III, 58.71%, and the highest gravel fraction is obtained at station II, 7.58%. Based on the Sheppard triangle, the substrate in the coastal waters of Jago-Jago Village is dominated by sand.

According to La Sara et al. (1996), the clustered distribution type is caused by the environmental conditions suitable for these organisms' lives. Clustered distribution patterns indicate that these organisms or animals can only live in certain habitats. This is because the ecological conditions are suitable for organisms to survive. Rosanti (2015) said that distribution patterns are influenced by habitat types, including physical and chemical water parameters, as well as food availability and adaptability of an organism in an ecosystem. Meanwhile, the results of the distribution pattern analysis of bivalves are clustered, which is

thought to be caused by the state of the aquatic environment of Jago-Jago Village, which is suitable for the life of organisms, as well as water parameters that support the life of bivalves

4. CONCLUSION

The results of observations of bivalve species in the waters of Jago-Jago Village during the study obtained six families from 3 stations: Cardiidae, Arcidae, Mesodesmatidae, Ostreidae, and Corbiculidae. There are six types of species found. The mean abundance at all stations ranged from 4.33-6.11 ind/m^2. The distribution pattern of bivalves between observation stations ranged from 1.65-1.86, indicating that the distribution pattern is clustered.

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