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A Diversity of Copepods in Gajah Mungkur in Wonogiri Regency, Central Java, Indonesia

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Abstract *- Gajah Mungkur Reservoir is a freshwater ecosystem that is located 6 km south of Wonogiri Regency, Central Java Province. Zooplankton is the primary consumer in the food chain of aquatic ecosystems. One of the common zooplankton found in freshwater ecosystem is copepod. Copepod is sensitive organism and play an important role as bioindicatator of water quality. The aimed of this study was to investigate the copepods diversity in Gajah Mungkur Reservoir. The method applied to this study is exploration and application of purposive sampling techniques in sampling. Copepods were collected from three different station, namely Station 1 (fishing area), Station 2 (tourism area), and Station 3 (fish cage area or keramba). The abiotic parameters were found to be varied on each station. Results showed that Gajah Mungkur Reservoir has moderately diverse copepods species with the average of diversity index 1.21. There were 7 species of copepods found in Gajah Mungkur Reservoir which mostly dominated by Mesocyclops sp., especially in Station 1 (fishing area). Meanwhile Microcyclops sp. was only found in Station 3 (fish cage area or keramba), suggesting that this species has a potential as bioindicator in Gajah Mungkur Reservoir. This study suggest that changes in physicochemical parameters might influence the diversity and abundance of copepod in Gajah Mungkur Reservoir.*

Keywords: *Determination, Zooplankton, Copepod, Gajah Mungkur Reservoir*

INTRODUCTION

Gajah Mungkur Reservoir is located 6 km south of Wonogiri Regency, Central Java. This reservoir plays a pivotal role in Wonogiri Regency community development especially ecotourism as many tourists come especially at the weekend (Wisnu et al., 2019). Gajah Mungkur Reservoir has an area of 8,800 ha, which is mainly used for rice fields irrigation, power plants, drinking water sources, fish breeding and fishing (Sitharam, 2017) .

Gajah Mungkur Reservoir is one of the freshwater ecosystems. Many freshwater organisms, such as fishes, inhabit this area because there are many natural food sources such as plankton. Plankton are organisms that inhabit the water column and lives floating and hovering in waters with relatively passive motion. They have an important role in aquatic ecosystems as the base of the food chain. Basically, plankton consists of two major groups, phytoplankton (plant-like organisms) and zooplankton (small animal plankton).

Zooplankton is very small animals that float freely in the water surface like ponds, lakes and oceans, with sizes ranging from a few tens of microns (Protozoa) to >2 mm (Paterson, 2014). Zooplankton is the primary consumer in the aquatic ecosystems, grazing on phytoplankton. Therefore, zooplankton play an important role in transferring energy from primary producers (phytoplankton) to higher trophic levels in the aquatic ecosystems, such as fish larvae, and zooplankton predatory fish (Perbiche-Neves & Nogueira, 2013).

Zooplankton abundance is influenced by environmental conditions, such as water temperature, pH, DO, and light intensity (Mulyadi & Murniati, 2017). The decreasing of zooplankton abundance has an impact on the abundance of other consumers such as fish larvae and small fish.

The abundance of zooplankton can change in response to changes in the physical, biological, and chemical conditions of the waters (Rayshita, 2021). One of the common zooplankton that is found in freshwater ecosystem is Copepods, which is dominated by small crustaceans such as copepods, shrimps, and their larvae. Their size between 0.2 to 20 mm (mesoplankton) which are commonly microscopic in size and visible to the naked eye. Copepods is a food source for larger animal, such as some jellyfish (Setiawan et al., 2022). representing a link between primary producers and higher trophic levels in aquatic ecosystems. Copepods is sensitive to the effect of domestic waste (Goswami & Markondi, 2012), thus the diversity of Copepods is one of the bioindicator of water quality (Drira, et al., 2017). Hence, this study aimed to investigate the diversity of copepods in Gajah Mungkur Reservoir, Wonogiri Regency, Central Java.

MATERIALS AND METHOD

1. Study site

This study was conducted in the Gajah Mungkur Reservoir, Wonogiri Regency, Central Java. The sampling stations is divided into three areas such as fishing area (Station 1), tourism area (Station 2) and fish cage area or *keramba* (Station 3) (Fig. 1) in which in each station was consists of three sub-stations. The distance between sampling stations was 500 m apart the distance between sub-stations was 10 m apart. The sampling stations assumed the whole area of reservoir. The sampling stations were determined by purposive sampling method based on the locations in which the community activities were estimated to influence the presence of zooplankton. This research was conducted from January to June 2019.

2. Sample collection

Sampling was conducted from January to June 2019. Copepods samples were collected using plankton net with 70 – 200 µm mesh to sample the Copepods size > 80 µm with three sample replicates. The samples were collected at the depth 5-7 m obliquely through the water using speed boat for each station modified by (Santhosh et al., 2018). Surface water profile such as air temperature (°C) and humidity (%) were measured at each sampling station using a digital thermohygrometer. Water samples were also collected at the depth 3 m to determine the water temperature (°C), current velocity (m/s), water brightness (m), and pH. All samples were transferred to Biology Education Laboratory, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta.

In the laboratory, each sample was placed in beaker glass. A Sedgewick Rafter Counting Cells was used for total counts. Copepods were identified to genus level based on "*Identification Handbook of Freshwater Zooplankton of the Mekong River and its Tributaries*".

3. Data analysis

The diversity of copepods in Gajah Mungkur Reservoir was calculated using Shannon-Wiener diversity index (H') (Shannon, 1948). The correlation between Copepods diversity and environmental conditions was analyzed using Pearson correlation.

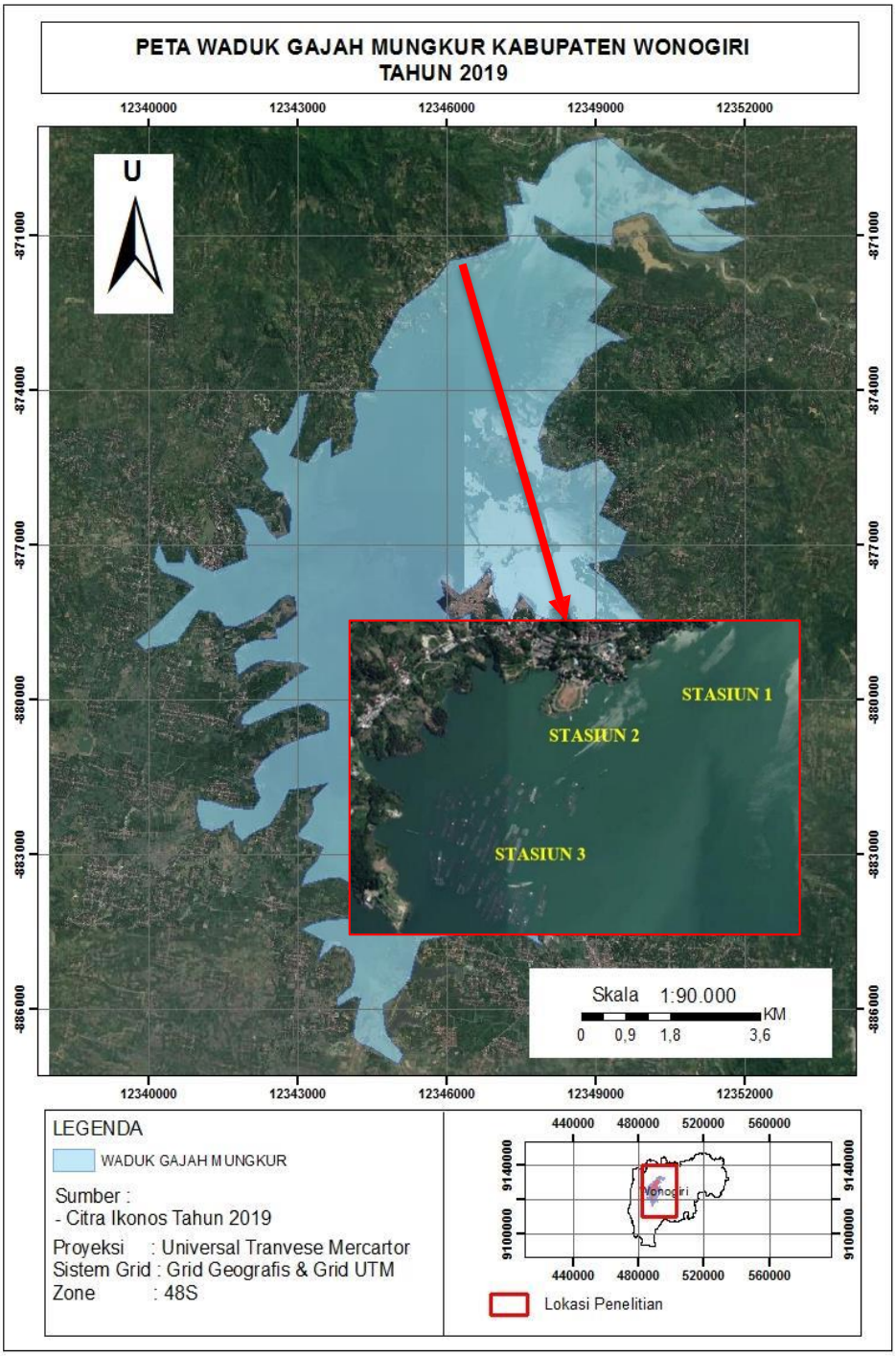

Figure 1. Sampling stations in Gajah Mungkur Reservoir, Wonogiri Regency, Central Java, that consist of three areas: Station 1 (fishing area); Station 2 (tourism area); and Station 3 (fish cage area or *keramba*) (Source: Citra Ikonos 2019)

RESULTS and DISCUSSION

1. Physicochemical parameters of Gajah Mungkur Reservoir

Humidity and Air Temperature. The result showed that Station 3 (fish cage area or *keramba*) has the highest humidity (59%), followed by Station 2 (tourism area; 49%) and Station 1 (fishing area; 44.33%) (Table 1). Meanwhile air temperature showed inverse order in which the highest air temperature was observed at Station 1 (fishing area; 33.63 °C), followed by Station

2 (tourism area; 33.16 °C) and Station 3 (fish cage area or *keramba*; 32.3 °C) (Table 1). Humidity and air temperature is known to have an inverse relationship. If the humidity increases, air and water temperature.

Water Temperature. The water temperature was quite similar in all stations (about 33 °C) (Table 1). Temperature is one of the important physical factors that affect the physiology of plankton. Water temperature is generally warmer during the daytime due to exposure to solar radiation. Higher water temperature could also decrease the oxygen solubility in the water. Previous study showed that optimum water temperature that is good for the reproduction of plankton in summer ranges from 25 – 28 °C (Perbiche-Neves & Nogueira, 2013). The upper temperature limit for plankton was around 30 °C. Therefore, water temperature measured in this study might already exceed the optimum temperature limit for zooplankton, thus zooplankton is rarely found on the surface of the water (Drira et al., 2018).

pH. The water pH in Gajah Mungkur Reservoir was ranged from 6 to 7 (Table 1). The water pH is known influenced by the biological activity of aquatic biota through photosynthesis and respiration activities. Photosynthesis assimilates CO_2 from the water, thus increase the pH of the water, while respiration releases CO_2 to the water, thus decrease the pH of the water. The pH value in Gajah Mungkur reservoir was considered still in a normal range for freshwater ecosystems, thus suggested still capable supporting healthy aquatic biota that inhabit Gajah Mungkur Reservoir (Rayshita, 2021).

Current Velocity. The current velocity in Gajah Mungkur Reservoir were 0.01 m/s in Station 1 (fishing area) and Station 3 (fish cage area or *keramba*) and 0.05 m/s in Station 2 (tourism area) (Table 1). The current velocity was higher in Station 2 because in this area there is a water tourism using a motorboat which caused faster current velocity. This condition was suggested to create turbulence thus to widely spread the plankton distribution in the waters (Wisnu et al., 2019).

Table 1. Physicochemical parameters of the Gajah Mungkur Reservoir, Wonogiri Regency, Central Java

No	Parameter	Station 1	Station 2	Station 3
1	Humidity (%)	44.33	49	59
2	Air temperature (°C)	33.63	33.16	32.3
3	Water temperature (°C)	33.1	33	33
4	pH	7	6	6
5	Current velocity (m/s)	0.01	0.05	0.01
6	Brightness (m)	1.31	1.13	1.19
7	DO (mg/L)*	6.94	6.94	4.46
8	BOD (mg/L)*	4	4	5.04

Source : *Pujiastuti, et al., 2013

2. Copepods diversity and abundance

A total of 7 species of copepods were found in Gajah Mungkur Reservoir. The copepods diversity in Gajah Mungkur Reservoir was varied from low diversity in Station 2 [Shannon-Wiener diversity index (H') 0.85, Table 2] to moderate diversity in Station 1 and 3 [Shannon-Wiener diversity index (H') 1.45 and 1.32 for Station 1 and 3, respectively, Table 2]. This result showed

that the copepods in Gajah Mungkur Reservoir was moderately diverse with the average of Shannon-Wiener diversity index (H') value was 1.21.

The copepods composition in Gajah Mungkur Reservoir were grouped into five families which was dominated by Family Cyclopidae 42.86% as many as 3 species, namely *Mesocyclops* sp., *Thermocyclops* sp., and *Microcyclops* sp. While the other families such as Acartiidae (namely *Acartiella* sp.), Diaptomidae (namely *Neodiaptomus* sp.), Centropagidae (namely *Sinocalanus* sp.), and Pseudodiaptomidae (namely Pseudodiaptomus sp.) each comprised 14.29% of total copepods composition in Gajah Mungkur Reservoir.

Copepods in Gajah Mungkur Reservoir were mostly found at Station 1 (fishing area; 28 individuals), followed by Station 2 (tourism area; 15 individuals) and Station 3 (fish cage area or *keramba*; 8 individuals) (Table 2). *Mesocyclops* sp. is the most abundance species that can be found in all stations, especially at Station 1 (fishing area) (Table 2). This genus is one of the largest cyclopid genera that commonly found in lake plankton communities (Perbiche-Neves & Nogueira, 2013).

The copepods occurrence was suggested to be affected by the physicohemical parameters in each station. In this study, copepods *Acartiella* sp. and *Neodiaptomus* sp. were only found in Station 1 (Table 2). Station 1 is a fishing area and considered as the least disturbed area compared with Station 2 and 3. The physicohemical parameters such as pH, current velocity, brightness in the Station 1 compared to the Station 2 (tourism area) and the Station 3 (fish cage area or *keramba*). Previous study showed that genus *Neodiaptomus*, such as *N. handeli*, was usually dominant at waters with high food availability such as phytoplankton (Mulyadi & Murniati, 2017).

On the other hand, copepod *Microcyclops* sp. was only found at Station 3 where the fish cage or *keramba* is located (Table 2). Previous study suggested that Station 3 (fish cage area or *keramba*) has the lowest water quality showed by the lowest DO (4.46 mg/L) and highest BOD (5.04 mg/L) values compared with Station 1 (fishing area) and Station 2 (tourism area) (Pujianti et al., 2013) (Table 1). This condition might be influenced by leftover fish foods that might contaminated the surrounding water. Previous study showed that *M. anceps* was suggested occurred in higher abundance in the eutrophic reservoirs. Therefore, it is suggested that *Microcyclops* can be a bioindicator of eutrophic reservoirs in freshwater ecosystems (Perbiche-Neves & Nogueira, 2013).

Additionally, another physicochemical characteristic such as current velocity was also suggested to be affected the copepods abundance in Gajah Mungkur Reservoir. In this study, Station 2 has the highest current velocity compared with other stations (Table 1). Station 2 was identified as tourism area in which motorboats were mainly used for water tourism activities. The motorboats could increase the current velocity and mix the waters. As the water current plays an important role in the migration and distribution of zooplankton (Perdana, 2016), the presence of motorboats activities might help in copepods distribution in Gajah Mungkur Reservoir. However, this study showed that Station 2 has relatively lower copepods occurrence. Therefore, it is suggested that the presence of waterboats could agitate the water and decrease the copepods occurrence (Mulyadi & Murniati, 2017).

Table 2. Copepod abundance in each Station in Gajah Mungkur Reservoir, Wonogiri Regency, Central Java

No	Family	Copepod species	Station 1 (fishing area)	Station 2 (tourism area)	Station 3 (fish cage area or *keramba*)
1		*Mesocyclops* sp.	11	9	1
2	Cyclopidae	*Thermocyclops* sp.	0	5	2
3		*Microcyclops* sp.	0	0	3
4	Acartiidae	*Acartiella* sp.	3	0	0
5	Diaptomidae	*Neodiaptomus* sp.	2	0	0
6	Centropagidae	*Sinocalanus* sp.	7	0	2
7	Pseudodiaptomidae	*Pseudodiaptomus* sp	5	1	0
Total individu of Copepods			**28**	**15**	**8**
Diversity index (H')			**1.45**	**0.85**	**1.32**

CONCLUSION

A total of 7 copepod species were found in Gajah Mungkur Reservoir in which *Mesocyclops* sp. was found to be a dominant species. Additionally, *Microcyclops* sp. that was only found in Station 3 (fish cage area or *keramba*) has a potential as a bioindicator of water quality in Gajah Mungkur Reservoir. Overall, the present study suggested that Gajah Mungkur Reservoir has moderately diverse copepods species in which the diversity and abundance of copepods might be influenced by the physicochemical parameters of the water.

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