Diversity of bivalves on the north coast of Lamongan, East Java, Indonesia

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Abstract. *Atlanta V, Ambarwati R, Rahayu DA, Mujiomo N. 2022. Diversity of bivalves on the north coast of Lamongan, East Java, Indonesia. Biodiversitas 23: 4263-4271.* Biodiversity in Indonesian waters is very abundant, one of which is bivalves. This study aimed to analyze the diversity, abundance, uniformity and dominance of bivalves, as well as to analyze the habitat profile of bivalves in the North Coast of Lamongan. Bivalves sampling was carried out at Kutang Beach and Joko Moersodo Beach. There were three research stations consisting of three sub-stations on each beach. At each sub-station, it was taken the plot of 5×5 m. Each plot contained five subplots of 1×1 m. The habitat profiles studied were temperature, pH, salinity, and turbidity and the type of substrate. Samples were identified based on morphological characters. The research data obtained were analyzed descriptive qualitatively. The results revealed that the bivalves found in the North Coast of Lamongan included *Anadara antiquata, Vasticardium elongatum, Donax faba, Asaphis* sp., *Gari elongata, Serratina perplexa, Gafrarium pectinatum, Heterocardia gibbosula, Marcia hiantina, Marcia japonica, Marcia opima, Meretrix* sp.*,* and *Venerupis aspera*. The index value of bivalves' diversity at the North Coast of Lamongan was 1.13-2.201. The habitat profile of the bivalves in the North Coast of Lamongan was as follows: temperature 29.3-31.7℃, salinity 25-32 ppt, pH 7.59-8.18, turbidity 10.6-17.3 NTU and the dominant type of substrate was sandy mud. Bivalves were more commonly found on beaches with dense mangroves.

Keywords: Bivalvia, *Gafrarium pectinatum*, Joko Moersodo Beach, Kutang Beach

INTRODUCTION

Indonesia has an abundant variety of fauna. One of them is the bivalves (Dharma 2005; Roshitafandi et al. 2018). The Bivalves have a fairly high economic value (Boominathan et al. 2008; Santhiya et al. 2013; Van Der Schatte Olivier et al. 2018), some of which can be used as a food source (Gopalakrishnan and Vijayavel 2009; Biandolino et al. 2019; Wijaya and Ambarwati 2021) because of their delicious taste and high protein content (La Valle et al. 2011; Admodisastro et al. 2021). In addition, coastal communities also use bivalves as ornaments (Santhiya et al. 2013; Sahidin et al. 2019; Venier et al. 2019). Its potential economic value can lead to overexploitation. As a result, some species of bivalves are becoming endangered, for example, *Hippopus* sp. and *Tridacna* sp. (Neo and Todd 2013; Triandiza et al. 2019). Several factors that affect the diversity and abundance of bivalves in their habitat are the availability of food sources, habitat conditions (physics-chemistry), competition, the presence of predators, and environmental changes due to human activities (Seitz et al. 2006; Haag and Warren Jr 2010; Kassim et al. 2018; Susetya et al. 2018; Baderan et al. 2019; Syukur et al. 2021a, 2021b).

Bivalves typically inhabit complex sedimentary substrates like mud, rocky, and sandy sediments. Due to their long habitation in the substrate or their connection to the water's bottom (benthic biota), bivalves are one of the macrozoobenthos that can be used as an indicator of water quality. The structure of the bivalves (benthic) community can be disturbed by physical, chemical and biological changes in the waters. One of the causes is the input of waste into water bodies, which can affect the presence of essential materials in the waters (Insafitri 2010). The types of waters where bivalves live are freshwater, estuary and marine waters (Nurdin et al. 2008). Bivalves live in several ways, including punching holes in the substrate and using cement or an intermediary such as thread to attach to the substrate (Ambarwati et al. 2016).

Several studies have shown that the coastal area of East Java has a diversity of bivalves. Research conducted by (Hidayah and Ambarwati 2020) showed that the bivalves found in the intertidal zone of the coast of Boom Beach, Tuban consisted of 13 species dominated by *Tellina timorensis*. Another study conducted by Rahayu et al. (2019) showed that the bivalves found in Kemantren Beach, Paciran, Lamongan consisted of six families, namely Cardidae, Veneridae, Arcidae, Cardiidae, Isognomonidae, dan Arcidae. Another study conducted by Zarkasyi et al. (2016) showed that the Coastal Coast of Ujung Pangkah, Gresik, was dominated by *Meretrix meretrix* yellow, *M. lamarckii*, and *Paphia undulata*.

One of the coastal areas located in the northern region of East Java is Lamongan. Based on previous research, it is known that there are several species of bivalves that are abundant on the coast of Lamongan, namely *Crassostrea*

iredalei, Anadara antiquata, Donax faba, Circe scripta, Gafrarium pectinatum (Asadi et al. 2018). In another study conducted by Rohmayani et al. (2021), the dominant bivalves in Paciran Lamongan Beach is *Gafrarium tumidum*, belonging to the family Veneridae.

Kutang Beach and Joko Moersodo Beach are beaches on the north coast of Lamongan, located in the Brondong region. The characteristics of Kutang Beach are sandy beaches with mangrove ecosystems along the coast (Fatimah et al. 2022; Fatimah et al. 2022). This beach is used for tourism and mangrove conservation which is useful for maintaining marine ecosystems and biota. Joko Moersodo Beach has three important ecosystems, namely mangrove, coral and estuary ecosystems (Sari 2021). This variety of substrate types allows various species of bivalves to live and thrive. Each bivalve taxon has a distinctive taxonomic character according to their respective habitats (Ambarwati and Trijoko 2010; Ambarwati et al. 2016). In addition, the research results of Rahmasari et al. (2015) also stressed that the diversity value of a species could be influenced by water conditions.

Given the importance of the role of bivalves in aquatic ecosystems and the lack of information about these data, it is necessary to conduct research on the diversity and habitat of bivalves in the North Coast of Lamongan to obtain information about diversity, abundance, and habitat profile. This study aims to analyze the diversity, abundance, evenness and dominance of bivalves, as well as the habitat profile of bivalves in the North Coast of Lamongan, namely Kutang Beach and Joko Moersodo Beach.

MATERIALS AND METHODS

Study area

The sampling was conducted at Kutang Beach and Joko Moersodo Beach, Lamongan District, East Java, Indonesia, during November-December 2021 (Figure 1). Measurement of physicochemical parameters was carried out at the research site, while the substrate test was carried out at ITS Laboratory of Soil Mechanics and Rocks. Bivalves identification was conducted by referring Poutiers (1998), Dharma (2005), Huber (2010) and the World Register of Marine Species (WoRMS) database website (2022).

Sampling was conducted in the intertidal zone during the lowest tide. There were three research stations for each beach. Each station had three sub-stations located at the upper, middle, and lower intertidal. Plots of 25 square meters were obtained at each sub-station. Each plot has five 1x1 m sub-plots. The determination of the station site was based on beach characteristics, as shown in Table 1.
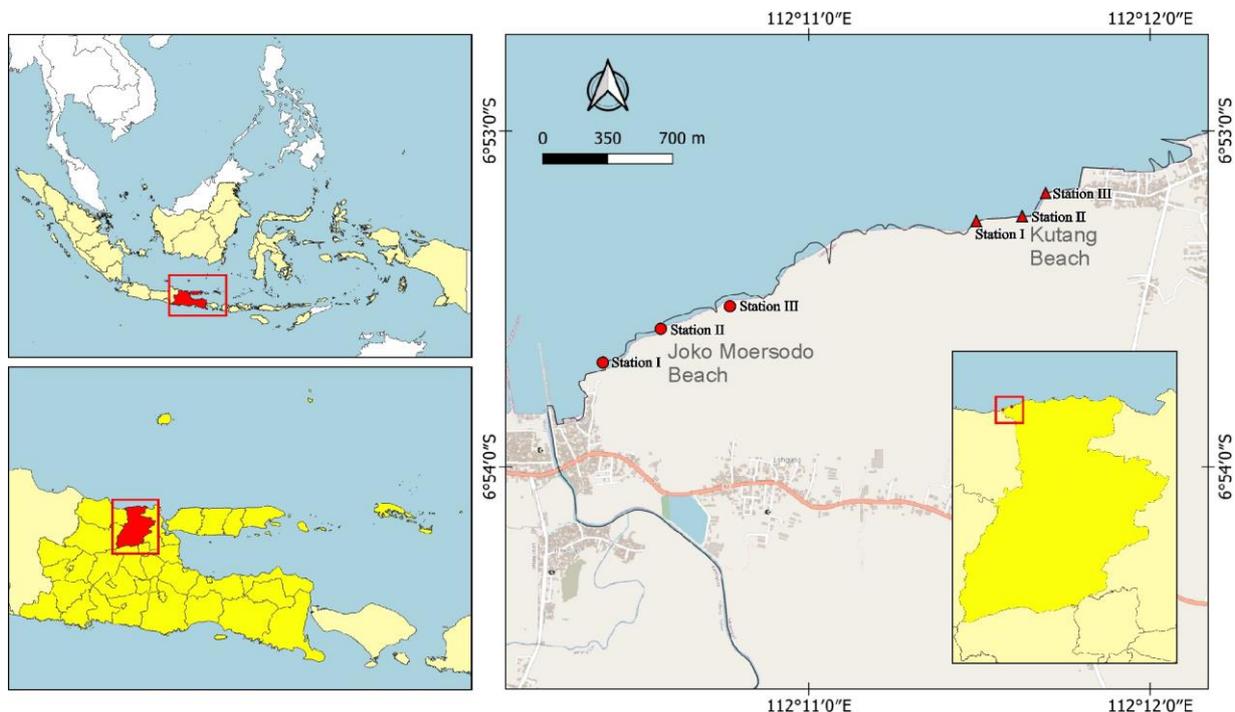
Figure 1. Research station locations at Kutang Beach and Joko Moersodo Beach, Lamongan District, East Java, Indonesia

Table 1. Research stations in Lamongan District, East Java, Indonesia

Stations	Kutang Beach	Joko Moersodo Beach
1	Dense mangrove area	Coastal area adjacent to the estuary
2	Thin mangrove area	A rocky beach area
3	Beach area without mangroves	A mangrove area

Procedures

A trowel was used to collect bivalves that were either on the substrate or on the surface. To collect bivalves that live in sand or mud substrates, excavations are carried out to a depth of 15 cm (Riniatsih and Kushartono 2009). All bivalves found were put into plastic bags for further sorting and identification. All samples of bivalves were put into bottles and preserved with 70% alcohol.

The habitat profile parameters that were measured in situ were the substrate type, temperature, pH, salinity, and turbidity. The temperature measurement was conducted using a thermometer. pH was measured using a pH meter. Measurement of salinity was carried out using a refractometer. Turbidity was measured using a turbidimeter. 250 grams of sediment were taken from each plot and then put into plastic bags that have been labeled for substrate type analysis.

Data analysis

Bivalves diversities were calculated using the Shannon-Wiener (H') formula below (Odum 1993):

$$H' = - \sum \frac{ni}{N} In \frac{ni}{N}$$

Where, H': Species diversity index; ni: Number of individuals of the i species; N: Total number of individuals.

The results of the diversity index are grouped into three categories, namely: H' < 1: Low species diversity; 1 < H' < 3: Medium species diversity; H' > 3: High species diversity.

The Evenness Index (E) is the community balance. The formula for the Evenness Index of bivalves according to Odum (1993):

$$e = \frac{H'}{lnS}$$

Where, H': Diversity index; S: Number of species; e: Evenness Index.

The Evenness Index according to Krebs (1985) ranges from 0-1. Note, $0 < E \leq 0.4$: low evenness, depressed community; $0.4 < E \leq 0.6$: moderate evenness, unstable community; $0.6 < E \leq 1.0$: high evenness, stable community.

Dominance index (C) is a parameter of a species group that dominates another group. Bivalve dominance index formula according to Odum (1993):

$$c = \sum_{i=l}^{n} pi^2 = \sum_{i=l}^{n} \left(\frac{ni}{N} \right)^2$$

Where, C: Dominance Index; ni: Number of individuals i; N: Total number of individuals.

The results of the dominance index in three categories (Odum 1993), namely: $0.00 < C \leq 0.50$: Low; $0.50 < C \leq 0.75$: Moderate; $0.75 < C \leq 1.00$: High.

Habitat profile data were analyzed descriptive qualitatively. Cluster analysis was performed on the bivalve's species composition data using the Jaccard similarity index in PAST 2.17 software (Hammer et al. 2001).

RESULTS AND DISCUSSION

Bivalvia community index

Based on the results of research conducted in the North Coast of Lamongan, it was collected 474 individuals of bivalves on Kutang Beach and 666 individuals on Joko Moersodo Beach. The species richness of bivalves found on the North Coast of Lamongan includes *Anadara antiquata, Vasticardium elongatum, Donax faba, Asaphis* sp.*, Gari elongata, Serratina perplexa, Gafrarium pectinatum, Heterocardia gibbosula, Marcia hiantina, Marcia japonica, Marcia opima, Meretrix* sp., dan *Venerupis aspera* (Figure 2). The thirteen species belong to 11 genera and 6 families (Table 2).

Each station in the North Coast of Lamongan has different environmental conditions. Kutang Beach is a tourist beach that has sandy mangrove characteristics and Joko Moersodo Beach has rocky characteristics along the coast. The highest diversity index at Kutang Beach was at station three, namely 1.96 and the lowest diversity index was at station two, namely 1.13. The highest diversity index at Joko Moersodo Beach was at station two, namely 1.95 and the lowest diversity index was at station three, namely 1.50 (Table 2).

The dominance index detects the presence or absence of species. The highest dominance index of Kutang Beach is at station two, which is 0.43 and the lowest is at station three, which is 0.17; while the highest dominance of Joko Moersodo Beach is at station three, which is 0.33 and the lowest is at station two, which is 0.20 (Table 2).

Each station in the North Coast of Lamongan has a different evenness. The highest evenness of Kutang Beach is at station three, which is 0.65 and the lowest is at station two, which is 0.44; while the highest evenness of Joko Moersodo Beach is at station two, which is 0.64 and the lowest is at station one, which is 0.65 (Table 2).

Dendrogram of cluster

Ecosystems found in the research location can be grouped based on their similarities. Group 1 consisted of all species (13) found at the study site, with 4 species (*Asaphis* sp.*, Gari elongata, Heterocardia gibbosula, and Venerupis aspera*) only found in group 1. Group 2 consisted of 9 species, without the presence of 4 species, namely *Asaphis* sp.*, Gari elongata, Heterocardia gibbosula, and Venerupis aspera* (Figure 3).

Habitat profile

The results of the analysis of the habitat profile in the Lamongan Coast were carried out in each sampling plot at each station based on the type of substrate, temperature, pH, salinity, and turbidity. The North Coast of Lamongan has a substrate type that is dominated by sandy mud (Table 3). Kutang Beach station 1 was a dense mangrove area, Station 2 was a thin mangrove area and Station 3 was a beach area without mangroves. At Joko Moersodo Beach,

station 1 was a coastal area adjacent to the estuary, Station 2 was a rocky beach area and Station 3 was a mangrove area (Figure 4). The temperature of each station has a different value. At Kutang Beach at Station 1, it had a value of 29.33ºC; Station 2 of 31.7ºC; Station 3 of 31.3ºC and at Joko Moersodo Beach at Station 1 it had an average value of 31.7ºC; Station 2of 30.3ºC; Station 3 of 31.3ºC. Salinity at each station has a ranging from 25-32 ppt. The pH of each station has almost the same value. At Kutang Beach at Station 1 it has a value of 8.17; Station 2 of 8.09; at Station 3 of 8.16 and at Joko Moersodo Beach at Station 1 it has a value of 8.18; Station 2 of 7.59; Station 3 of 8.11. The turbidity of each station has a different value. At Kutang Beach at Station 1 it has a value of 11.7; Station 2 of 14.4; at Station 3 of 10.6 and at Joko Mursodo Beach at Station 1 it has a value of 17.3; Station 2 of 13.2; Station 3 of 17.2. The Bivalve habitat profile for each sub-station in the North Coast of Lamongan is presented in (Table 4).
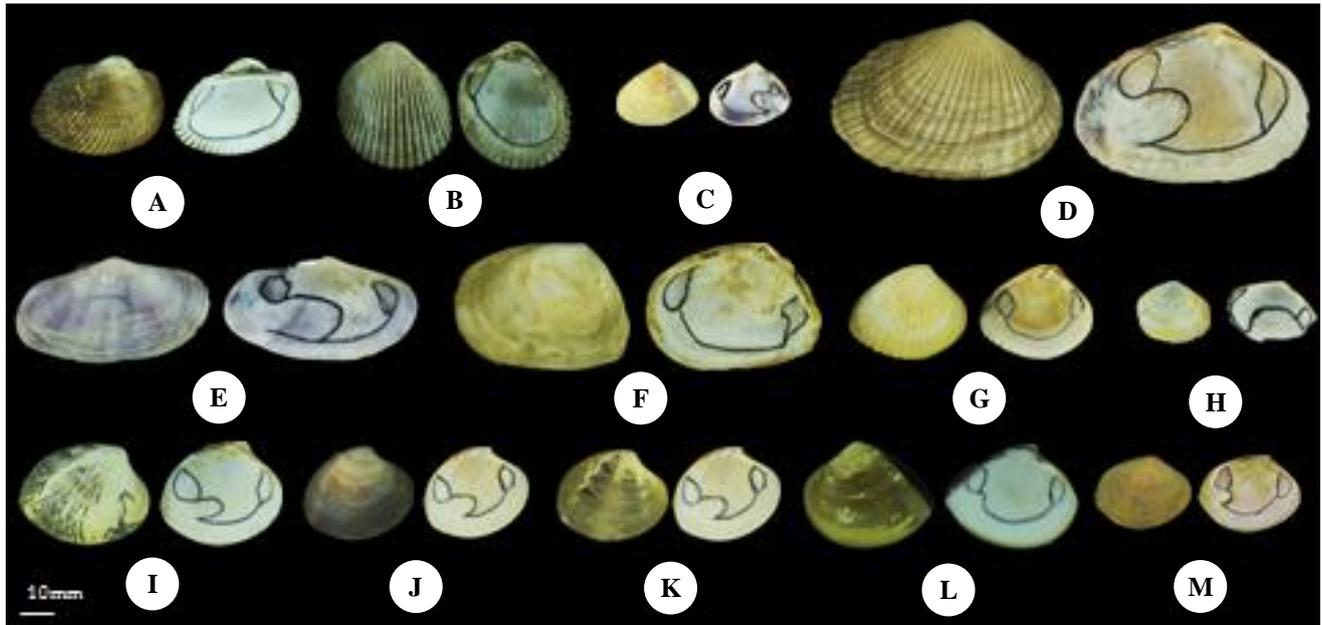

Figure 2. Species of bivalves found at Kutang and Joko Moersodo Beaches, Lamongan District, East Java, Indonesia. A. *Anadara antiquata;* B. *Vasticardium elongatum;* C. *Donax faba;* D. *Asaphis* sp.*;* E. *Gari elongata;* F. *Serratina perplexa;* G. *Gafrarium pectinatum;* H. *Heterocardia gibbosula;* I. *Marcia hiantina;* J. *Marcia japonica;* K. *Marcia opima;* L. *Meretrix* sp.*;* M. *Venerupis aspera.* Scale bar: 10 mm

Table 2. Bivalvia Community Index

Family	Species	Number of individuals	Kutang Beach			Joko Moersodo Beach		
			S1	S2	S3	S1	S2	S3
Arcidae	*Anadara antiquata*	64	17	0	17	0	16	14
Cardiidae	*Vasticardium elongatum*	93	17	9	0	17	45	5
Donacidae	*Donax faba*	26	1	0	2	5	8	10
Psammobiidae	*Asaphis* sp.	45	2	0	0	13	30	0
	Gari elongata	26	2	0	7	8	9	0
Tellinidae	*Serratina perplexa*	45	3	1	19	11	0	11
	Gafrarium pectinatum	507	81	77	40	135	89	85
	Heterocardia gibbosula	7	0	0	2	5	0	0
	Marcia hiantina	123	32	32	24	22	10	3
Veneridae	*Marcia japonica*	98	9	2	39	19	2	27
	Marcia opima	37	14	2	4	0	12	5
	Meretrix meretrix	54	4	5	5	26	14	0
	Venerupis aspera	14	3	0	2	0	9	0
	Species		12	7	11	10	11	8
	Individual		185	128	161	261	244	160
	Diversity		1.79^m	1.13^m	1.96^m	1.69^m	1.95^m	1.50^m
	Dominance		0.25^l	0.43^l	0.17^l	0.30^l	0.20^l	0.33^l
	Evenness		0.50^m	0.44^m	0.65^h	0.54^m	0.64^h	0.56^m

Note: l: low; m: moderate; h: high
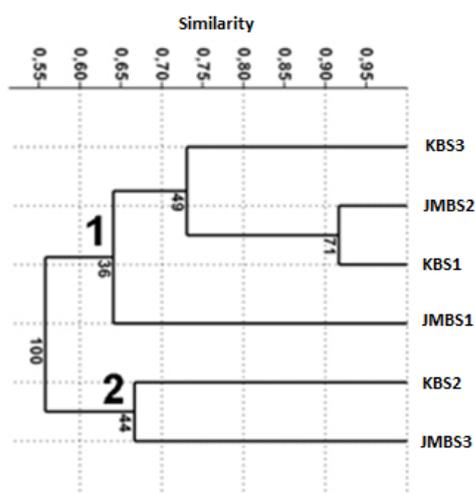
Figure 3. Dendrogram of cluster analysis results; KBS3: Kutang Beach Station 3; JMBS2: Joko Moersodo Beach Station 2; KBS1: Kutang Beach Station 1; JMBS1: Joko Moersodo Beach Station 1, KBS2: Kutang Beach Station 2; JMBS3: Joko Moersodo Beach Station 3

Discussion

Each species of Bivalvia in the North Coast of Lamongan has a different distribution; this is due to the varied substrates. *Gafrarium pectinatum* had the largest number of individuals. This species was found at every station, suggesting that a large number of *G. pectinatum* species is a result of this species' widespread distribution. The substrate where *G. pectinatum* was found was predominantly sandy mud. This type of substrate contains high organic matter, so it is suitable for the habitat of Bivalves of the Veneridae family. Sitompul (2020) also proves that in the intertidal and sublittoral areas reaching a depth of 30 meters, several species to the Veneridae family are still alive. While the least number of individuals was *Heterocardia gibbosula*, which was 7 and only found in 2 stations. According to Ambarwati and Trijoko (2015), *H. gibbosula* is usually found in the subtidal area with a muddy substrate. Riniatsih and Kushartono (2009) stated that the sandy mud substrate has a fairly high organic matter content, hence there is abundant food for bivalves.

Overall, the species with the widest distribution and found at all stations were *G. pectinatum, Marcia hiantina* and *M. japonica*; belongs to family Veneridae. Rakmawati and Ambarwati (2019) stated that members of the Veneridae have a wide diversity compared to other family members. Asadi et al. (2018) reported that the family Veneridae is a group of bivalve infauna that live in sandy substrates. According to Ambarwati and Trijoko (2010) the Veneridae family has a substrate preference that has a high sand content. Members of the family Veneridae have many variations in shape and size. Besides that, members of the Veneridae can also pump water because Veneridae can feed on suspension (suspension feeders).

The diversity index (H), the species dominance index (C), and the evenness index (e) are parameters that describe the community structure and the balance of the number of each species in a community. This study obtained a diversity index of 1.13-1.95, including the medium category. The results of this diversity index are different from the research conducted by Yuliana et al. (2020) that the index of bivalve diversity in Prawean Beach Bandengan Jepara is 0.76 - 1.01, which belongs to the low category. In this study, 15 species were found, belonging to 14 genera and 8 families. This is different from the research conducted by Hidayah and Ambarwati (2020) that the bivalve community found in the intertidal zone of the coastal area of Boom, Tuban, consisted of 13 species from 10 genera, 8 families and six orders, with the most dominating species, *Tellina timorensis*. A community has high diversity if all the species found have almost the same abundance.

Table 3. Substrate conditions at the research site in Lamongan District, East Java, Indonesia

Substrate location		Gravel (%)	Sand (%)	Fine details		Substrate type
				Silt (%)	Clay (%)	
Kutang	Station 1	14.13 ± 0.07	32.26 ± 0.39	31.21 ± 0.24	22.4 ± 0.3	Mud
Beach	Station 2	13.51 ± 0.09	39.22 ± 0.31	31.24 ± 0.35	16.03 ± 0.07	Sandy mud
	Station 3	11.92 ± 0.09	27.01 ± 0.09	41.54 ± 0.5	19.53 ± 0.35	Sandy mud
Joko	Station 1	13.15 ± 0.03	28.12 ± 0.23	30.95 ± 0.13	27.77 ± 0.36	Sandy mud
Moersodo	Station 2	13.18 ± 0.04	31.03 ± 0.25	39.28 ± 0.53	16.51 ± 0.12	Sandy mud
Beach	Station 3	15.35 ± 0.08	31.8 ± 0.2	37 ± 0.3	15.85 ± 0.29	Mud

Table 4. Environmental parameters at the research site in Lamongan District, East Java, Indonesia

Substrate location		Temperature (ºC)	Salinity (ppt)	pH	Turbidity (NTU)
Kutang	Station 1	29.3 ± 1.15	31.3 ± 0.7	8.17 ± 0.11	11.7 ± 7.36
Beach	Station 2	31.7 ± 0.57	25,3 ± 0.3	8.09 ± 0.16	14.4 ± 1.66
	Station 3	31.3 ± 0.57	37.3 ± 0.11	8.16 ± 0.2	10.6 ± 6.07
Joko	Station 1	31.7 ± 0.57	32 ± 0	8.17 ± 0.54	17.3 ± 4.11
Moersodo	Station 2	30.3 ± 1.15	33.3 ± 0.5	7.59 ± 0.51	13.2 ± 6.05
Beach	Station 3	31.3 ± 0.57	31.3 ± 0.3	8.11 ± 0.03	17.2 ± 9.09

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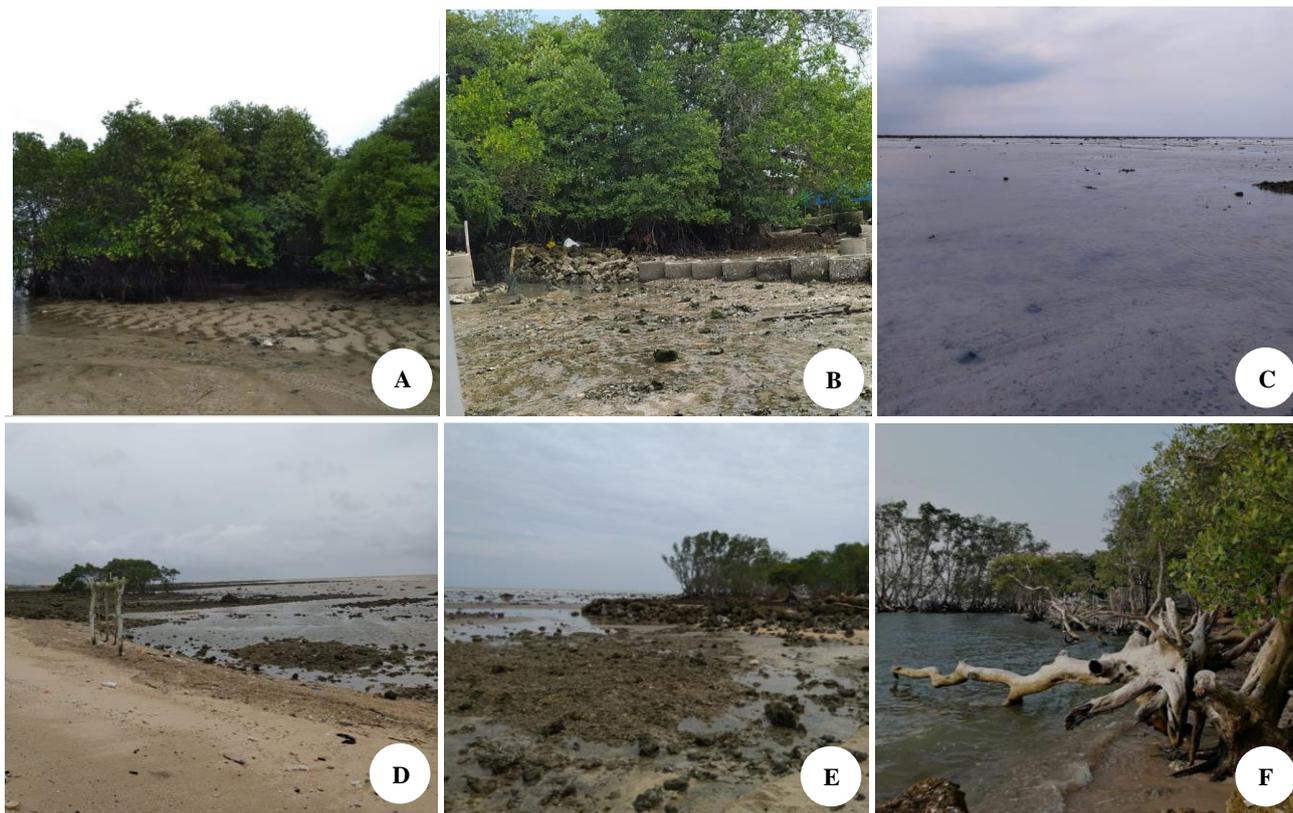
Figure 4. Habitat profile in Lamongan District, East Java, Indonesia. A. Kutang Beach Station 1; B. Kutang Beach Station 2; C. Kutang Beach Station 3; D. Joko Moersodo Beach Station 1; E. Joko Moersodo Beach Station 2; F. Joko Moersodo Beach Station 3

The calculation of the community index shows variation. However, tends to be in the moderate category. The diversity index ranged from 1.13 to 1.95. All stations on Kutang Beach and Joko Moersodo are classified as moderate. The diversity index can be used as a parameter of community stability. The results obtained are in the moderate category so that it shows the condition of the community, which is unstable and easily affected by changes in environmental conditions.

The highest diversity index value at Kutang Beach is at Station three, namely 1.96; habitat conditions at station three are tourist beaches and there are many human activities such as tourism and fishing. The lowest diversity index at Kutang Beach is at station 2, namely 1.13; the substrate of station 2 is dominated by coral and there were no human activities. It revealed that the bivalve diversity is more affected by the substrate profile rather than human activities, such as tourism activities. The highest diversity index at Joko Moersodo Beach is at station 2, namely 1.95; habitat conditions at station one are thick mangrove vegetation and there were few human activities. The lowest diversity index is at station 3, namely 1.50; habitat conditions at station 3 are overgrown with mangrove vegetation.

The diversity index at station one of Kutang Beach is 1.79, and the area is covered in sparse mangrove vegetation and few human activities. The diversity index at Joko Moersodo Beach at station one is 1.69; conditions at station one are close to the river mouth and there are community activities in the form of a pier where fishing boats dock. The difference in the value of diversity at each station is due to the different characteristics of each station. The difference in diversity at each station is due to the different characteristics at each station.

The dominance index detects the presence or absence of a species. According to Soegianto (1994) if a community is composed of many species, it can be said that its species diversity is high. Otherwise a community is said to be low if it is composed of very few species and only a few dominant species. The dominance index ranged from 0.17 to 0.43; is low. Odum (1993) states that if the species dominance index is close to 0 it means that the level of dominance is low. Hence, in general, it is said that in the community, no species dominates and the community is in a state of stress. The data obtained showed that *G. pectinatum* had more individuals than other species. This indicates that this species is the dominant species. The substrate where *G. pectinatum* was found was predominantly sandy mud. This is different from the research conducted by Sa'adah and Ambarwati (2021) that *G. pectinatum* found on the South Coast of Sreseh District, Madura has a sandy substrate with a muddy, sandy substrate.

The high and low diversity index is determined by differences in characteristics of habitat, the number of species found and the generality of the population in the community (Nurdin et al. 2008). The evenness index ranged from 0.44-0.56. Station 3 on Kutang Beach and station 2 on Joko Moersodo Beach are relatively high.

Stations 1 and 2 on Kutang Beach and stations 1 and 3 are moderate. The evenness index can describe the stability of a community, which is stable if it has an evenness of species close to 1, and vice versa. The smaller the evenness index indicates that the distribution of species is not evenly distributed, while the greater the evenness index reveals the distribution of species is relatively even. The number of individuals of *G. pectinatum* tended to be more than other types at the six stations. This situation is thought to affect the evenness of individuals on the two beaches. High evenness indicates that the community is in a stable condition, medium evenness indicates that the community is in an unstable state and ecological stress occurs (Magurran 2004).

Kutang Beach station 1 has the highest number of species, but the highest diversity is found at Kutang Beach station 3. The high and low diversity index does not only depend on the number of species found but because of the effect of the even distribution of the number of individuals for each species of macrobenthos (Nurdin et al. 2008). If more species are found and the population is evenly distributed, the species diversity index obtained will be higher than the population with an uneven distribution.

Station 1 of Kutang Beach (dense mangroves) had 13 species; Station 2 (thin mangroves) had 12 species without *Heterocardia gibbosula*. According to Ambarwati and Trijoko (2015) *H. gibbosula* is commonly found in intertidal areas that have sandy mud substrates. Riniatsih and Kushartono (2009) stated that the sandy mud substrate has a fairly high organic matter content, so there is abundant food and a place to attach to Bivalves. At station 3 (without mangroves), 12 species were found without the presence of *Asaphis* sp. Aji and Widyastuuti (2017) reported that *Asaphis* was found mostly in sandy mud and mud. The texture of the sandy mud bottom substrate has a high organic matter content when compared to other substrate textures because the finer the texture of the substrate, the greater the ability to trap organic matter. The high content of the suspension also supports the food needs of bivalves because the suspension contains many minerals and organic elements, which are the food of Bivalves species by filtering food ingredients from the waters (Nybakken and Bertness 2003; Riniatsih and Kushartono 2009).

The habitat profile studied included: substrate type, temperature, pH, salinity, and turbidity. According to Riniatsih and Kushartono (2009), the most important factor influencing the distribution of species is the bottom substrate of the water. This is because the role of the basic substrate is as a place to live and nutrient hoarder, gathering place for organic matter and protecting organisms from predators. Muddy substrates tend to have smaller grains than sandy ones, so they are able to deposit more organic matter. The type of substrate in the North Coast of Lamongan is dominated by sandy mud, which is a substrate condition that supports the survival of bivalves. The results showed that there were different substrates at each station. Station one on Kutang Beach and station three on Joko Moersodo Beach have a mud substrate type. Stations two, three on Kutang Beach and stations one, two on Joko Moersodo Beach have a sandy mud substrate type (Table 3).

The temperature in the North Coast of Lamongan ranges from 29.3-31.7°C, according to the Ministry of Environment (2004), which states that the optimal temperature for the survival of bivalves is 28-32°C. According to Islami (2012) an increase in air temperature from higher to lower temperatures can lead to better growth yields. Salinity at each Lamongan North Coast station ranges from 25.3-37.3 ppt (Table 4). This value is still within the normal range for bivalves.

The degree of acidity (pH) at each station was different, at Kutang Beach at Station 1, it has a value of 8.17; Station two of 8.09; Station three was 8.16 and at Joko Moersodo Beach at Station 1, it was 8.17; Station two of 7.59; Station three was 8.11 (Table 4). The normal degree of acidity (pH) that supports the life of bivalves is between 6.5-7.5 (Hardianti et al. 2014). Each research station has a different pH. Tourism activities, community activities in looking for shellfish, and the presence or absence of settlements can affect pH. This is because there are settlements around the coast that produce waste. The presence of waste can affect the pH. Organic waste originating from organisms can lower the pH (Hidayah and Ambarwati 2020).

The results of this study indicated that the index of bivalves' diversity in the North Coast of Lamongan was in the medium category. Different species of bivalves in the area had different abundances. The follow-up of this research can be used as a basis for information regarding the diversity, abundance, dominance, evenness, and habitat conditions of bivalves in the North Coast of Lamongan as well as a source of information for further researchers who will conduct further research.

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