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COMMUNITY STRUCTURE AND DIVERSITY OF BENTHIC MACROINVERTEBRATES IN ALAM KANDUNG WATERFALL TULUNGAGUNG REGENCY

Desi Kartikasari[1*], Tutik Sri Wahyuni[2], Syaiful Amfri[3], Rafinda Herina Suci[4]

[1]Biology Education Department Faculty of Tarbiyah, UIN Sayyid Ali Rahmatullah Tulungagung
[2]Chemical Education Department Faculty of Tarbiyah, UIN Sayyid Ali Rahmatullah Tulungagung
[3]Biology Education Department Faculty of Tarbiyah, UIN Sayyid Ali Rahmatullah Tulungagung
[4]Biology Education Department Faculty of Tarbiyah, UIN Sayyid Ali Rahmatullah Tulungagung

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Corresponding Author
Desi Kartikasari,
desi.kartikasari88@gmail.com

ABSTRACT

This research aims to determine the profile of the community structure and diversity of benthic macroinvertebrates in Alam Kandung Waterfall. Sampling was carried out at six stations of ± 100 individuals or stations that use surber net and hand net. Data collection for each station includes the composition and density of each species which is used to calculate taxa richness, abundance, IVI (Important Value Index), and diversity index (H'). The results showed that 37 taxa from 11 classes were found and varied at each station. At the first station, the highest taxa were found with a total of 19 taxa, and the lowest taxa at the second station with 7 taxa. The highest abundance is known at the first station and the lowest at the sixth station. The IVI results show that the first and second stations are dominated by the type of *Sulcospira testudinaria* which is sensitive to pollutants, and the third station and fourth are dominated by *Tarebia granifera* and *Vellidae*. The fifth station was dominated by *Corixidae*, while *Thiara scraba* and *Atyidae* were found in all stations. The results of the diversity index show that the first and fourth are lightly polluted, the second station is moderately polluted and the rest are not polluted. It can be concluded that the quality of waterfalls in Alam Kandung is still in a good category, reflected by the diversity of taxa and the presence of riparian vegetation

Keywords:
Community Structure; Benthic Macroinvertebrates; Diversity; Alam Kandung Waterfall

1. INTRODUCTION

Water is a fundamental substance that is needed by all living things. However, under certain conditions water quality standard can be degraded. Various kinds of human activities through the use of water bodies can ultimately have the potential to harm reducing water quality (Setiawan, 2008) so it needs to be monitored regularly. Monitoring the quality of water can be carried out using physical-chemical and biological parameters. One of the biological parameters that can be used to monitor the quality of water is the use of benthic macroinvertebrate animals. Benthic macroinvertebrates can be used as bioindicators of water quality because they can provide an overview of the physical, chemical, and biological conditions of a body of water (Kartikasari,

2013). Benthic macroinvertebrate have also been used in several countries as biological indicators to assess the health status and ecological integrity of a body because benthic macroinvertebrates play an important role in the food chain system (Arimoro & Ikomi, 2008). Macroinvertebrates are also very sensitive to change in the environment and habitat characteristics caused by the existence of human activities both naturally and artificially (Kratzer et al., 2006; Kartikasari, 2013).

On the other side, Alam Kandung Waterfall is the main icon in the Alam Kandung tourism area located in Tanen Village, Rejotangan District, Tulungagung Regency. The waterfall with its original name Grojogan Sewu Waterfall has the characteristics of a water reservoir that is not too heavy has a height of 10 meters, and there is a whirlpool in the pool at the bottom of the waterfall (Wahyudi, 2020). With stunning natural charm, causing quite a lot of tourist visits to the location. This situation will affect the quality of the Alam Kandung. Moreover, until now the data and reports related to the quality of Alam Kandung Waterfalls have never been carried out. The research on the study of the community structure of benthic macroinvertebrate has also never been conducted at Alam Kandung Waterfalls. Based on these facts, it is necessary to research the community structure and diversity of benthic macroinvertebrates in Alam Kandung Waterfall to provide information about the profile of community structure and the diversity of benthic macroinvertebrates in Alam Kandung Waterfall, Tulungagung Regency.

2. METHOD

This research was conducted on October 13, 2018, at the location of Alam Kandung Waterfall in Tanen Village, Rejotangan District, Tulungagung Regency. The identification and calculation of benthic macroinvertebrate samples were carried out at the Biology Laboratory of the Biology Education Department, Faculty of Education and Teacher Training, Sayyid Ali Rahmatullah State Islamic University Tulungagung. A sampling of benthic macroinvertebrates was carried out at six stations located along the river flow of Alam Kandung Waterfall. Station I is under the bridge ±200 metres to the Southeast of the waterfall (8^{o}10.2680'S 112^{o}4.5490'E), Station II is ±5 metres north of station I (8^{o}10.2610'S 112^{o}4.5490'E), Station III is ±10 metres north of station II (8^{o}10.2510'S 112^{o}4.5630'E), Station IV is ±10 towards north of station III (8^{o}10.2340'S 112^{o}4.5610'E), Station V is ±10 metres north of the waterfall (8^{o}10.1720'S 112^{o}4.5600'E), and Station VI is ±15 metres north of the waterfall (8^{o}10.1580'S 112^{o}4.5630'E) (Figure 1).

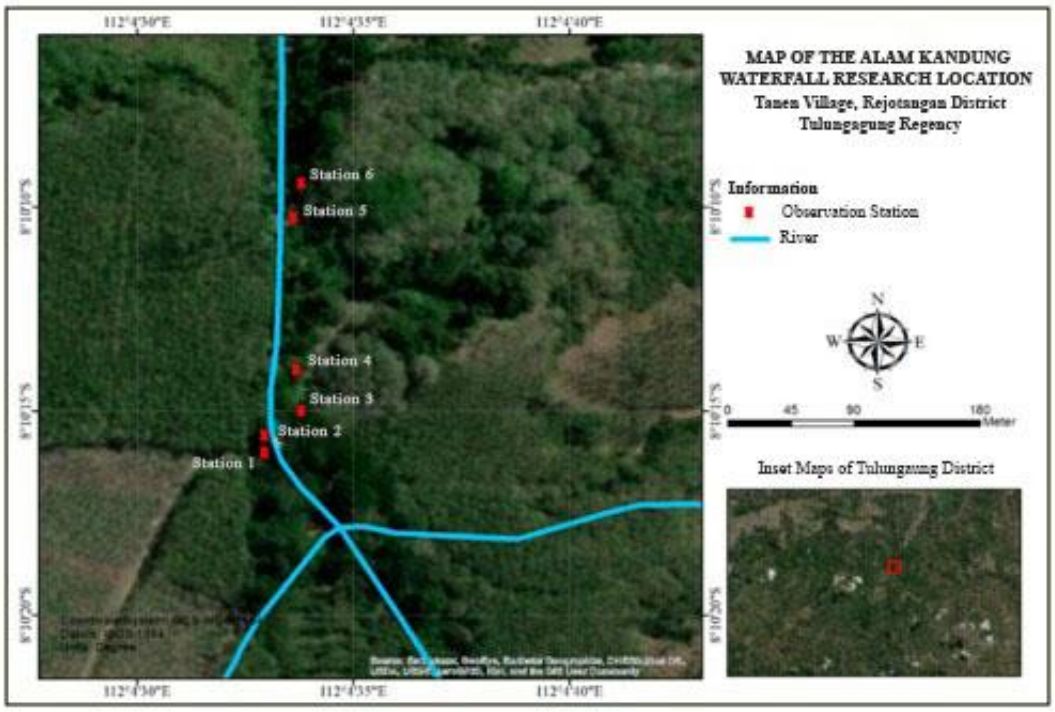

Figure 1. Location Map of Benthic Macroinvertebrate Research in Alam Kandung Waterfall, Tulungagung Regency

At each of these stations, three plots of benthic macroinvertebrate sampling were carried out as a test at about the same time in one day (Figure 2). The location of benthic macroinvertebrate sampling was taken at a predetermined location, namely in the substrate section in the middle of the river channel of Alam Kandung Waterfall taken using a surber net, while those found in the riparian vegetation area on the left and right of the river flow of Alam Kandung Waterfall were taken using a hand net. Samples of benthic macroinvertebrates were taken ± 100 individuals at each observation station (Mandaville, 2002). Furthermore, macroinvertebrate samples that have been taken will be observed using a microscope and identified based on the identification key (Jutting, 1956; Edmondson, 1959; Quigley, 1977; Ristiyanti et al, 2011). The value of the community structure is also determined, which includes the average value of abundance (A) and frequency (F) of each species per station on three sampling tests. Based on these data, further analysis was carried out to calculate taxa wealth, benthic macroinvertebrate abundance, important value index (IVI), and Shannon-Wiener diversity index (H') which can later be used to describe the profile of the benthic macroinvertebrate community structure.

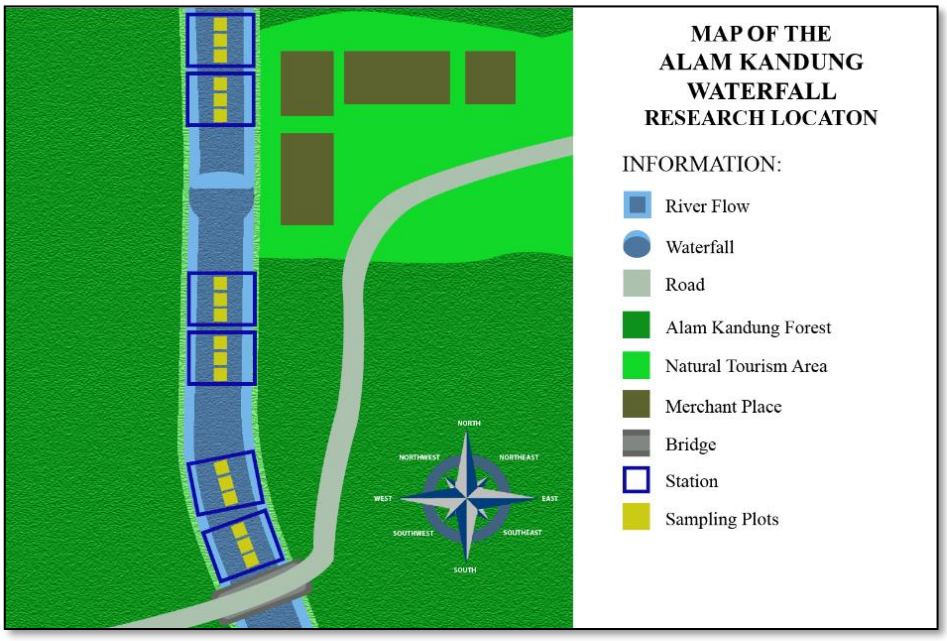

Figure 2. Bentos Macroinvertebrate Research Site Plan in Alam Kandung Waterfall, Tulungagung Regency

3. RESULTS AND DISCUSSION

The profile of benthic macroinvertebrates in Alam Kandung Waterfall, Tulungagung Regency is described by the community structure and diversity of benthic macroinvertebrates including taxa wealth, abundance, important value index (IVI), and Shannon-Wiener diversity index (H"). At all six stations, the study found 37 taxa from 11 classes and varied at each station (Table 1). The Gastropod class is seven taxa, the Ephemeroptera class is five taxa, the Coleoptera class is four taxa, the Lepidoptera class is one taxa, the Hemiptera class is eight taxa, the Odonata class is three taxa, the Decapoda class is three taxa, the Diptera class is three taxa, the Arhynchobdellida class is one taxa, the Tricladida class is one taxa and the Haplotaxida class is one taxa.

Table 1. Benthic Macroinvertebrate Community Structure found in Alam Kandung Waterfall, Tulungagung Regency

Ordo	Famili/Genus/Spesies	Station of Taxa
Gastropoda	*Melanoides tuberculata*	1,2,3
	Melanoides plicaria	1,2,3,4
	Tarebia granifera	1,3,4,6
	Thiara scraba	1,2,3,4,5,6
	Thiara winteri	1
	Sulcospira testudinaria	1,2,4,6
	Viviparidae/*Filopaludina javanica*	3,5,6
Ephemeroptera	Baetidae	1,5
	Leptophlebiidae	1
	Heptageniidae	1,3,5
	Metretopodidae	3
	Caenidae	3,5

Continued Table 1. Benthic macroinvertebrate community structure found in natural waterfalls in Tulungagung Regency

Ordo	Famili/Genus/Spesies	Station of Taxa
Coleoptera	Amphizoidae	1
	Elmidae	1,4
	Scirtidae	1
	Chrysomelidae	3
Lepidoptera	Pyralidae	1,4
Hemiptera	Gerridae/*Trepobates sp*	1,5
	Nepidae/*Ranatra sp*	1
	Corixidae/*Sigara sp*	3,5,6
	Mesoveliidae/*Mesovelia sp*	3,5,6
	Vellidae	3,4,5,6
	Hebridae/*Merragata sp*	6
	Hydrometridae	6
	Gerridae/*Gerris sp*	6
Odonata	Platycnemididae	1
	Coenagrionidae	1
	Epiophlebiidae	4
Decapoda	*Parathelpusa convexa*	1,2,3,5,6
	Atyidae	1,2,3,4,5,6
	Palaemonidae	2,3
Diptera	Tipulidae	3
	Pupa Culicidae/*Mosquito larvae*	5
	Chironomidae	5
Arhynchobdellida	Erpobdellidae	3
Tricladida	Planariidae	3
Haplotaxida	Naididae/Tubificidae	5

The results of the richness of taxa and the abundance of benthic macroinvertebrates found at each observation station showed variations at each station. Station one found the highest taxa of 19 taxa and the lowest taxa on station two of 7 taxa. The highest abundance is known at station one and the lowest at station six (Figure 3).

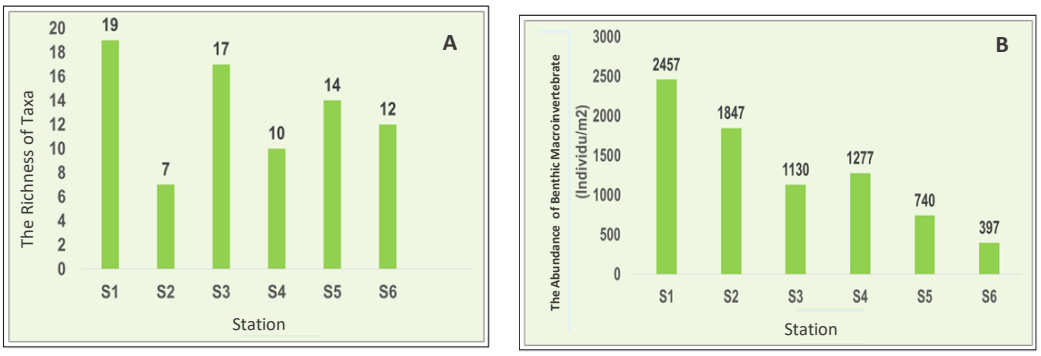

Figure 3. The richness of Taxa (A) and Total Abundance of Benthic Macroinvertebrates (B) found in Alam Kandung Waterfall, Tulungagung Regency

The increase in the number of taxa at stations one, three, and five is thought to be related to nutrient levels of organic matter derived from natural activities such as tree litter in the vicinity (riparian vegetation). Riparian vegetation acts as a phytoremidiator of pollutants, reducing extreme temperatures, protecting erosion pressures, controlling water flow, and providing a food supply for most deposit-eating benthic macroinvertebrates and organic matter (Oates, 2001). Meanwhile, the decrease in the number of taxa at station two is thought to be due to human activities utilizing the channel with the presence of merchant stalls around the channel and is also suspected to be related to an increase in the level of pollutants due to human activities around the observation station.

The highest abundance of benthic macroinvertebrates at stations one and two are because this station is dominated by the presence of *Sulcospira testudinaria* and *Thiara scraba* are very abundant organisms. *Sulcopira testudinaria* is a freshwater snail that can live both in clean water and acts as a biofilter that uses organic matter as a food source or feeder suspension (Suwignyo et al., 2005). While the lowest abundance lies at station six with the predominantly presence of the order Hemiptera and the order Decapoda such as the families Corixidae, Mesoveliidae, Veliidae, Hebridae, Hydrometridae, Gerridae, Atyidae and *Parathelpusa convexa* which are very few.

Based on the Important Value Index (IVI) shows that stations one and two are dominated by the type of organism *Sulcospira testudinaria* which is sensitive to pollutants. While the third and fourth stations are dominated by *Tarebia granifera* and *Vellidae*. Station five is dominated by *Corixidae*, while *Thiara scraba* and *Atyidae* are found at all stations (Figure 4).

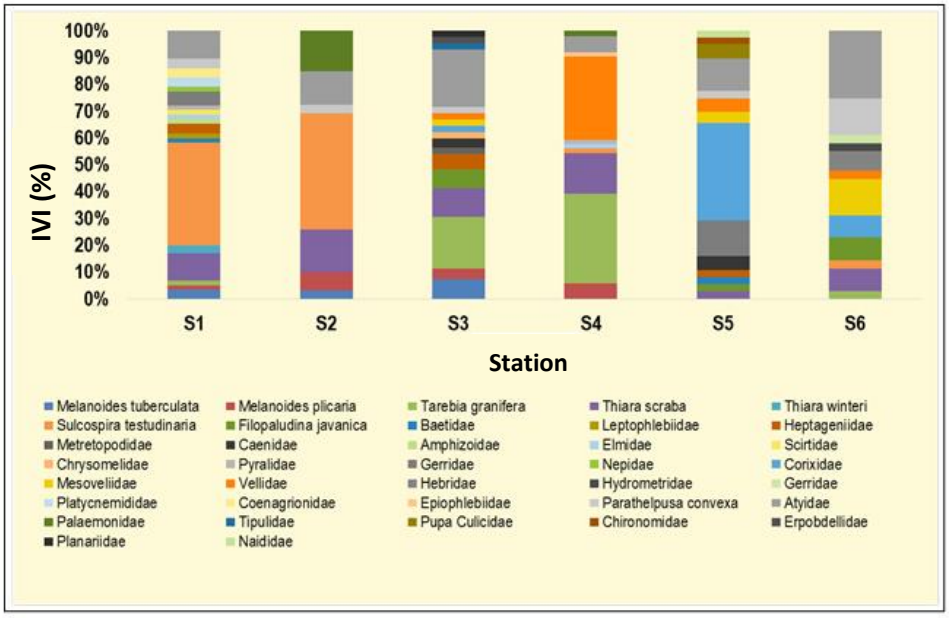

Figure 4. Important Value Index (IVI) Benthic Macroinvertebrate found in Alam Kandung Waterfall, Tulungagung Regency

The Important Value Index (IVI) indicates that a species has an important role in ecosystem stability, indicating that the *Sulcospira testudinaria* organisms that dominate at stations one and two have an important role in the ecosystem at Alam Kandung Waterfall. This species has a habitat in rivers or lakes that is calm or swift and sandy, rocky substrates, and like layers of organic matter such as leaf litter (Isnaningsih & Listiawan, 2010). This species depends on high oxygen levels in the surrounding waters, making it classified as sensitive to pollution (Kelly et al., 2017). Based on this, the species can show that the quality of the waters at Alam Kandung Waterfall is still in the good category.

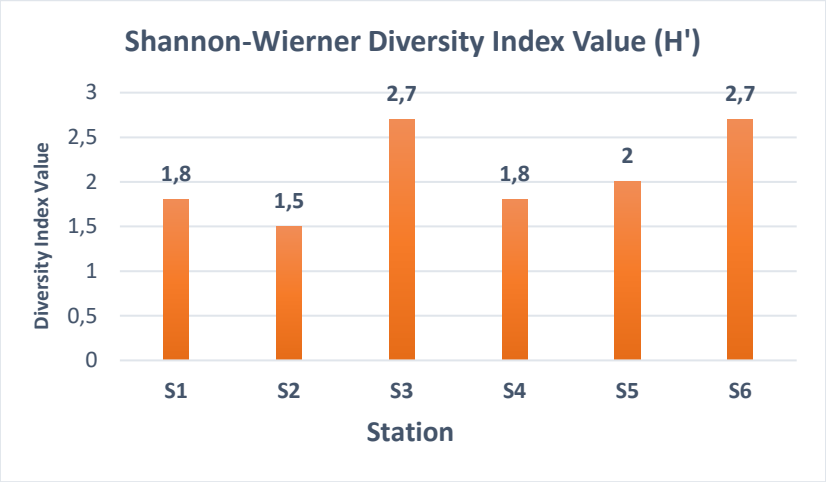

Figure 5. Shannon-Wiener Diversity Index Value (H') found at Each Station

The Shannon-Wiener Diversity Index (H') value is highest (2.7) at stations three and six, while the lowest diversity index (1.5) is at station two (Figure 5). The diversity index is an accurate index to show the level of pollution of a body of water due to the presence of toxic materials. The water quality at station two is thought to be influenced by the impact of human activities around the station because at that station there are merchant stalls that are often visited by tourists and is reflected in the value of the taxa wealth index at least at station two which is dominated by the presence of organisms *Sulcospira testudinaria* and *Thiara scraba*. *Thiara scraba* is an adaptive species and resistant to waste (Tarwotjo et al., 2018), it likes calm waters with muddy or rocky substrates and is often found attached to rocks at the bottom of river banks or attached to stems of riverside plants that are submerged in the air (Djajasasmitha, 1999). *Thiara scraba* is often found in abundant and widely distributed populations, this is because *Thiara scraba* has good adaptation or survival abilities in the process of competition with other types of snails in the same habitat (Isnaningsih & Listiawan, 2010).

Stations three, five, and six in the category have not been polluted because they have a heavy water flow, smooth sandy substrates, gravel, and pebble, thus the biotic components of the inhabitants of the substrate are generally organisms that can adapt to aquatic habitats with heavy currents. The diversity and density of macrobenthic fauna are generally higher on substrates dominated by pebble and gravel, white sand and mud are inhabited by lower diversity and benthic density (Kaller & Hartman, 2004). Stations three, five, and six show the category has not been polluted also because it has a heavy current and there is a lot of riparian vegetation along the waterfall flow. Riparian vegetation has several important benefits, including as a provider of energy sources, a provider of wood debris supply, shading, habitat for various types of fauna, a soil protector from erosion, a filter for sediment, phosphorus, organic nitrogen, so that water quality in water bodies are protected (Richardson et al., 2007). The difference in the values of the diversity index is also influenced by the current, depth, and availability of food.

4. CONCLUSION AND SUGGESTION

Conclusion

In Alam Kandung Waterfalls and its channels, 37 taxa from 11 classes are found and vary

from station to station. Station one found the highest taxa of 19 taxa and the lowest taxa on station two of 7 taxa. The highest abundance is known at station one and the lowest at station six. Based on the results of the Important Value Index (IVI) shows that station one and two are dominated by *Sulcospira testudinaria* types that are sensitive to pollutants, and station three, and four are dominated by *Tarebia granifera* and *Vellidae*. Station five is dominated by *Corixidae*, while *Thiara scraba* and *Atyidae* are found at all stations. Shannon-Wiener Diversity Index (H′) results show stations one and four are lightly polluted, station two is moderately polluted and stations three, five, and six have not been polluted. It can be concluded that the quality of waterfalls in Alam Kandung is still in the good category reflected in the diversity of taxa and the presence of riparian vegetation along the river flow of Alam Kandung Waterfall.

Suggestion

Based on the condition of the quality of the waterfall in Alam Kandung which is still in the good category reflected in the diversity of taxa and the presence of riparian vegetation along the river flow, it is necessary to make preventive efforts or mechanisms as an act to prevent the entry of pollutants to maintain the quality of water bodies so that they are always in optimal condition, considering that the essence of the waterfall is currently used as a natural tourism area which certainly has a high level of human activities, so that it has the potential to reduce the quality of waters.

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