



DISTRIBUTION OF BENTHIC FORAMINIFERA IN SURFACE SEDIMENTS OF EAST COAST OF PANGANDARAN AND KARAPYAK BEACH OF WEST JAVA

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KeyWords

Benthic Foraminifera, Environmental Conditions, Distribution, East Coast of Pangandaran Beach, Karapyak Beach, Rotaliina, Sediment

ABSTRACT

The purpose of this research is to figure out the community structures, distributions and environmental conditions based on the presence of benthic foraminifera in the coastal zones of East Coast of Pangandaran and Karapyak beach, West Java. This study was carried out on 19 April 2018 till 21 August 2018. Six samples from this research were used to analyze the community structures and benthic foraminifera distributions, along with their connection with environmental conditions. The analysis results showed that the largest number of sub-order discovered throughout the whole research stations is Rotaliina sub-order with its typical genus, Ammonia. It has an abundance of 48% in the East Coast of Pangandaran beach and 36% in Karapyak beach. The calculation result of the community structures has an average diversity value of 1.68 and the uniformity value has an average of 0.74, indicating that the environments are in stressed conditions, both naturally and anthropogenically which are characterized by the abundance of opportunistic genera of Ammonia, Pararotalia and Pseudorotalia from Rotaliina sub-order.

INTRODUCTION

The East Coast of Pangandaran Beach and Karapyak Beach are coastal tourism destinations which are located in Pangandaran Regency. According to Pangandaran Regency Disparbud (2017), activities that are generally carried out in the Eastern Coast of Pangandaran are Culinary Tourism & shopping, water-sports, and nature reserve tours. Meanwhile, Karapyak Beach is a tourism area that is less attractive to tourists due to the lack of supporting facilities development (Vestikowati 2018). The presence of human activities and river flows are assumed to have effects on the surrounding environment which then impact the lives of benthic organisms. One of the benthos organisms that is affected by environmental changes is foraminifera.

Foraminifera is a member of the single-celled Protozoa phylum which is known to fill up 2.5% of all animals found living in the Cambrian era till Resen (Boltovskoy and Wright 1976). Based on its habitat, foraminifera is divided into two, namely benthic foraminifera and planktonic foraminifera. Benthic foraminifera live in seabed sediments whose existence can indicate the environment where they live in. Groups of foraminifera from a region reflect the relationship between species that are affected by ecological factors and their adaptation abilities towards their environment (Suhartati 1988 in Natsir 2010). One of the prominent characteristics of benthic foraminifera is its simple and hard shell body structure, relatively short life cycle, wide distribution in the waters and its high ability to respond to its environment (Nurruhwati et al. 2012). The purpose of this study is to determine the community structure and distribution of benthic foraminifera found in surface sediments, as well as to determine the environmental conditions of East Coast of Pangandaran Beach and Karapyak Beach.

METHOD

The method used in this study is survey method. This research was conducted in several phases which include : preparation, sampling, data processing, and data analysis. The location for data retrieval is divided into 6 stations : 3 stations are located in the Eastern Coast of Pangandaran and the other 3 are in tourist areas of Karapyak Beach (Figure 1). The study was conducted on April 19, 2018 until August 30, 2018.

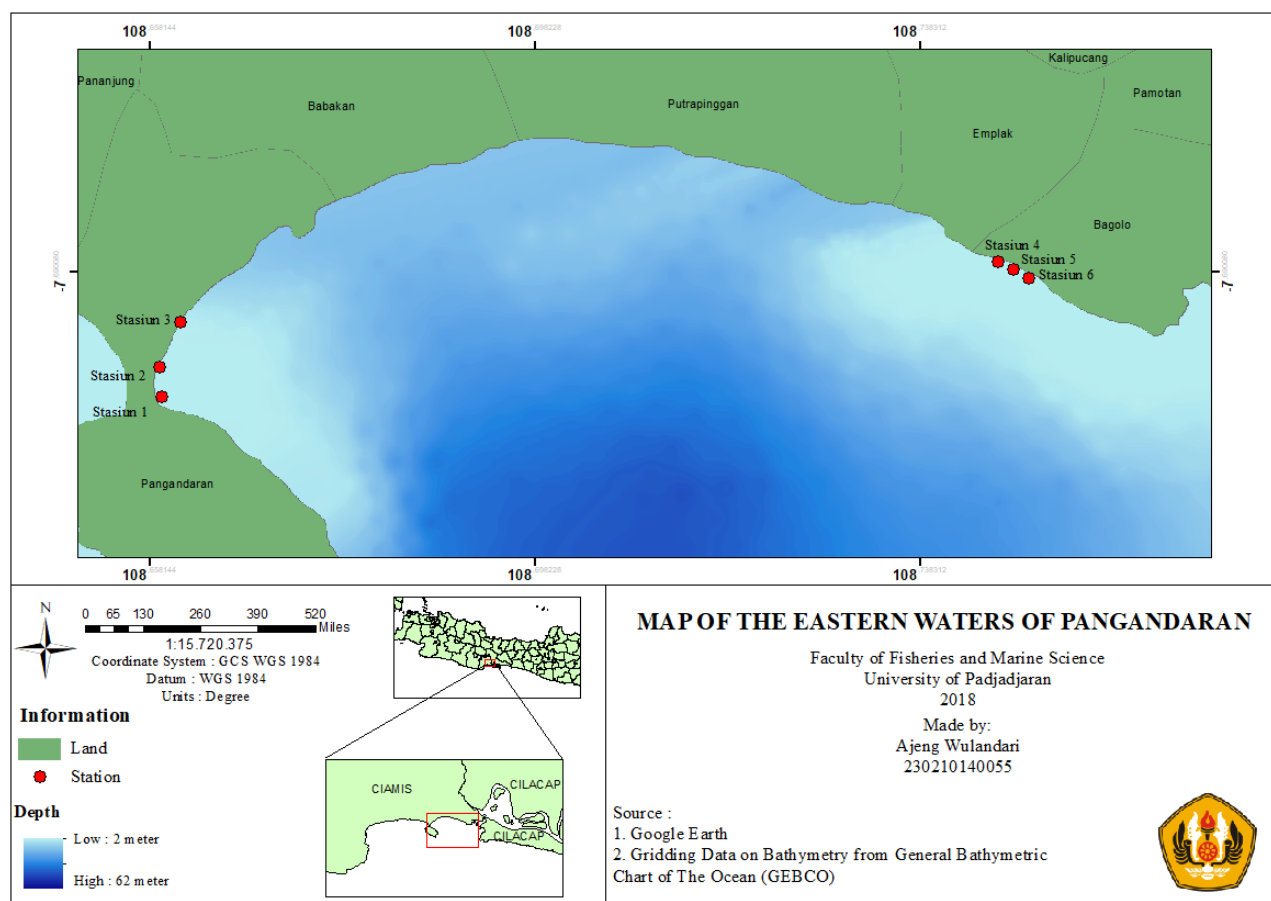


Figure 1. Research Sampling Locations

Data processing is carried out in several stages i.e. granulometric test, sample preparation which consists of washing, soaking, drying samples and picking, sample determination which involves identification and sample documentation, as well as index calculation. Granulometric tests were done to determine sediment types based on Folk scale (1980).

Sample preparation is accomplished by using the residual method based on Pringgoprawiro and Kapid (2000). The next step is picking and determining. In picking, benthic foraminifera were separated according to the shape of the shell and were placed on foram slides. It was then followed up by the determining phase which are divided into 2 parts: identification and documentation. Identification was executed on specimens on the foram slide based on their morphology (shell shape, chamber shape and its arrangement, chamber quantity, ornamentation, aperture shape, aperture position, and additional aperture). Foraminifera was then identified till the genus level by referring to Barker (1960), and Loeblich and Tappan (1994). Documentation of the identification results was done digitally, i.e. by selecting one foraminifera organism from each group that has been found, then photographed under a binocular stereoscope microscope with 40x magnification. The next phase is quantitative analysis to obtain abundance value, diversity index, and uniformity index.

Data analysis in this study was done by descriptive-comparative analysis method, by collecting genera data from benthic foraminifera, then describing the distribution of benthic foraminifera in each station, and comparing data of benthic foraminifera distribution in East Coast of Pangandaran and Karapyak beach. The analysis results of benthic foraminifera distribution were then used to describe the overall environmental conditions of East Coast of Pangandaran and Karapyak beach. Water quality and community structure data in this study are used as supporting data to help carry out the analysis.

RESULT AND DISCUSSION

The results showed that benthic foraminifera at the research site was abundant, with 30 genera found and a total of 751 individuals (Table 1). The genus found are mostly from Rotaliina sub-order (23 genera), but there are also genera from Miliolina sub-order (3 genera) and Textulariina (1 genus). The abundance of foraminifera between East Coast of Pangandaran and Karapyak beach are significantly different; this is due to the differences in their conditions in which East Coast of Pangandaran has a sandy bottom and is not affected by river flow, whereas Karapyak beach has a base dominated by large rocks while being affected by the presence of Citanduy river. The abundance of individual benthic foraminifera at each station varies due to differences in composition, sediment types and environmental conditions. The variation of environment conditions between these two regions are shown by the measurement results of water physical-chemical parameters.

The highest number of individuals was found at station 3 (399 individuals) and the lowest number at station 6 (19 individuals). Station 6 is located close to the estuary of Citanduy river in Karapyak coastal area.

Table 1. The amount of Benthic Foraminifera on the East Coast of Pangandaran and Karapyak Beach

No	Subordo	Genera	East Coast of Pangandaran			Karapyak Beach			Amount
			ST01	ST02	ST03	ST04	ST05	ST06	
1	Rotaliina	Ammonia	5	66	260	26	13	7	377
2		Amphistegina	0	0	7	5	2	1	15
3		Anomalinella	1	0	5	3	0	2	11
4		Anomalinoidea	0	1	0	2	0	0	3
5		Bolivina	0	1	0	0	0	0	1
6		Calcarina	0	0	0	0	0	0	0
7		Elphidium	0	7	6	1	1	1	16
8		Epinodes	1	0	0	0	0	0	1
9		Hanzawaia	6	0	0	0	0	0	6
10		Heterolepa	6	0	0	0	0	0	6
11		Hyalinea	2	0	0	0	0	0	2
12		Lenticulina	5	0	0	0	0	0	5
13		Melonis	2	0	0	0	0	0	2
14		Nonion	1	1	0	0	0	1	3
15		Pararotalia	10	42	29	15	16	3	115
16		Planulina	0	3	1	7	4	1	16
17		Pseudorotalia	9	91	2	0	0	0	102
18		Stomatorbina	3	0	0	0	0	0	3
19		Trochulina	9	0	0	0	0	0	9

Continuation of Table 1. The amount of Benthic Foraminifera in East Coast of Pangandaran and Karapyak Beach

No	Subordo	Genera	East Coast of Pangandaran			Karapyak Beach			Amount
			ST01	ST02	ST03	ST04	ST05	ST06	
20	Rotaliina	Valvulineria	7	0	0	0	0	0	7
21		Quadriformina	0	0	1	0	0	0	1
22		Rectobolivina	0	0	0	1	0	0	1
23	Miliolina	Dendritina	1	0	0	0	0	0	1
24		Massilina	0	4	1	0	0	0	5
25		Quinqueloculina	0	7	85	7	6	3	108
26	Textulariina	Textularia	0	0	2	0	0	0	2
Total			68	223	399	68	42	19	751

East Coast of Pangandaran

The results of the study on the Eastern Coast of Pangandaran show that the distribution of benthic foraminifera in this region falls under the category abundant because it has more than 50 individuals in each station. The benthic foraminifera distribution in East coast of Pangandaran beach throughout all stations is dominated by the sub-order Rotaliina (Figure 2).

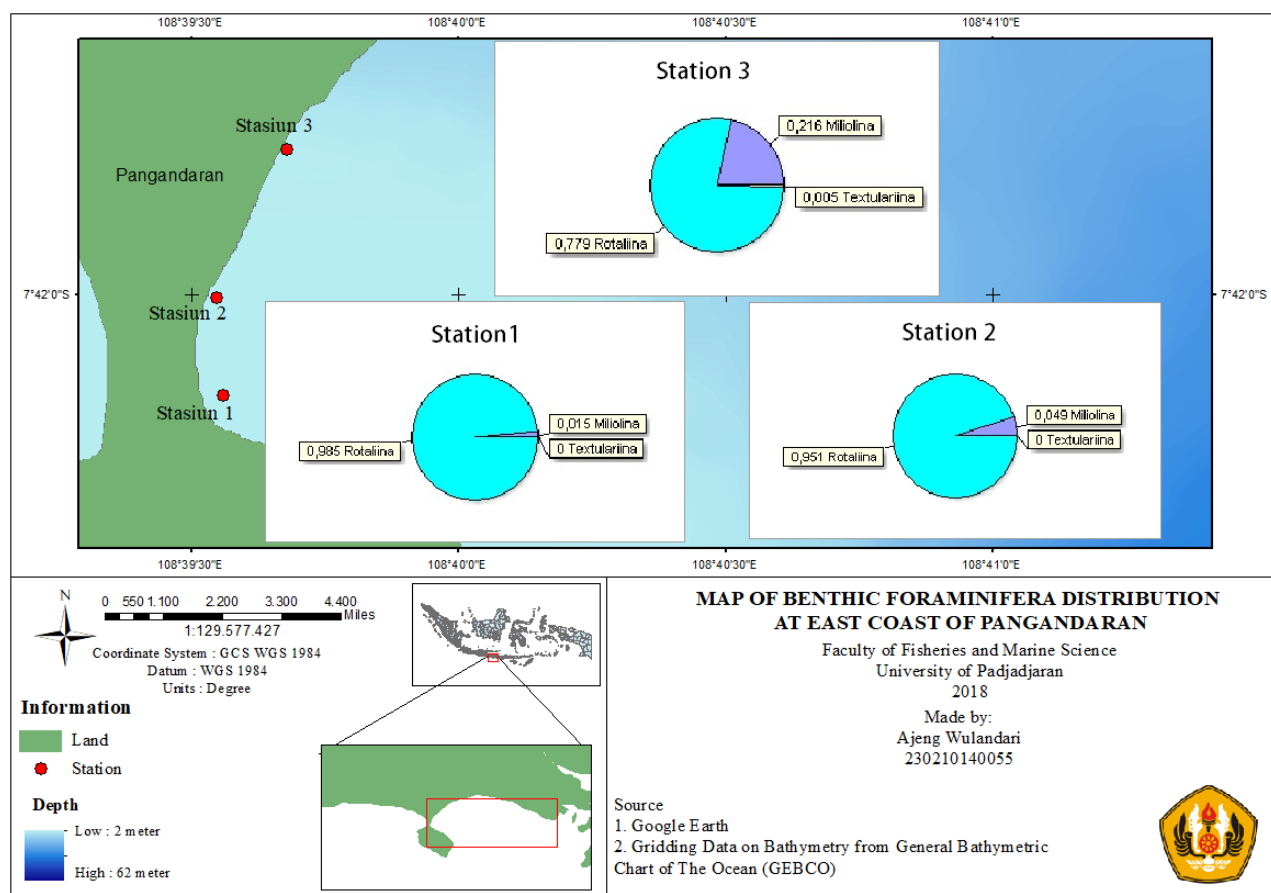


Figure 2. The Map of Benthic Foraminifera Distribution on the East Coast of Pangandaran Beach

Sediments in the region of East Coast of Pangandaran are dominated by sand substrates with a rather smooth grain size and the sand fraction composition exceeds 50% at each station (Table 2). One of the effects caused by sediment types is towards the morphology of the foraminifera, especially in agglutinin shells which compose shells based on the materials around them, as well as a support in nutrient sources for the growth of benthic foraminifera (Boltovskoy and Wright 1976). Generally, benthic foraminifera can

be found abundantly on sandy or sandy-mud substrates (Natsir 2010). This is compatible with the abundance calculation results of this region where the abundance of each station is in the high category.

Table 2. Sediment Fraction Percentage on the East Coast of Pangandaran

Station	Phi	Grave (%)	Sand (%)	Sediment type
1	1,3	11,9	88,1	Gravelly sand (gS)
2	2,5	0,1	99,9	Slightly gravelly sand ((g)S))
3	2,4	0	100	Sand (S)

The Diversity Index and Uniformity Index in Eastern Pangandaran beach show that the region is in the moderate category, meaning that the ecosystem is still stable enough to support the lives of benthic foraminifera (Figure 3). However, station 3 has the smallest diversity and uniformity index value due to the domination of Ammonia genus which has a total number of 260 out of 399 individuals. Station 1 has the highest Diversity and Uniformity Index value as its location is included in the natural reserve management area.

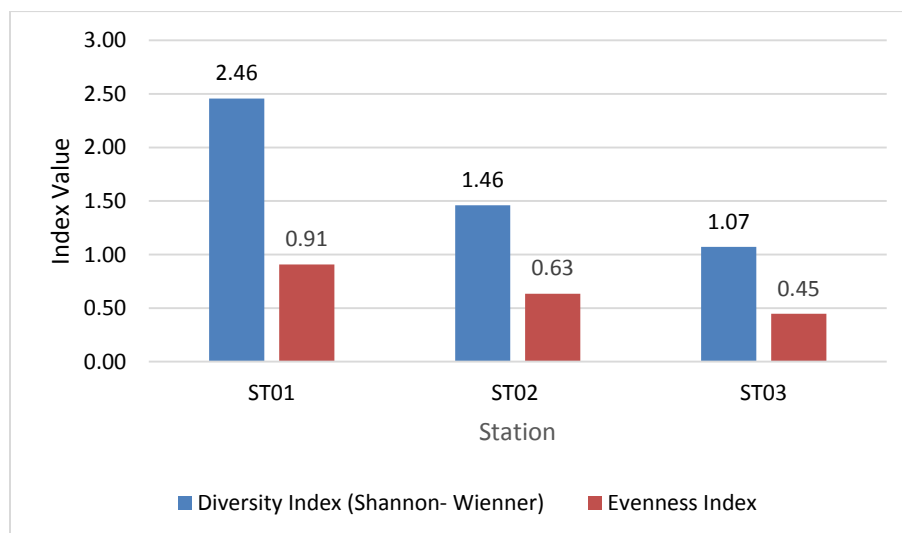


Figure 3. The Diversity Index and Uniformity Index graph of benthic foraminifera on the East Coast of Pangandaran

Based on 3 observation stations in Eastern Pangandaran Beach with depths ranging from 130-150 cm, it was discovered that the largest number of benthic foraminifera was found at station 3 (399 individuals) with sediment type in the form of sand. The most abundant genus in this station is Ammonia (260 individuals) and Quinqueloculina (85 individuals), whereas the lowest number of foraminifera is at station 1 (68 individuals) (Table 1). According to Gustiantini and Ilahude (2012), it is stated that the genus Ammonia belongs to the opportunistic foraminifera group which can be found in almost every environmental conditions whereas the reason why Quinqueloculina genus is found abundantly in this station, is due to its genus which is typical to shallow and open-water environments with moderate to high current velocity, as well as mud or sand sediments (Natsir and Rubiman 2010).

Table 3. Physical-chemical parameters value of Eastern Pangandaran beach

Physical-chemical parameters	Station		
	ST01	ST02	ST03
Temperature ($^{\circ}$ C)	29	30	30
Sakinity ($^{\circ}$ / $_{\infty}$)	30	31	32
pH	8,62	8,19	8,7
Dissolved Oxygen (mg/L)	6,17	6,03	5,93
Brightness (cm)	134	112	84
Depth (cm)	150	130	145

In addition, at station 3, Textularia genus from the Textulariina sub-order was discovered but with a small quantity, or considered as low abundance (2 individuals). Its low abundance is caused by the incompatibility of the sampling environment as it prefers environments with deep depth and high salinity (Moghaddasi et al. 2009).

Other types of benthic foraminifera from other genera with very low abundance (<5 individuals) were discovered at station 3 which consists of the genera : Planulina (1 individual), Pseudorotalia (2 individuals), Quadrimorphine (1 individual), Massilina (1

individual) and *Textularia* (2 individuals). The abundance of the genus *Ammonia* which belongs to the opportunistic foraminifera group, is generally found in environments with polluted conditions and low level of visibility (Sidiq et al. 2016). This is reinforced by the measurement results of water physical-chemical parameters in station 3, especially at the highest pH among the other 2 stations in Eastern Pangandaran Beach with a value of 8.7 and the lowest amount of dissolved oxygen with a value of 5.93mg / L (Table 3). Both of these values indicate a decreasing water quality as one moves further to the east.

Karapyak Beach

The results of the research at Karapyak Beach show that the distribution of benthic foraminifera at each station is in low to moderate category because it has a number of 11-50 individuals at each station. The benthic foraminifera distribution in Karapyak Beach is dominated by *Rotalina* sub-order throughout all the stations (Figure 4).

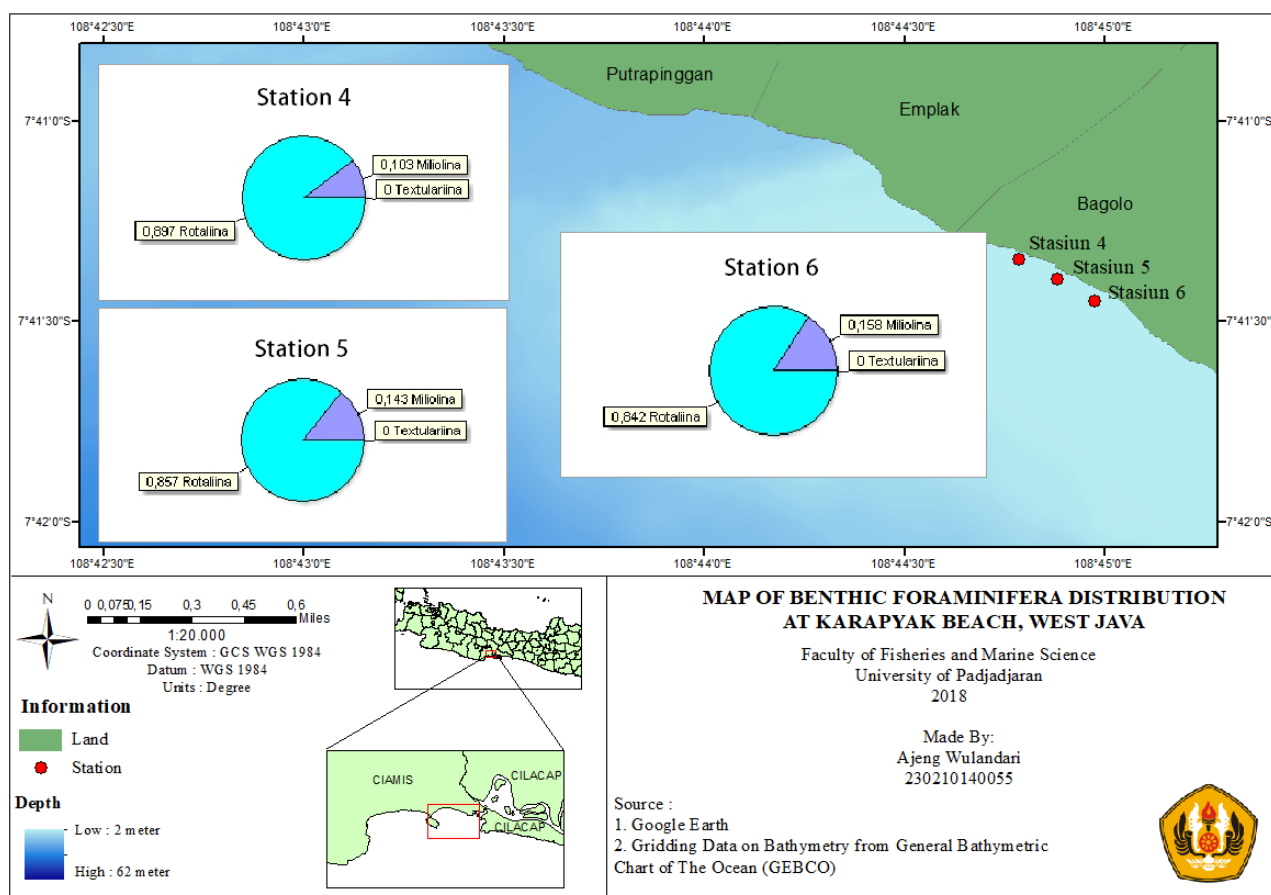


Figure 4. Map of the Foraminifera Bentik Distribution on Karapyak Beach

Sediments in the coastal regions of Karapyak are categorized as slightly gravelly sand with coarser grain size compared to the sand substrates in the eastern coast of Pangandaran, and has sand fractions composition that exceeds 50% in each station (Table 4). One of the effects caused by sediment types is towards the morphology of the foraminifera, especially in agglutinin shells which compose shells based on the material around them, as well as a support in nutrient sources for the growth of benthic foraminifera (Boltovskoy and Wright 1976). Generally, benthic foraminifera can be found abundantly on sandy or sandy-mud substrates (Natsir 2010). The presence of gravel fraction and grain size of the sediment is thought to affect the presence of benthic foraminifera, therefore in the Karapyak Coastal region, it has a lower abundance value compared to the Eastern Coast of Pangandaran.

Table 4. Sediment Fraction Percentage in Karapyak Beach

Station	Phi	Grave (%)	Sand (%)	Substrat type
4	2,4	0,4	99,6	Slightly gravelly sand ((g)S))
5	1,7	2,9	97,1	Slightly gravelly sand ((g)S))
6	1,3	2,7	97,3	Slightly gravelly sand ((g)S))

The Diversity Index and uniformity index in the Karapyak Coast region indicate that the region is still in the moderate category, meaning that the ecosystem is still stable enough to support the lives of benthic foraminifera (Figure 5). However, the value obtained for the diversity index is closer to 1. Therefore it can be assumed that the area has decreased water quality or is in fact, lightly polluted. The value of uniformity shows a value close to 1, which means that almost all genera found in Karapyak Beach region are distributed evenly.

From the results of the abundance calculation, it is known that in Karapyak Beach, no genus are found to be plentiful. Almost all genera are found evenly in each station. However, based on the 3 stations in Karapyak beach, there occur stations with great abundance, i.e. at station 4 with 68 individuals and the lowest is at station 6 with 19 individuals. At station 4, the 2 most abundant genera were Ammonia (26 individuals) and Pararotalia (15 individuals) from the sub-order Rotaliina. According to Gustiantini and Ilahude (2012), the genus Ammonia and Pararotalia belong to the opportunistic group of foraminifera which can be found living in various environment conditions. In addition to those two genera, in this station, another genus was discovered from the sub-order Rotaliina and Milioliina which are low in number. The genera includes Amphistegina (5 individuals), Anomalinella (3 individuals), Anomalinoides (2 individuals), Elphidium (1 individual), Neouvierina (1 individual), Planulina (7 individuals), Rectobolovina (1 individual), and Quinqueloculina (7 individuals). At station 6, the lowest abundance is 19 individuals and are divided into genera : Ammonia (7 individuals), Amphistegina (1 individual), Anomalinella (2 individuals), Elphidium (1 individual), Nonion (1 individual), Pararotalia (3 individuals), Planulina (1 individual), and Quinqueloculina (3 individuals). The greatest amount of genus found in this station is Ammonia (7 individuals). The station's low abundance is thought to be caused by the beach's unsuitable conditions and the presence of Citanduy river estuary in the eastern part of Karapyak Beach. The estuary is thought to have pollutants carried by the river flow, thus changing the water conditions of Karapyak Beach. This fact is supported by the high pH value of all stations which approach the value 9 (Table 5). High pH indicates that the waters have decreased water quality, thus becoming one of the factors that causes the low abundance of benthic foraminifera.

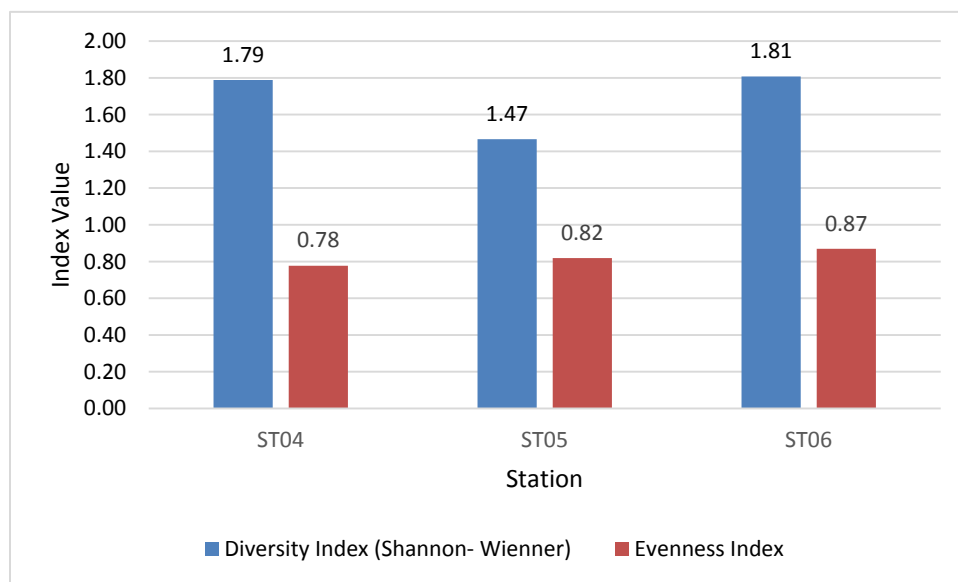


Figure 5. Graph of Diversity Index Value and Foraminifera Uniformity Index Bentik on Karapyak Beach

In addition to the genus's nervousness, this station found another genus from the sub-order Rotaliina and Milioliina which have low abundance. The genera include Amphistegina (5 individuals), Anomalinella (3 individuals), Anomalinoides (2 individuals), Elphidium (1 individual), Neouvierina (1 individual), Planulina (7 individuals), Rectobolovina (1 individual), and Quinqueloculina (7 individual). Whereas at station 6 which has the lowest abundance with 19 individuals divided into Ammonia (7 individuals), Amphistegina (1 individual), Anomalinella (2 individuals), Elphidium (1 individual), Nonion (1 individual), Pararotalia (3 individuals), Planulina (1 individual), and Quinqueloculina (3 individuals). The most popular genera found at this station is Ammonia (7 individuals). The low abundance at this station is thought to be due to unsuitable beach conditions and the presence of the Citanduy river estuary in the eastern part of Karapyak Beach. The river estuary is thought to have pollutant content carried by the river flow, thus changing the condition of Karapyak Beach waters. This is supported by the high pH value of all stations approaching the value of 9 (Table 5), the high pH value indicates that the waters have decreased the quality of the water so that it becomes one of the factors that causes the low abundance of benthic foraminifera.

Table 5. Physical-chemical values of Karapyak Beach

Physical-chemical parameters	Station		
	ST04	ST05	ST06
Temperature ($^{\circ}\text{C}$)	30	29	29
Salinity ($^{\circ}/_{\text{oo}}$)	33	35	33
pH	8,8	8,58	8,89
Dissolved Oxygen (mg/L)	5,6	7,43	8,43
Brightness (cm)	30	20	30
Depth (cm)	30	20	30

Conclusion

1. The highest abundance is at station 3 with 399 individuals, and the lowest abundance is at station 6 with 19 individuals. Diversity and uniformity of all stations have moderate diversity and an evenly distributed uniformity, except at station 3 as there is 1 genus which is much higher than the rest..
2. The genus found in the Eastern Coast of Pangandaran is as many as 24 genera from the sub-order Rotaliina, Miliolina, and Textulariina with genera dominance from the sub-order Rotaliina (20 genera). 11 genera are discovered in Karapyak Beach from the sub-order Rotaliina, Miliolina, and Textulariina with genera dominance from the sub-order Rotaliina (10 genera). The most abundant genus in the waters of Eastern Pangandaran Beach and Karapyak Beach is *Ammonia* with 331 individuals and 46 individuals respectively.
3. From the results of this research, it is known that the ecological conditions are fairly good, but it is close to being polluted and are in oppressed conditions both naturally and anthropogenically that are characterized by the presence of opportunistic genera such as *Ammonia*, *Pararotalia* and *Pseudorotalia* from Rotaliina sub-order.

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