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THE RELATION BETWEEN ZOOPLANKTON ABUNDANCE AND WATER QUALITY IN JATIGEDE RESERVOIR

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Jatigede Reservoir, Relation, Trophic Status, Water Quality, Zooplankton abundance

ABSTRACT

Jatigede reservoir is a reservoir in West Java Province located in Semedang District. This research aims to determine the relationship of zooplankton abundance with water quality, in order to support the management of the Jatigede Reservoir as sustainable capture fisheries area. This method used in this research was purposive sampling. Research was conducted in June - September 2018, sampling was carried out in four stations with six times repetitions. The result showed that zooplankton community in Jatigede Reservoir were 23 species consisted of 5 phylum. Zooplankton abundance ranges from 524 - 7,423 individuals / liter. Based on the abundance of zooplankton, Jatigede Reservoir is classified into waters which have moderate (mesotrophic) fertility levels with water quality parameters that fall into the class II and III categories that support zooplankton life. Diversity index (H ') is 1.54 which belong to the category of moderate diversity and evenness index (E) is 0.25 which belongs to the category of low evenness. Zooplankton correlation coefficient (R) is 0.733[a] with a coefficient of determination (R2) 53.8% indicating a strong relation between zooplankton abundance and water quality.

INTRODUCTION

Jatigede reservoir is a reservoir in West Java Province located in Semedang District. The construction of Jatigede reservoir was conducted by stemming Cimanuk River. Capacity of Jatigede reservoir was about ± 980 millions m^3, with volume surface flow was 2.0 billion m^3/year (BBWS Cimanuk-Cisanggarung 2017). The Jatigede Reservoir has multinational functions including irrigation, flood control, electricity and raw water builders for the Sumedang, Indramayu, and Cirebon areas including Kertajati Airport (BBWS Cimanuk-Cisanggarung 2017).

As a multi-functional water body in West Java Province, the Jatigede Reservoir does not yet have complete water quality data including data on the abundance of zooplankton and its composition which is one indicator of water quality. Zooplankton is an aquatic organism that has weak swimming power and floats in the water column (Ferdous and Muktadir 2009). According to Rahayu (2013) the fertility and stability of a waters can be seen from the diversity and abundance of zooplankton. This research is important to do in order to know the relationship between the abundance of zooplankton and the water quality in the Jatigede Reservoir. This research is carried out to obtain a number of information that can be used as basic data to support the determination of the Jatigede reservoir management and its development policy in a sustainable manner.

METHODS

Research Time and Place

This research was conducted in Jatigede Reservoir Sumedang District. Method used in this research was purposive sampling. Measurement of water quality was conducted in in situ and ex situ. Insitu measurement consists of temperatur, transparency, pH, and DO sample. Ex Situ measurement consists identification of zooplankton. This research was conducted in June - September 2018. Samples were taken in 4 stations, with 6 times of repetitions. Research located at:

-Station 1, is the Jatigede Reservoir inlet located in Sukamenak Village, Darmaraja District, obtaining water input from the Cimanuk River, Cimuja River, Cibelah River, Cialing River, and Cijajaway River.
- Station 2, is a captured fisheries area, located in Leuwihideung Village, Darmaraja District and received water from the Cihonje River.
- Station 3 is located in Jemah Village, Jatigede District, received waters from the Cinambo River.
- Station 4, is Jatigede Reservoir's dam which located in Cijeungjing Village, Jatigede District.

The location of the research station can be seen in Figure 1.

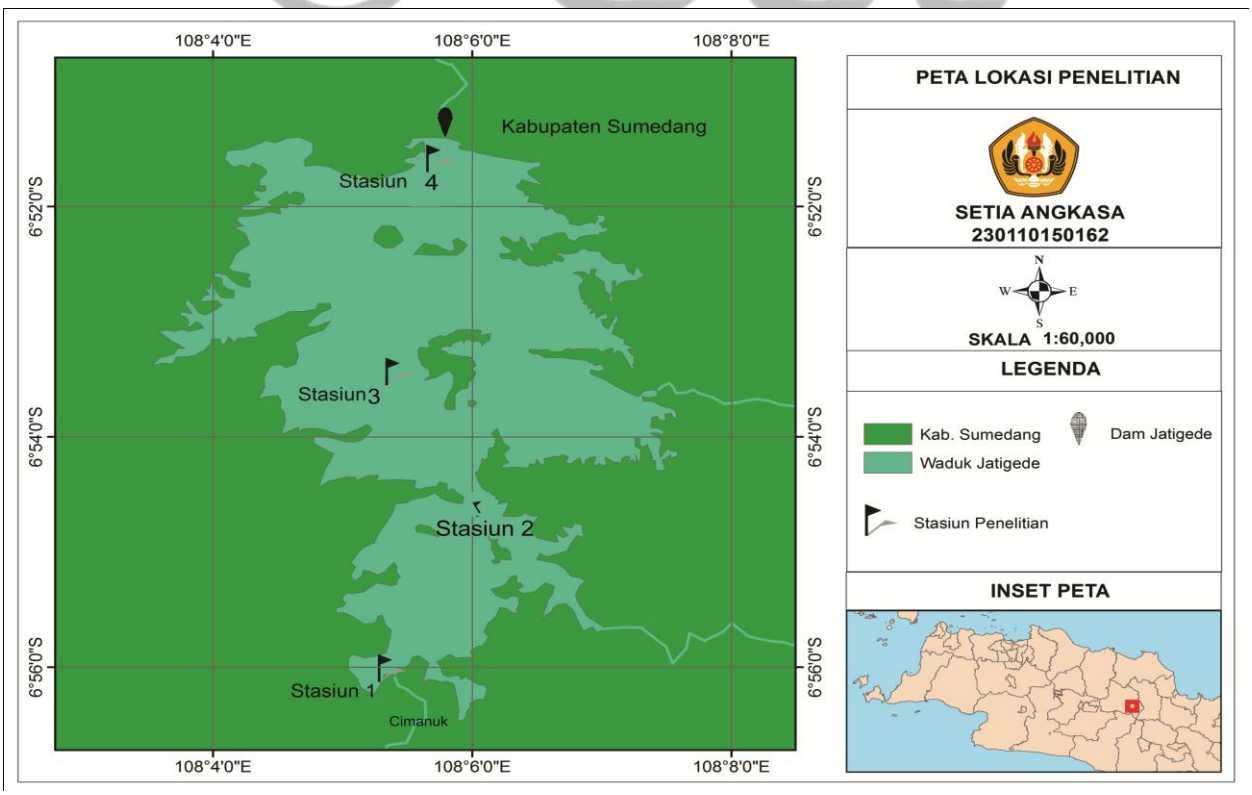

Figure 1. Map of Research Location

Tool and Material

Device/tools used in this research were Plankton net number 20 µm, GPS (Global Positoning System), sample bottle, secchi disc, thermometer, pH meter, DO meter (0.1 mg/1), winkler bottle, cool box, dropper pipette, binocular microscope, counting chamber, cover glass and Book of Fresh Water Bellinger & David C. Sigee.

Zooplankton Abundance

Determination of plankton abundance was carried out based on the segwick rafter's method of sweeping over the glass of object. Calculate the abundance of equations as follows (APHA 2017):

Abundance= $N\ x\ multiplier$

Multiplier = $\frac{consentrated\ V}{\boldsymbol{Calculated\ V}} \times \frac{1\ litre}{\boldsymbol{strained\ V}}$

Information:

N = number of all individual type

Diversity Index

The diversity index is calculated using the Shannon-Wiener formula (ALPHA 2017) as follows:

$$H' = -\Sigma(pi) \times (lnpi)$$

Information :

H' =Diversity index Shanon-Winner

Pi =Proportion The number of individuals in a species divided by the total number of individuals

Categories of diversity according to Whilm and Dorris (1968) as follows:

H' < 1 = Low diversity * description

1 < H' < 3 = Moderate diversity

H' > 3 = High diversity

Evenness index (E)

The evenness index is calculated by the Pielou formula (Heip *et al*. 1998), as follow:

$$E = \frac{H'}{Log\ S}$$

Information :

The index value of evenness is distinguished by categories:

E < 0,4 = Low evenness (depressed community)

0,4 ≤ E ≤ 0,6 = Medium evenness (labile community)

E > 0,6 = High evenness (stabile community)

Relation Analysis

Relation Analysis is used to see the relation between zooplankton abundance with water quality parameters, while the analysis used using Annova and multiple linear regression with SPSS application version 20. Multiple linear regression is used to analyze the relationship of several physical, chemical parameters to zooplankton abundance at each station (Mattjik and Sumertajaya 2000). The functional relation model is presented as a relation between water quality and zooplankton abundance.

$Y = a + b_1x_1 + b_2x_2 + \ldots + b_ix_i$

Information: y = zooplankton abundance (ind/liter)

A = regression coefficient

b = intercept

Zooplankton x_i = independent variable (temperature, abundance of phytoplankton, pH, DO)

RESULT AND DISCUSSION

Abundance, Diversity, and Evenness of Types of Zooplankton

Zooplankton identified in the Jatigede Reservoir waters during the research amounted to 23 species from 5 phylum, namely Rotifera, Ciliata, Copepoda, Cladocera, and Protozoa. The abundance of zooplankton in the Jatigede Reservoir can be seen in the table.

Tabel 1. Average abundance at each Observation Station

No	Phylum	Species	The average abundance of each station			
			1	2	3	4
1		*Keratella serrulata*	5.276	1.163	70	157
2		*Keratella valga*	451	115	99	105
3		*Brachionus angularis*	94	111	6	30
4		*Brachionus falcatus*	15	137	9	7
5		*Brachionus calyciflorus*	1	8	0	0
6		*Brachionus bidentata*	7	6	4	29
7		*Filinia sp.*	126	172	3	1
8	Rotifera	*Trichocerca* sp.	119	146	26	136
9		*Polyarthra* sp.	872	370	204	371
10		*Philodina* sp.	3	4	4	0
11		*Notholca* sp.	82	0	0	0
12		*Cephalodella* sp.	1	1	2	0
13		*Lepadella* sp.	1	1	0	0
14		*asplachna brightwelli*		1	0	1
15		*Monostyla lunaris*	0	0	0	1
1	Ciliata	*Epistylis* sp.	9	5	21	8
1	Copepoda	*Cyclops* sp.	1	3	3	7
2		*Nauplii* sp.	2	7	49	107
1	Cladocera	*Moina* sp.	2	0	0	2
1		*Difflugia* sp.	179	127	20	41
2	Protozoa	*Arcella* sp.	3	2	3	0
3		*Centropyxis* sp.	2	0	0	0
1	Ciliophora	*Chilodonella* sp.	1	0	0	0
Abundance *(Ind/l)*			7.243	2.378	524	1.001
*H' (*Diversity Index*)*			1,35	1,43	1,51	1,66
*E (*Evenness Index*)*			0,2	0,22	0,24	0,26

The average abundance of zooplankton in the Jatigede Reservoir ranges from 524 - 7,243 individuals/liter with an overall average of 2,787 individuals/liter. Stations that have the highest abundance average are station 1 at 7,243 individuals/liter and the lowest is station 3 with an average abundance of 524 individuals/liter. According to Landner (1978) fertility based on plankton abundance are divided into three, namely oligotrophic with an abundance of plankton 0-200 individuals/liter, mesotrophic with plankton abundance ranging from 2,000-15,000 individuals/liter and eutrophic with plankton abundance of more than 15,000 individuals/liter. Based on the classification of Landner et al. (1987), the Jatigede Reservoir waters included in the water category with mesotrophic fertility levels.

The zooplankton diversity index (H') is equal to 1.54, which ranges from 1.35 to 1.66. Wilhm and Dorris (1986) state that the diversity index criteria are divided into 3 categories, namely, H '<1 means low diversity, 1 <H '<3 means moderate diversity and if H'> 3 then the species diversity is high. Based on the classification according to Wilhm and Dorris (1986) zooplankton in the Jatigede Reservoir fall into the category of moderate species diversity. The diversity index of zooplankton in Jatigede Reservoir can be influenced by the amount of nutrients, predators and physical-chemical parameters at each station.

Zooplankton's evenness index (E) average in Jatigede Reservoir is 0.25 with a range of 0.06-0.35. This value shows the evenness of zooplankton types in the Jatigede Reservoir is low because of E <0.4. Species that contribute greatly to the abundance of zooplankton are Keratella serrulata and Polyarthra sp originating from the phylum of Rotifera. This is because the Rotifera phylum has the most widespread species distribution in the Reservoir. This is supported by the statement of Zamroni et al. (2000), that phylum Rotifera is a large group commonly found in freshwater. Rotifers are also commonly found because species from this phylum have a stronger resistance than other species of phyla to changes in temperature, pH and changes in other environmental parameters. Rotifers have morphological adaptations to avoid predators, namely mucous sheaths to escape prey. Besides according to Stemberger et

al. (1987), Rotifers have a fast life cycle reproducing without fertilization and all eggs hatch into females, so that the spread in the waters is quite extensive.

Parameter of Water Quality

Table 2. Parameter of Water Quality

Unit Parameters		Stasiun 1	Stasiun 2	Stasiun 3	Stasiun 4	Standard Quality PP No. 82 of 2001 Class II	Standard Quality PP No. 82 of 2001 Class III
Temperature (^{0}C)	K	24,8-27,2	25,9-27,7	25 - 28,7	25 -26,7	Deviation 3*	Deviation 3*
	R	26,21	26,7	26,5	26,66		
		±0,89	±0,58	±1,29	±1,23		
transparency (cm)	K	22,5-85,5	57,3-158,5	114,2-224,3	92,8-185,6	-	-
	R	49,06	105,55	150,3	149,15		
		±23,90	±35,84	±41,42	±34,39		
pH	K	6,67-7,54	6,84-8,04	6,94 - 8,11	6,78-8,4	6 – 9	6 – 9
	R	7,14	7,51	7,62	7,76		
		±0,36	±0,54	±0,42	±0,59		
DO (mg/l)	K	2,3 - 4,4	3 - 6,7	4,4 - 5,5	4,2 - 6,5	4	3
	R	3,56	5,05	5,08	5,71		
		±0,76	±1,28	±0,39	±1,17		
abundance of phytoplankton (inviduals/liter)	R	299.605	193.831	101.333	120.802		
Abundance of zooplankton (inviduals/liter)	R	7.243	2.378	524	1.001		

Information: k=range, r= average

Based on observations of temperature at each station it is known that the temperature of the Jatigede Reservoir ranges from 24.8 ° C-28.7 ° C with an average of 26.5 oC. The temperature is still in the optimum range of zooplankton life. The zooplankton optimum life temperature range is between 20-30ºC (Effendi 2003). One of the factors that affect temperature is transparency of light. This is because light has a direct effect on temperature, which means that the high light intensity will produce heat which in turn will increase the temperature and vice versa (Zahidah 2017). Light transparency measured in the Jatigede Reservoir during the research ranged from 22.5 - 224.3 cm with an average of 113.51 cm. The higher the transparency of the light, the easier the light to enter into the waters, and conversely the lower will inhibit photosynthesis by phytoplankton which become zooplankton food sources.

The Degree of Acidity (pH) in the waters of the Jatigede Reservoir ranged 6.72 - 8.21 with an average of 7.5. Aquatic organisms are sensitive to changes in pH. According to Zahidah (2017), the pH in a water body can affect the production of zooplankton. Putra et al. (2012) stated that the acidity of waters ranging from 7-8 is still ideal for zooplankton life and allows the development of animals in these waters. Based on the statement of Putra et al. (2012), the pH of the Jatigede Reservoir waters is still at the optimum life condition of zooplankton.

Dissolved oxygen (DO) is an important parameter in waters and is a limiting factor for zooplankton life. Stations that have the highest DO average are station 4 and the lowest station 1. DO levels that can cause death in aquatic organisms are less than 2 mg /l (Effendi 2003). Based on this statement, DO levels in the Jatigede Reservoir are still in accordance with the life of zooplankton.

In general, the results of measurements of water quality parameters of the Jatigede Reservoir waters fall into the categories II and class III, including PP No. 82 of 2001. Waters with class II and III water quality can be used for fishing activities and are not harmful to aquatic organisms. Based on this, the water quality of Jatigede Reservoir supports zooplankton life.

Based on Table 2, it can be seen that the stations that have the highest abundance of zooplankton is station 1. The cause of the high abundance of zooplankton at station 1 is because it is the inlet of the Jatigede Reservoir which receives a lot of nutrient input compared to other stations. The higher the nutrient it will spur phytoplankton growth which is a food source for zooplankton. The high abundance of zooplankton at station 1 is thought to be related to the presence of phytoplankton, where at station 1 the abundance of phytoplankton is also the highest. According to Hutabarat and Evans (2000) zooplankton which is herbivores eat phytoplankton directly. Based on this statement, the high zooplankton abundance at Station 1 is due to the availability of large quantities of food.

The station that has the lowest abundance of zooplankton is station 3. The low abundance of zooplankton at Station 3 is estimated due to the low abundance of phytoplankton at this station. Faiqoh et.al (2015) stated that when the number of phytoplankton decreases, the amount of zooplankton will decrease due to lack of food. The abundance of zooplankton is also influenced by predators such as zooplankton-eating fish. Availability of phytoplankton and zooplankton-eating fish affects zooplankton populations (Wayudiati et al. 2017).

The Relation Between Zooplankton Abundance and Water Quality

Based on the analysis of the statistical test of the relation of zooplankton abundance (dependent variable) with phytoplankton abundance parameters, temperature, pH, DO (independent variables), it was found that the correlation coefficient (R) was 0.733a. This value shows that there is a strong correlation between zooplankton abundance and water quality because it is in the interval of 0.60 - 0.79 (Sugiyono 2005). The coefficient of determination (R2) obtained is 0.538. This value shows that as much as 53.8% of zooplankton abundance is influenced by variables of temperature, DO, pH and abundance of phytoplankton while for 46.1% zooplankton abundance is influenced by other unknown variables (inherent).

Then the multiple linear regression model is obtained as follows:

$$\mathbf{Y= -19.873{,}564 + 0{,}027phythoplankton + 469{,}486_{temperature} - 1.005{,}089_{DO} + 1.366{,}097_{pH}}$$

The multiple linear regression model shows that there are parameters that have a direct relation, which includes those that are positive such as phytoplankton abundance, temperature, and pH. Zahidah (2017) states that pH in a body of water can affect zooplankton production. This is because each species has a different tolerance to pH so that changes in pH can cause changes in zooplankton abundance.

The effect of the presence of phytoplankton on zooplankton abundance is when the number of phytoplankton decreases, the amount of zooplankton will decrease due to lack of food (Faiqoh et.al 2015). Damayanti et al (2017) stated that phytoplankton that grows well causes food availability for zooplankton so that the abundance of zooplankton becomes abundant. It can be concluded that besides the parameters of water quality, zooplankton abundance is strongly influenced by the abundance of phytoplankton.

Conclusion

The zooplankton community of the Jatigede Reservoir in June-September 2018 consists of 23 species, which are from 5 phylum. The average abundance of zooplankton ranges from 524 - 7,423 individuals/liter, based on the abundance of zooplankton the waters of the Jatigede Reservoir are at mesotrophic fertility levels. The Jatigede Reservoir Zooplankton has a moderate diversity (H ') which is equal to 1.54 and a low evenness (E) is 0.25. The quality of water in the Jatigede Reservoir is included in the class II and III categories which can be used for fishing activities and support the life of zooplankton. 53.8% of zooplankton abundance is influenced by water quality parameters (phytoplankton, temperature, DO, and pH), indicating that the abundance of zooplankton has a strong relationship with water quality.

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