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Research Article

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Waters quality test based on macrozoobenthos bioindicator parameter in the Bolong river, Magelang

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ABSTRACT

The exploration of macrozoobenthos diversity as a bioindicator parameter in the Bolong river, Magelang has not been widely carried out. This study aims to determine the water quality of the Bolong river based on macrozoobenthos Bioindicator parameters. This research method uses a qualitative descriptive approach. The water quality test is measured based on the level of macrozoobenthos diversity according to the Shannon-Wienner diversity index. The purposive sampling method is used to determine 5 stations for sample collection. The intake of macrozoobenthos is done by using a Surber net and a tray at the bottom of river waters. Moreover, sampling is carried out with three repetitions. The data is analyzed using a diversity index, uniformity index, and dominance index to determine the water quality based on the Bioindicator parameters. Based on the result of the study, the macrozoobenthos diversity index is 1.028. Based on this index, the quality of waters in the Bolong river is considered as moderate pollution.

Keywords: Water quality; Bolong river; macrozoobentos; bioindicator

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INTRODUCTION

A river is a form of aquatic ecosystem that has an important role in the hydrological cycle and functions as a water catchment area for its surrounding. Therefore, the condition of a river is influenced much by the characteristics of the surrounding environment (Setiawan, 2009). A river as an ecosystem has the biotic and abiotic components that interact with each other in an integrated manner to form an energy flow that will maintain the stability of a river (Vilmin et al., 2018). One of the factors that can affect river stability is the quality of river water. The quality of river water will affect the presence of the biotic and abiotic components. This can lead to an imbalance of interactions between components in the river

ecosystem (Rafi'i & Maulana, 2018). A well understanding of rivers is needed in the handling, management, and utilization of waters resources and their development in the various study fields while maintaining their sustainability (Wiadnyana & Husnah, 2017; Prajoko & Ismawati, 2018).

Bolong river is a river-flows area or well known as a watershed in Njurip Village, Ngasem Village, and Geger Village. This river provides various water needs for the consumption of drinking water, for agriculture, and the activities of the people there. These various kinds of river utilization activities have an impact on the river, which is a decrease in water quality. This is because some of what is produced are discharged into the river before going through any treatment process. A river can clean itself or known as self-purification from various sources of input. However, if it exceeds the carrying capacity of the river, it will cause serious problems for the health of the river environment (Setiawan, 2009). Moreover, if this is continuing, it will have an impact on the poor quality of river water and the stability of the river ecosystem.

The decrease in river water quality will affect the biota in it (Fadhilah et al., 2013). Then, if the river water is polluted, the diversity and number of biota that live in the river will be less than the river which is not polluted yet. One of the biotas that can be used as the biological parameter in determining the quality of river water is macrozoobenthos. Macrozoobenthos is one of the biotas that lives sessile on the bottom of the waters, creeping or digging holes (Ilarri et al., 2012). Generally, macrozoobenthos cannot move quickly. Their size is large so they are easy to identify and their habitat in and at the bottom of the waters (De Jong et al., 2015; Riniatsih et al., 2018). With these properties, the changes in the quality of the water in the living substrate greatly affect the abundance and diversity of macrozoobenthos. This abundance and diversity are very dependent on tolerance, activity, and sensitivity to environmental changes. The tolerance range of the macrozoobenthos to the environment is different (Indra & Sahidin, 2019). Therefore, it is necessary to research on the diversity of macrozoobenthos in the Bolong river. Somehow, waters with good quality usually have high species diversity and vice versa, in bad or polluted waters it usually has low species diversity.

Furthermore, research was conducted to determine the quality of the Bolong river waters based on Macrozoobenthic bioindicator parameters. The existence of macrozoobenthos can be used as an indicator of water quality. Therefore, macrozoobenthos are bioindicators to detect whether or not the environmental quality of waters is good (Akindele et al., 2019; Khedhri et al., 2017; Tarwotjo et al., 2018).

RESEARCH METHODS

This research method uses a qualitative descriptive approach. This research was conducted in the watershed ecosystem area of Bolong river in Ngasem Village, Wates District, Magelang City in May 2019 (dry season). The sampling was carried out by purposive sampling method, which is based on the consideration of the overall picture of the ecosystem is represented (Afif et al., 2014). The research location can be seen in Figure 1.

The sampling of Macrozoobenthic used five tools which are net, scoop, tray, guidebook, and square plate. Then, the macrozoobenthos sampling method was carried out by using a scoop and a square plate for the sand substrate. Then, the sand was filtered using a net. Then, place the macrozoobenthos on a tray to identify them. The Macroozoobenthos identification could be done by using a guidebook. For the rock substrate, the identification of macrozoobenthos could be done by taking the rock. Then, place it on a tray and identify the macrozoobenthos found in the guidebook.

Figure 1. The Research Location in the Bolong river Watershed, Ngasem Village, Wates District, Magelang City. The Red Circle Indicates The Sampling Location for Macrozoobenthos (Source: Google Maps, 2019)

The Macrozoobenthic sample was taken at 5 different research stations. At each station, three spots were chosen to represent the right bank, the left bank, and the middle of the river. The data analyzed was not only the number of Macroozoobenthos but also the physical parameters. The physical parameters are temperature, depth, turbidity, the color of water, and water odor that were also identified as supporting data, as well as uniformity and diversity indexes to determine the quality of river water. The data analysis in this research uses the Shannon-Wienner Diversity Index ($\hat{H}$) and the level of water pollution is determined based on the Krebs classification (Akindele et al., 2019; Fastawa et al., 2019).

FINDINGS AND DISCUSSION

The biological indicator used in this research is macrozoobenthos. The result of Macrozoobenthic observation carried out in the Bolong river aquatic ecosystem is specifically described in a table detailing the number of macrozoobenthos found at each station consisting of taxa of sensitive organisms, moderate organisms, and tolerant organisms. The data about the diversity of macrozoobenthos is presented in Table 1 below.

Table 1. The Number of Macrozoobenthos Found at Each Station

No	Macrozoobenthos Taxa	The Number of Individual				
		Station 1	Station 2	Station 3	Station 4	Station 5
	Sensitive Organisms					
1	*Nemouridae*	3	8	0	0	2
2	*Leptophlebidae*	3	2	0	0	0
3	*Philopotamidae*	1	1	0	0	1
4	*Rhyacophilidae*	0	2	0	0	0
5	*Palaemonidae*	0	0	0	1	1
	Moderate Organisms					
1	*Gerridae*	16	0	0	0	0
2	*Glossiphonidae*	0	0	4	0	0
3	*Hydrophilidae*	0	0	0	18	18
	Tolerant Organisms					
1	*Tubificidae*	1	20	44	0	3
2	*Lymnaeidae*	5	0	0	1	0
3	*Lampyridae-larva*	0	0	3	0	9

Based on the result, the research obtains the types of macrozoobenthos which are obtained from several stations in the research location shown in Table 1. The table shows that there are 29 macrozoobenthos obtained at station 1, 33 macrozoobenthos at station 2, 51 macrozoobenthos at station 3, 20 macrozoobenthos at station 4, and 34 macrozoobenthos at station 5. The most common macrozoobenthos found are *Tubificiae* which belong to the tolerant organisms. Somehow, this is due to the environmental condition of their life. However, there are also several types of Gastropods found in the Bolong river. They are water snails (*Lymnaea* sp.), and snails (*Acihatina fulica*). According to (Sinaga et al., 2019; Yanygina, 2012) Gastropods are animals that can live and grow well on various types of substrates that have stock food, and their lives are always influenced by the physical and chemical conditions of the waters such as temperature, pH, and dissolved oxygen.

Based on the result of the research, eleven organisms in 5 stations are classified as sensitive organisms, moderate organisms, and tolerant organisms. Besides, organisms that have a high density are Lymnaeidae and Lampyridae-larva. It is assumed that the condition of the waters environment shows a fairly high ecological pressure due to the input of dangerous waste for the survival of macrozoobenthos. Then, it results in the death of the macrozoobenthos that are not able to adapt. However, the species that can adapt may dominate at each extraction station. This shows that the three species are more tolerant about the changing of environmental conditions. Therefore, they have a high survival rate (Mulia, 2016).

The difference in the tolerance limit between populations to environmental factors affects the ability to compete (Rafi'i & Maulana, 2018). Therefore, if the condition of the waters environment decreases due to pollution, the species of organisms that are intolerant of this condition will decrease in population. On the other hand, the types of organisms that are tolerant of this condition will increase in population because the types of competitors are reduced. Besides, the types of organisms that can survive will usually dominate the community. The diversity in species is an important communication character and it is a combination of species richness and evenness. Furthermore, diversity can be taken both to indicate the number of species in a particular area and to be the number of species among the total number of individuals from all existing species (Allesina & Levine, 2011).

Besides, the sensitive organisms such as *Nemoridae, Leptophlebidae, and Philopotamidae* are still found at each station. Therefore, the water quality of the Bolong river can still be labeled as good and with no pollution. Then, if there are still found sensitive organisms in a particular area, the water quality in this area is undoubtedly good because it is sensitive to pollution. Therefore, these aquatic organisms are commonly used as indicator organisms (Purwati, 2015). Whereas in moderate organisms, there are 2 organisms that dominate. They are *Gerridae and Hydrophilidae* which are found at station 1, station 4, and station 5. For this reason, the quality of river water can be said to be moderate and not be polluted yet.

The existence of Macrozoobenthic animals can also be used to determine the condition of the waters apart from using SI and TSI as mentioned above. Surely, the data of macrozoobenthos captured numbers can be used to determine the value of diversity index (H '), uniformity index (E), and dominance index on the estuary of the Bolong river, Magelang. The condition of uniformity and diversity of macrozoobenthos in the Bolong river waters ecosystem can be seen in Table 2 below.

Table 2. The Value of Uniformity and Diversity of Macrozoobenthos in All Waters of The Bolong River

Value	Stations					Average
	1	2	3	4	5	
Diversity Index	1.89	1.09	0.49	0.39	1.28	1.028

Uniformity Index	0.97	0.68	0.45	0.35	0.72	0.634
Dominance Index	0.33	0.49	0.75	0.81	0.38	0.552

Based on the finding of research conducted in the area of the Bolong River waters ecosystem, the information is obtained that the overall macrozoobenthos diversity calculated using the Shannon Weiner index is classified as moderate with its diversity index which is $\hat{H}$ = 1.028. According to Setiawan (2009), the category of Shannon-Wiener diversity index value has a certain range of values which is H' < 1 has low diversity, 1 < H' < 3 has moderate diversity, and H' > 3 has high diversity. The H' value which is classified as moderate is due to the existence of the river which is not too far from the settlement so that it allows pollution from the people surrounding it. Therefore, if this pollution continues, it will result in a low diversity of organisms. The result of the diversity index value calculation (H) for three-time observations obtains the diversity index value ranging from 0.39 - 1.589. The diversity of macrozoobenthos at the 5 stations is classified as moderate. Somehow, moderate diversity is due to the type of substrate. The basic substrate at each research location is rocky which is in the form of large stones and gravel. The sand substrate tends to make it easier to shift and move to other places especially for the Gastropods class (Triwiyanto, 2015).

The water quality based on the diversity index station 1, station 2, and station 5 belongs to moderate pollution while at station 3 and station 4 are much polluted. One of the causes of Macrozoobenthic diversity being moderate is because of a decrease in waters quality with the low value of dissolved oxygen and the high substrate organic carbon (Fadhilah et al., 2014). The organic matter that settles at the bottom of the waters is a source of food for benthic organisms. Therefore, the amount and rate of increase in sediment have a major influence on the population of benthic organisms. According to (Fisesa et al., 2014), the entry of organic matter through land run-off and the decay of dead organisms at the bottom of the waters. The high level of pollution in the waters of the Bolong River is because of the pollution from the indiscriminate disposal of people's waste in the river. Last but not least, estuary waters that are polluted due to human activity will result in a low value of diversity of aquatic organisms. The other factors that are thought to affect the low diversity index are the basic substrate, DO, and BOD content.

Based on Table 2, the uniformity index (E) of the 5 stations ranges from 0.72 to 0.97 with the highest uniformity index at the third station of 0.97 and the lowest uniformity index at station 2 of 0.68. Overall, the uniformity index of the 5 stations is high, which means that the distribution of individuals in uniform and evenly distributed. Then, the uniformity index (E) ranges from 0-1. Therefore, if the value is close to zero, it means that the uniformity is low because of the dominating species. If it is close to one, it means that the uniformity is high, which indicates the absence of the dominating species. Moreover, the highest dominance index is at station 4 with a value of 0.815. The result of the calculation of the uniformity index value (E) for three-time observations obtains the diversity index value that ranges from 0.3 to 0.9. As a result, the Macrozoobenthic uniformity at the 5 stations is low. The low uniformity is caused by the type of substrate. The basic substrate at each research location is rocky which is in the form of large stones and gravel. This results in the small number of macrozoobenthos inhabiting these locations (Fastawa et al., 2019).

Based on Table 2, the dominance index value ranges from 0.33 - 0.81. The dominance index values at station 1, station 2, and station 5 have smaller values than the uniformity value, which means that almost no individuals dominate. However, the uniformity index is high and there is no dominance but the diversity of macrozoobenthos belongs to moderate. This indicates that the waters of the Bolong River are polluted because the Macrozoobenthic group can adapt to certain environments (Fadhilah et al., 2014).

Besides, station 3 and station 5 show that the dominance index value is greater than the uniformity index. This means that there is one genre that dominates. Moreover, the dominance index is small.

Physical parameters are used for supporting data in determining the waters quality of the Bolong river. Based on the research, the result of the physical parameters is presented in the Table 3 below.

Table 3. The Water Quality Obtained at Research Stations in The River Ecosystem

Variables	Stations				
	1	2	3	4	5
Temperature (^{0}C)	24	24	25	23	21
Depth (cm)	30	62	43	40	450
Water color	Brownish	Brownish	Brownish	Brownish	Brownish
Water smell	Odorless	Odorless	Odorless	Odorless	Fishy
Turbidity	Turbid	Clear	Turbid	Turbid	Turbid

Table 3 shows that the temperature of the 5 stations ranges from 21 - 24^{o}C with the highest temperature at station 3, which is 25^{o}C. Moreover, the lowest temperature is at station 5 which is 21^{o}C. Somehow, the low temperature at station 3 is due to the conditions that are shaded more by plants around the river than the other 4 stations. The aquatic ecosystems are influenced by the light penetration, heat exchange between water and the surrounding air, the height of the canopy (vegetation cover) of trees on the river bank (De Jong et al., 2015; Khedhri et al., 2017). Besides, the depth of the 5 stations ranges from 30 - 450 cm. The highest one is at station 5, which is 450 cm, and the lowest one is at station 1, which is 30 cm. The high depth at station 5 is because of its location, which is close to the dam. The color of the water at the 5 stations almost has the same color, which is brownish. In station 3, there is the most macrozoobenthos in which the color of the water is brownish. Station 3 has a basic substrate in the form of rocks. This rocky substrate is good for macrozoobenthos to survive. This causes river water to be odorless.

Thus, the quality of waters in the Bolong river based on the macrozoobenthos found is in the category of moderate pollution. This can be known by the discovery of several macrozoobenthos around and at the bottom of the Bolong river with a diversity index of 1.028. Several types of macrozoobenthos that have been found are *Nemouridae, Leptophlebideae, Philopotamidae, Gerridae, Tubificidae, and Lymnaeidae.* The quality of waters that begins to be moderately polluted can be caused by river pollution from the surrounding people. Moreover, it is also due to the existence of the river which is not far from the residential areas, and the abiotic factors that affect the low diversity and high uniformity of macrozoobenthos. Taqwa states that estuary waters that are polluted because of human activity will result in the low value of diversity of aquatic organisms.

CONCLUSION

Based on the finding of the research and discussion, it can be concluded that the quality of waters in the Bolong river based on the macrozoobenthos is considered as moderately polluted (moderate pollution). This can be known by the discovery of several macrozoobenthos around and at the bottom of the Bolong river with a diversity index of 1.028. This shows that the diversity index is in the medium category. Moreover, the uniformity index (E) in this research is similarly classified as moderate with the index value ranging between 0.72 - 0.97. Besides, the dominance index from the finding of this research similarly belongs to the category of moderate pollution with the index value ranging between 0.33 - 0.81. Based on this index, the quality of waters in the Bolong river undoubtedly belongs to moderate pollution. Last but not least, several types of macrozoobenthos found include *Nemouridae, Leptophlebideae,*

Philopotamidae, Gerridae, Tubificidae, and Lymnaeidae. Thus, based on the results of this study, it can be recommended that the community and government jointly carry out rehabilitation and prevention of pollution in the Bolong River.

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