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Macrozoobenthos Community Structure in Cijulang River Pangandaran District, West Java Province, Indonesia

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ABSTRACT

Cijulang River, Pangandaran is a river that is used for agriculture, fisheries, industry, household activities and even as a tourist attraction. Macrozoobenthos is a bioindicator that can show changes in the quality of river waters due to these activities. The purpose of this study was to determine the macrozoobenthos community structure found on the Cijulang River, Pangandaran. The research method used is Purposive Sampling. The study was conducted at 4 stations along the Cijulang River from upstream to downstream in September - November 2018. The results of the research on the Cijulang River found 27 species of 5 classes included in 3 fillum namely Mollusca (23 species), Arthropoda (3 species) and Annelida (1 species). The value of macrozoobenthos density in the Cijulang River ranges from 29.7 - 416.3 ind/m^2. Diversity index ranges from 1.48 - 2.24. The uniformity index ranges from 0.49 - 0.80. The range of water quality and substrate showed variations and dynamics that were still within the tolerance limits of macrozoobenthos life and water salinity is the main causes of variations in the macrozoobenthos community structure on the Cijulang River.

***Keywords*:** Cijulang River, Community Structure, Macrozoobenthos, bioindicator, Pangandaran District, Neritidae, Thiaridae, Gastropoda, Bivalvia

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1. INTRODUCTION

Cijulang River is a river located in Pangandaran Regency, West Java. Cijulang River has many benefits for the lives of the surrounding communities. Cijulang River is one of the leading ecotourism objects in Pangandaran, namely the Green Canyon cliff area and mangrove conservation area, besides that the water from the Cijulang River is also used by the community for household, agricultural and industrial needs, namely the Nata De Coco, Coconut and Sugar industries. The use of the Cijulang River to support human activities can produce organic waste which can reduce the quality of the river. The decline in river quality can affect the macrozoobenthos community structure found on the Cijulang River. The macrozoobenthos community inhabiting these locations will experience structural changes because macrozoobenthos are biota that has a close relationship with environmental conditions (Wardiatno et al. 2017).

Picture 1. Research location.
(Geogle Earth 2018)

Macrozoobenthos is the most important group of organisms in aquatic ecosystems. Macrozoobenthos are key biota in food webs and function as degradation of organic matter. In other words, macrozoobenthos is a biota that has a function as a counterweight to environmental

nutritional conditions and can be used as a bioindicator of water conditions (Setiawan and Zulkifli 2011). This research aims to determine the community structure of macrozoobenthos which includes density, diversity and uniformity on the Cijulang River. The results of this research are expected to provide information about the macrozoobenthos community structure found in the Cijulang Pangandaran River so that it can become a reference in efforts to monitor river quality.

2. METHODOLOGY

2. 1. Time and Place

The research was carried out at four stations along the Cijulang River, Pangandaran, West Java Province, Indonesia (Picture 1). Station 1 is located near the Green Canyon tourist attraction, station 2 is located near the fishing boatyard, station 3 is located in the mangrove area of Nusawiru and station 4 is located in the estuary of Bojongsalawe. Determination of research stations based on Purposive Sampling method which is based on differences in river pollution conditions. This research was conducted in September - November 2018.

2. 2. Tool and Material

The tools used were quadrant transect, mesh surber, macrozoobenthos identification book, pH meter, DO meter, thermometer, refractometer, current meter, disk sechi, scale stick, shovel, 0.5 mm filter, sample plastic, sample bottle, a documentation tool, label paper and cold box. The materials used were macrozoobenthos samples, substrate samples, river water samples, 4% formalin, chemicals to test BOD and substrate and ice cubes.

2. 3. Sampling and Measurement

A sampling of water and macrozoobenthos was carried out three times in September - November 2018 while for substrate samples carried out only once in October 2018. Benthic sampling using the quadrant transect method and swipe method. Measurement of samples is done in situ and ex-situ. Observations and measurements of water samples such as temperature, depth, transparency of light, current velocity, DO, pH and salinity were carried out (in-situ), observations of BOD carried out in the Laboratory of Aquatic Resources FPIK Unpaid, observations of macrozoobenthos carried out at PPSDAL Unpad Laboratory and substrate characteristics covering the fraction texture, pH, C-organic, N-organic and C / N ratio conducted at the Laboratory of Soil Chemistry and Plant Nutrition, Faculty of Agriculture, Padjadjaran University.

2. 4. Sample Analysis

The sample analysis carried out included the density, diversity and uniformity of macrozoobenthos.

1) Density of Type

$$K_j = \frac{a}{b \times n}$$

Information:

Kj = Density of type (ind/m^2), a = Number of macrozoobenthos (ind), b = Total plot area (m^2), and n = Number of retrieval tests.

2) Relative Density

$$Kr = \frac{K_i}{K_j} \times 100\%$$

Information:

Kr = Relative Density (%), Ki = Density of type I, and Kj = Density of all types.

3) Diversity Index

$$H' = -\Sigma (pi \ Log_2 \ pi), \ pi = \frac{ni}{N}$$

Information:

H' = Shannon-Wiener Index, *ni* = Number of individual *i* and *N* = Total number of individuals.

4) Uniformity Index

$$E = \frac{H'}{H \ maks}$$

Information:

E = Uniformity Index, $H_{maks} = Log_2 S$ (3.3219 Log S) and S = Number of species.

5) Dominance Index

$$C = \Sigma (ni/N)^2$$

Information:

C = Dominance index, *ni* = Number of individual i and N = Total number of individuals

3. RESULT AND DISCUSSION

3. 1. Physical and Chemical Parameters of Water

This research shows that in the Cijulang River there are variations in the physical and chemical qualities of the waters (Table 1).

The temperature of the Cijulang River ranges from 25.3 – 34 ºC, the lowest temperature is at station 2 and the highest at station 4. This temperature difference is caused by geographical factors and the time of sampling. Geographical conditions and sampling time will affect the

intensity of light entering the waters. The temperature is less favorable and causes macrozoobenthos deaths in the range of 35 – 40 ºC and in general, the temperature of the Cijulang River is still within tolerance limits for macrozoobenthic life.

The depth at which macrozoobenthos are taken ranges from 0.64 to 1.23 meters. The variability of depth values is caused by tides and rainfall conditions. This condition is proven by the brackish water in the Cijulang River due to a mixture of seawater and fresh water and rainfall will affect the amount of water intensity in the river which makes the depth higher than the month that has not rained.

Table 1. Physical and Chemical Parameters of Water.

No	Water Parameters	Research Station			
		1	2	3	4
1	Temperature (ºC)	27,3 – 29,0	25,3 – 31,0	28,4 – 29,0	29,8 – 34,0
2	Depth (m)	0,8 – 1,02	0,97 – 1,23	0,64 – 0,76	0,91 – 1,04
3	Transparency of light (m)	0,8 – 1	9,7 – 1,19	0,64 – 0,69	0,91 – 1,04
4	Current (m/sec)	0,17 – 0,19	0,08 – 0,09	0,04 – 0,05	0,06 – 0,07
5	DO (mg/L)	6,2 – 9,2	6,1 – 9,1	6,7 – 8,9	7,1 – 8,8
6	BOD (mg/L)	0,72 – 1,55	3,33 - 4,54	5,84 – 6,81	3,40 – 4,53
7	pH	6,72 – 7,69	6,34 – 7,87	5,94 – 8,05	5,96 – 8,00
8	Salinity (ppt)	4 – 13	7 – 21	12 – 27	20 – 35

Transparency of light entering the river ranges from 0.64 - 1.19 meters. Clear waters have a transparency value of light reaching 40 cm, so that in general Cijulang River is a clear river. The current on the Cijulang River ranges from 0.04 - 0.19 m/sec. Wang et al (2016) states that rivers that have a range of currents of 0.1 - 0.25 m/sec, including slow current rivers and those that have a current <0.1 m/sec, are categorized as river flows are very slow, so it can be concluded on the Cijulang River including the river is very slow except station 1 which is a slow stream.

DO concentrations in the Cijulang River range from 6.1 to 9.2 mg/L. The value of the DO range is included in unpolluted waters. According to Sahidin et al (2018), unpolluted waters have to DO concentrations > 6 mg/L. DO concentrations in rivers are usually <10 mg/L so it can be concluded that the range of doing values is still deep macrozoobenthos life tolerance threshold.

The BOD concentration value in the Cijulang River ranged from 0.72 - 6.81 mg/L. The quality of unpolluted waters has a BOD value < 3.0 mg/L, so that in the Cijulang River there are stations that have not been polluted and have been polluted. For stations that have not been

polluted at station 1 because they have a BOD concentration of < 3.0 mg/L, lightly polluted stations are at station 2 and station 4 which have a BOD range of 3.3 - 4.5 mg/L and polluted stations currently in station 3 which has a BOD range of 5.8 - 6.8 mg/L. At station 1 the BOD value is low because there is no anthropogenic activity that can pollute the waters inversely with station 3 which has settlements, ecotourism and agricultural locations whose waste can pollute the waters. Stated that the ideal and productive water conditions for aquatic biota life are waters which have a pH ranging from 6.5 to 8.5. The pH value in the Cijulang River ranges from 5.94 - 8.05 and in general, the value of the pH range is classified into waters which can be tolerated by macrozoobenthos.

The salinity concentration in the Cijulang River ranges from 4 - 35 ppt, station 1 which is located upstream of the Cijulang River has the smallest salinity and on the downstream of Cijulang River, station 4 has the highest salinity. Overall, the condition of the Cijulang River is brackish with salinity values increasing from upstream to downstream of the river. Salinity has an influence on the community structure of macrozoobenthos because it can affect the growth rate and survival rate of macrozoobenthos.

3. 2. Substrate Parameters

The substrate content that dominates the Cijulang River is the sand fraction which ranges from 8% - 87% and is followed by clay fractions ranging from 10% - 50% (Table 2). The difference in the type of base substrate is influenced by the characteristics of the waters and due to the influence of the mass movement of water. The dominance of the sand substrate fraction on the Cijulang River is due to the relatively low flow and movement of the water mass, making smaller particles carried away by the mass of water and leaving a sand fraction that has a larger particle size which then settles first. While the dominance of clay fraction on the substrate is at station 3 (50%), this is due to station 3 located near the mangrove forest which is a sediment trap. According to Arrivabene et al (2015), the mangrove area is mud and land which is continuously formed by plants so that the substrate fraction that dominates is clay.

The chemical content of the substrate especially C-organic and N-total in each Cijulang River is classified as low, namely C-organic <1.56% and N-total <0.13%. Whereas the C / N ratio in each station is classified as moderate, which ranges from 11 to 14. The content of organic materials such as C and N in the substrate will affect the type and abundance of macrozoobenthos, this is because the deposition of organic matter into the bottom of the water can be used as food for organisms macrozoobenthos so that the amount and rate of addition of organic matter to certain limits will affect macrozoobenthos.

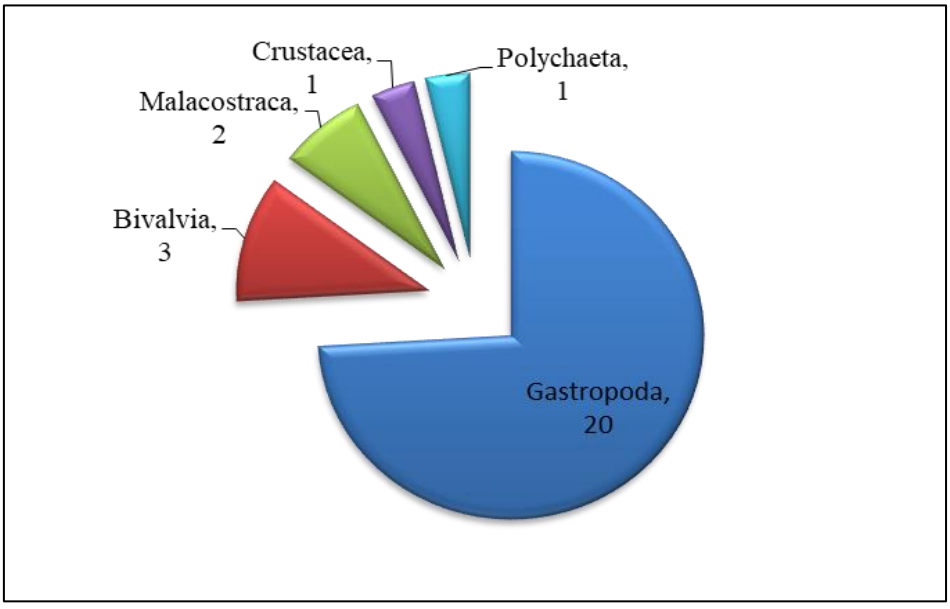
Table 2. Physical and Chemical Parameters of Substrates.

No	Substrate Parameters	Research Station			
		1	2	3	4
1	pH-Substrates	7,41	7,35	7,04	8,46
2	C-Organic	0,97%	1,09%	1,56%	0,51%
3	N-Total	0,08%	0,10%	0,13%	0,04%

4	C/N Ratio	12	11	12	14
5	Sand	63%	43%	8%	87%
	Dust	19%	24%	42%	3%
	Clay	18%	33%	50%	10%
	Texture	Sandy clay	Clay Clay	Dusty Clay	Clay Sand

3. 3. Biological Parameters

This research shows that macrozoobenthos found along the Cijulang River numbered 27 species consisting of three fillums and five classes (Picture 2 and Table 3).



Picture 2. The number of macrozoobenthos species found during the research

Table 3. Macrozoobenthos species found during the research [7-36].

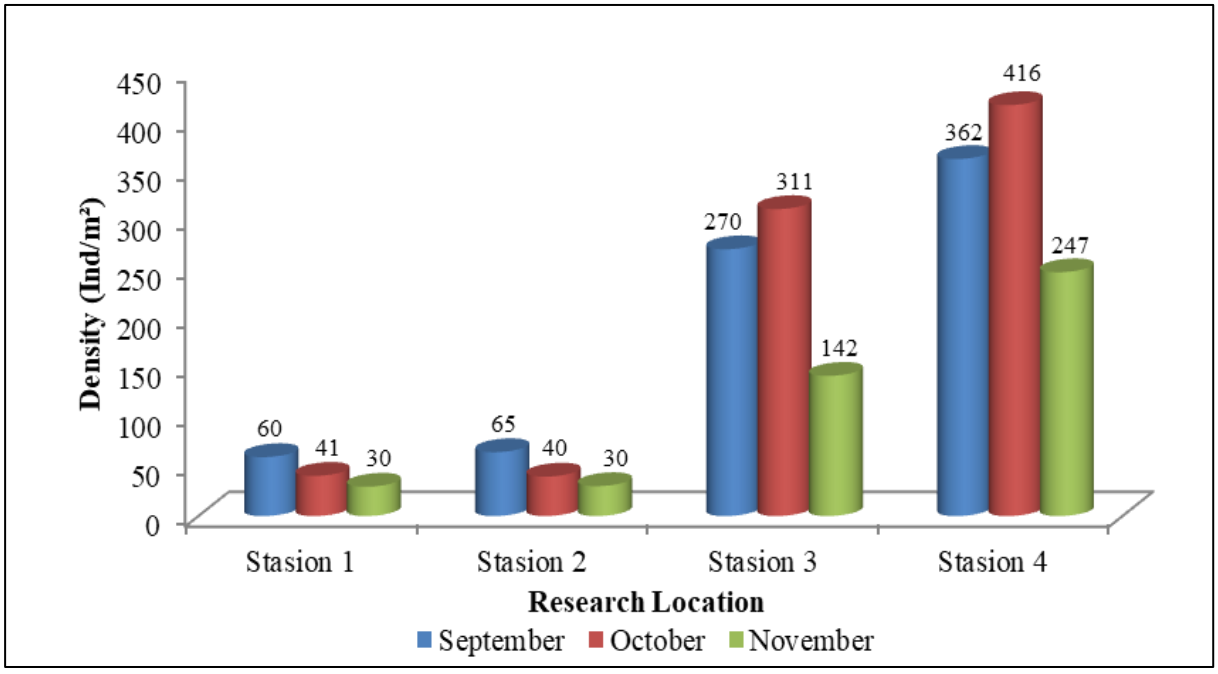
No	Macrozoobenthos species	Research Station			
		1	2	3	4
1	*Thiara concellata*	+	+	-	-
2	*Thiara winteri*	+	-	-	-
3	*Tarebia* sp.	+	+	+	-

4	*Balanocochlis* sp.	+	-	-	-
5	*Melanoides maculata*	+	-	+	-
6	*Melanoides pilcara*	-	+	-	-
7	*Clithon bicolor*	+	+	-	-
8	*Clithon corona*	+	+	+	-
9	*Clithon coronata*	+	+	-	-
10	*Clithon ovalaniensis*	-	+	+	+
11	*Clithon faba*	-	+	+	+
12	*Clithon diadema*	-	+	-	-
13	*Clithon squarrosus*	-	+	-	+
14	*Septaria pareceliana*	-	+	-	-
15	*Faunus ater*	+	+	+	+
16	*Trochus* sp.	-	-	+	-
17	*Tarebralia sulcata*	-	-	-	+
18	*Cerithium salebrosum*	-	+	-	-
19	*Cerithium alveolum*	-	-	-	+
20	*Cerithium kobelti*	-	-	-	+
21	*Saccostrea cucullata*	-	-	+	+
22	*Suneta tuncatta*	-	-	+	-
23	*Perna viridis*	-	-	-	+
24	*Ucha* sp.	+	-	-	+
25	*Pagurus* sp.	-	-	+	+
26	*Penaeus* sp.	+	-	-	-
27	*Nereis* sp.	-	-	-	+

Gastropoda is the most common type of macrozoobenthos found in the Cijulang River, which is as many as 25 species which are dominated by the family Neritidae (8 species) and Thiaridae family (6 species). The condition of sandy substrate is the main cause of a large number of gastropods found in the Cijulang River. Organisms that can adapt to a sandy substrate

are macro infauna organisms (1-10 cm) that are capable of digging holes in the sand and micro meiofauna (0.1-1 mm) that are able to live in sand grains. States that the Gastropoda and Bivalvia groups are macrozoobenthos that are able to adapt and are most commonly found on sandy substrates. The most dominating macrozoobenthos species found on the Cijulang River is *Faunus ater*. Other species that dominate are *Tarebia* sp., *Melanoides pilcara*, *Saccostrea cucullata*, and *Cerithium kobelti*. While the species *Balanocochlis* sp., *Thiara winteri*, *Septaria pareceliana*, *Trochus* sp., *Suneta tuncatta*, and *Penaeus* sp. only found on one stations. This difference in community structure is caused by differences in water quality. In the research group which has a relatively high level of pollution, there are many macrozoobenthos tolerant groups (Station 2, station 3 and station 4) and at stations with low pollution (Station 1) there is still intolerant macrozoobenthos although there are some facultative and tolerant macrozoobenthos dominate.

The highest macrozoobenthos density found in Cijulang River is located at station 4 (Bojongsalawe Estuary) which is 247 - 416.3 ind/m^2 dominated by *Faunus ater* species (87 – 148 ind/m^2), *Saccostrea cucullata* (61 – 134 ind/m^2) and *Cerithium kobelti* (27 – 125 ind/m^2). The lowest density is found at station 1 (Green Canyon) which is equal to 30 – 60 ind/m^2 which is dominated by Tarebia sp. (9 – 41 ind/m^2). In this research, macrozoobenthos which had the highest total density were species of *Faunus ater*. *Faunus ater* is a macrozoobenthos which has a high tolerance level to aquatic conditions and includes brackish macrozoobenthos.



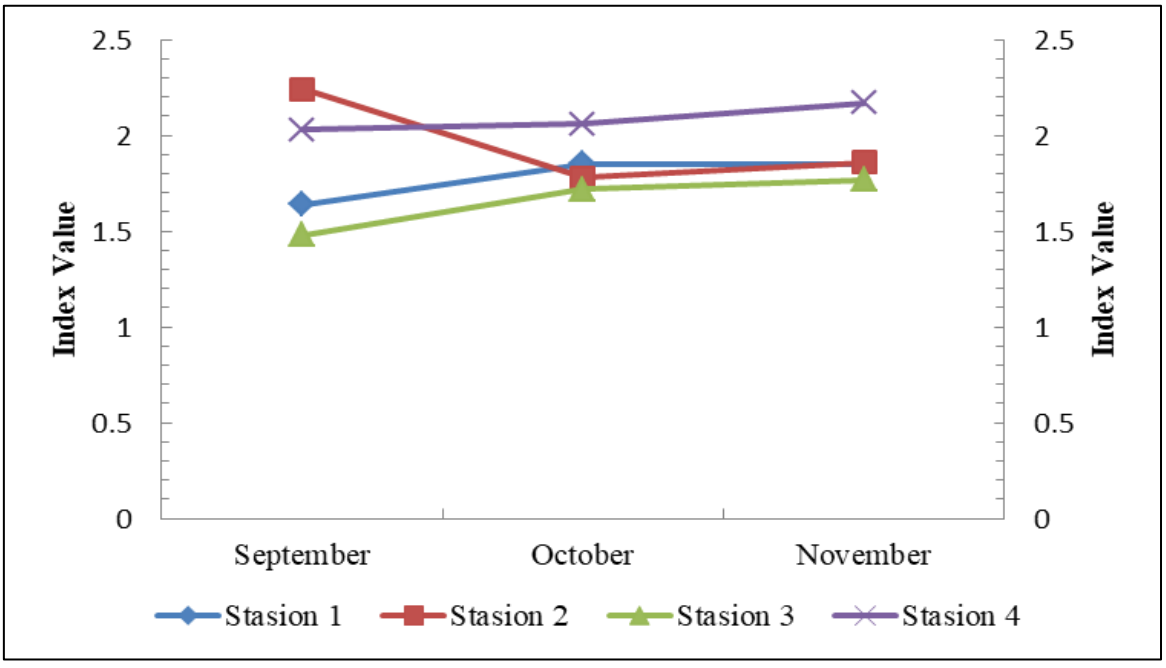
Picture 3. Macrozoobenthos density

Macrozoobenthos density in the Cijulang River has decreased in each period of sampling (Picture 3). September to November 2018 is the transition phase from the dry season to the rainy season. During the rainy season, there will be a very large transport of organic matter to coastal waters from the mainland through rivers and runoffs. Increasing organic matter on

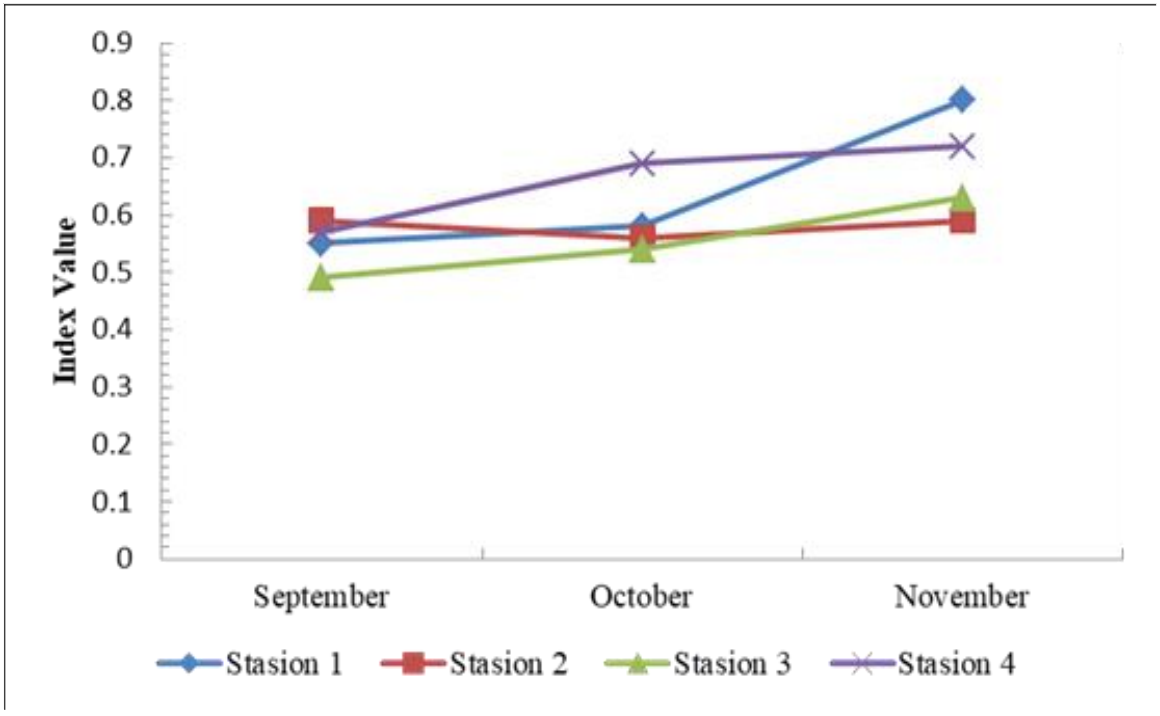
aquatic substrates will affect the condition of macrozoobenthos especially in the metabolic process. Increased metabolism will cause the level of oxygen consumption to rise and result in a decrease in oxygen in the bottom of the water so that the bottom condition of the waters becomes anoxic. In addition to pollution factors of organic matter and salinity, this condition will also affect the presence of macrozoobenthos. Anoxic conditions cause a decrease in species and an abundance of macrozoobenthos.

Based on Picture 3, it was found that the density of macrozoobenthos found in the Cijulang River increased from the upstream to the downstream stations. The causes of this condition can come from the conditions of water quality, substrate and salinity, but based on Table 1 and Table 2 which are in line with the conditions of density is the salinity while the BOD and substrate parameters on the Cijulang River are relatively the same value.

States that salinity has a direct influence on the community structure of macrozoobenthos because each type of macrozoobenthos has a different tolerance limit depending on the ability of macrozoobenthos to control their body's osmotic pressure. At stations 1 and 2 have the lowest salinity and density of macrozoobenthos, this is due to the macrozoobenthos inhabiting these stations including freshwater groups and their low density because they cannot adapt to the effect of salinity from sea water which makes the condition of the waters become brackish. At stations 3 and 4 macrozoobenthos found in these locations include brackish macrozoobenthos which makes the density high. The range of the Shannon-Wiener (H') diversity index during this research was 1.48 - 2.24 (Picture 4). The lowest diversity index is found at station 3 and the highest at station 2. While for the uniformity index (E) range of 0.49 - 0.8 with the lowest index value at station 3 and the highest at station 1 (Picture 4). From the results of the H' and E index, it can be concluded that the level of diversity of macrozoobenthos in the Cijulang River is classified as moderate and its distribution tends to be evenly distributed and there is no tendency for dominating species.

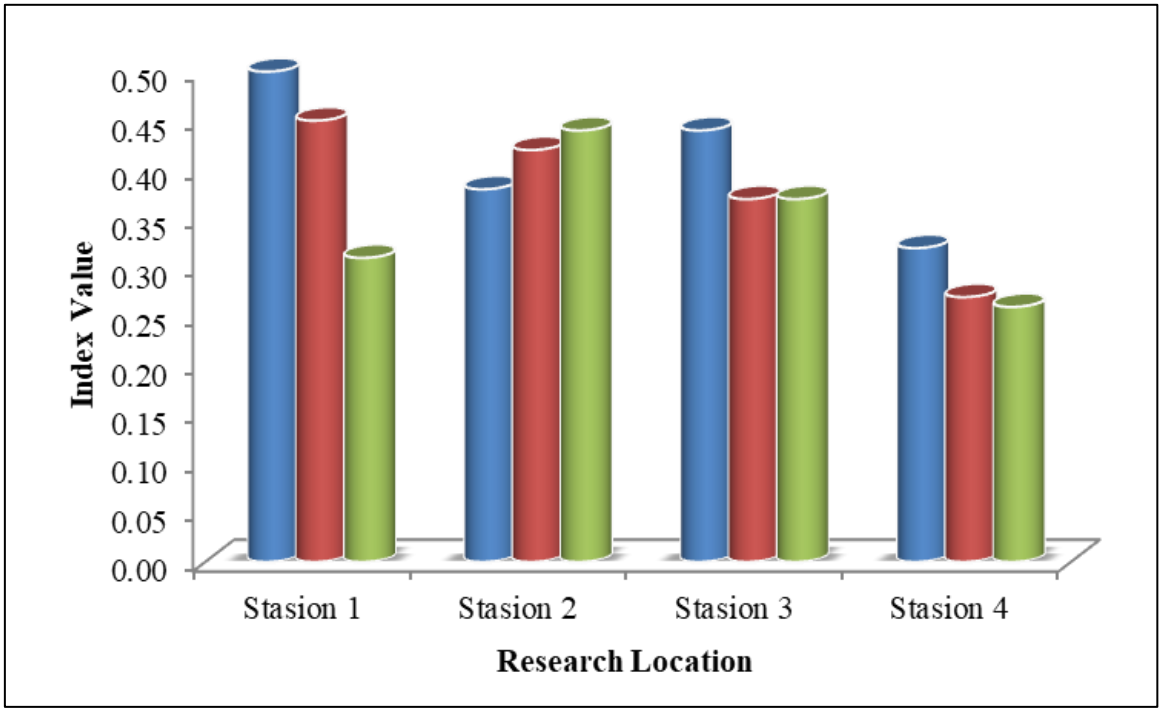


(a)



(b)

Picture 4. (a) Macrozoobenthos diversity, **(b)** Macrozoobenthos uniformity.



Picture 5. Dominance of macrozoobenthos.

At station 3 the H 'and E index values are lower than the other research stations because even though 7 to 9 species are found, there are 2 dominating species, namely *Faunus ater* (Kr 36-59%) and *Tarebia* sp. (Kr 21% - 47%) which results in the low index value. Overall the highest H 'index is found at station 4 and at this station the E index value is also high, this illustrates the condition of the macrozoobenthos community at station 4 which is quite stable and more diverse. The higher the diversity value of benthos means that the environmental conditions are getting better and the community is classified as stable (Reshetnikova et al 2017).

The level of dominance of macrozoobenthos which tends to be low in the Cijulang River is also indicated by the dominance index values ranging from 0.26 - 0.50 (Picture 5). The low dominance index value describes the condition of the waters stable and still intolerance for macrozoobenthic life, so there are still many types of macrozoobenthos living in the Cijulang River, but differences in macrozoobenthos community structures in the upstream and downstream rivers indicate that water salinity factors greatly affect the abundance and macrozoobenthos diversity on the Cijulang River.

4. CONCLUSIONS

Macrozoobenthos density in the Cijulang River ranged from 29.7 - 416.3 ind/m^2. Diversity index ranges from 1.48 - 2.24. The uniformity index ranges from 0.49 - 0.80. Dominance index ranged from 0.26 - 0.50. In general, the cause of the variation in the macrozoobenthos community structure on the Cijulang River is the difference in salinity values between stations.

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