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Comparison of Pollution Level at Jangkok River Estuary and Ancar River Estuary Using Periphyton Bioindicators

Syamsul Bahri[1,2] Priyo Hartanto[1], Anak Agung Ayu Diah Kusumadewi[1], Halimatusa'adiah[1], Bung Ashabul Kahfi[1]

[1]Sciences Education, Mataram University, Indonesia
[2]Biology Education Study Program, FKIP, Mataram University, Mataram, Indonesia

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Corresponding Author:
Syamsul Bahri
syamsulsalihu@gmail.com

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Abstract: Water quality can be determined using various parameters such as physical, chemical and biological parameters. In this study, researchers used biological parameters, namely using periphyton organisms as bioindicators of water pollution. The aims of this study were to determine the abundance and diversity index of periphyton species in the Jangkok and Ancar rivers, to determine the periphyton species found in the Jangkok and Ancar rivers, and to determine the water quality of the Jangkok and Ancar rivers based on periphyton bioindicators. Sampling was only at the mouth/downstream of the Jangkok and Ancar rivers. Periphyton sampling at each location was carried out three times in the downstream part of the river. The division is located on the right, middle and left bank of the river body. At each of the three sample locations, 1 sample of the substrate will be taken, namely in the form of stones submerged under the surface of the river water, so that the total samples taken are 9 samples. The data obtained then calculated the Abundance Value and Diversity Index in order to get a value in determining the Quality of River Pollution. Periphyton abundance values in the Jangkok and Ancar rivers were 30,116 and 4,948 cells/cm^2, then the periphyton species diversity index in the Jangkok and Ancar rivers were 2,021 and 2,329. The temperature values obtained at both locations ranged from 22-25 ^{0}C with a pH ranging from 7.8-8.3. The water quality of the Jangkok River and Ancar River is based on the index value of species diversity, including in the category of light pollution/unpolluted which means that fertility can be utilized. So that people need to keep paying attention to the cleanliness of the environment for the sake of survival in the future.

Keywords: Abundance value; Diversity index; Periphyton Bioindicato; River pollution.

Introduction

River is a flowing ecosystem with one-way movement of water. River ecosystems are usually characterized by the presence of heavy water flows, so they are classified as flowing water ecosystems (Soemarwoto, 2003). In river ecosystems there are biotic and abiotic components that need each other (Barus et al., 2014). One of the biotic components that play a significant role in a river ecosystem is periphyton.

Periphyton has an important role in an ecosystem because it can function as natural food for several types of invertebrates, fish and livestock, as a raw material for biologically treating wastewater, as a contributor to oxygen in aquatic ecosystems and plays an important role in the food chain (Soeprobowati, 1999; Pratiwi, 2005). Addition, periphyton is a group of living things that can quickly respond to environmental changes that occur. The presence of periphyton can describe these environmental changes because their presence in relatively sedentary waters responds to any changes in river flow conditions that occur.

The Jangkok Watershed (DAS) is located on the island of Lombok, precisely in the city of Mataram,

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where this city is classified as the most populous city in NTB because Mataram City is the center of government, the center of population economic activity, culture and tourism. The Jangkok River has a length of 48.868 Km with an average river width of 34.20 m. The downstream area of the jangkok river is widely used by residents as a place to bathe, wash, defecate and dispose of garbage or waste Nusa Tenggara River Region I, 2011).

Another river that is no less polluted in the Mataram City area is the Ancar River. Research of Khairuddin et al. (2016), stated that the water quality in the Ancar river is categorized as low quality with an Overall Quality Rating (OQR) of 2 to 2.5. This is because the Ancar river receives almost all types of waste materials, whether in the form of solids, organic, inorganic, oily liquids and others. This can be easily observed along the Ancar river. Research supported by Kusnandi (2015) stated that the Ancar river has been polluted.

Water quality can be determined using various parameters such as physical, chemical and biological parameters. In this study, the researchers used biological parameters, namely using periphyton organisms as bioindicators of water pollution. The aims of this study were to determine the abundance and diversity index of periphyton species in the Jangkok and Ancar rivers, to determine the periphyton species found in the Jangkok and Ancar rivers, and to determine the water quality of the Jangkok and Ancar rivers based on periphyton bioindicators.

Method

Population and Sample

The population in this study is the flow of the Jangkok and Ancar rivers. This sample location was chosen based on the *purposive sampling technique*. Where the researcher deliberately chose this location to be used as a sample point for the research location. The sample point in this study is at the downstream of the Jangkok and Ancar rivers.

Data Collection Method

Research was carried out in the range of September-October. Sampling was only at the estuary/downstream of the Jangkok and Ancar rivers. Periphyton sampling at each location was carried out three times in the downstream part of the river. The distribution was on the right, middle and left edges of the river body. At each of the three sample locations, 1 sample of the substrate will be taken, namely in the form of stones submerged under the surface of the river water, so that the total samples taken are 9 samples.

Periphyton sample data collection was carried out by taking stones that were submerged under the water surface of the lower reaches of the Jangkok and Ancar rivers. The stone that has been taken will then be scraped with a predetermined surface area using a ruler with an area of (5 x 5) cm^2 on the surface of the stone facing the surface of the river water. The stone is scraped using a soft-bristled brush gently facing one direction. When scraped the sample is also sprayed with distilled water. The stone is scraped on a plastic container to accommodate the scraps. Then the holding water was put into a sample bottle which already contained 30 ml of distilled water. After that, 3 ml of formalin was given with a concentration of 40%, so that the concentration of formalin in the sample bottle was 4%. Then the periphyton samples taken were brought to the Mathematics and Natural Sciences Laboratory, Mataram University to be identified using a microscope. Prior to observation, the sample bottle was stirred slowly so that the sample water was mixed and nothing would settle.

Data Analysis

Obtained were then calculated for the Abundance Value and Diversity Index in order to obtain a value in determining the River Pollution Quality.

Periphyton Abundance

Abundance Analysis of periphyton using the APHA (2012), equation 1:

$$K = \frac{n \; x \; At \; x \; Vt}{Ac \; x \; Vs \; x \; As} \quad (1)$$

K = Periphyton abundance (cells/cm^2)
n = Number of observed periphyton
As = Area of substrate scraped (5 x 5) cm^2
At = Area cover glass (mm^2)
Ac = Observable area of object (22 x 22) mm^2
Vt = Volume of concentrate in the periphyton sample bottle (30 ml)
Vs = Volume of concentrate in observed (0.05 ml)

Diversity Index (H')

Value Periphyton diversity index is used to see the water quality, the diversity index value can be seen using the *Shannon Weiner* in Widyastuti (2011) at each point as equation 2, namely:

$$H' = -\sum pi \ln pi \; ; \; pi = \frac{n_i}{N} pi = \frac{n_i}{N} \quad (2)$$

Information:
H´ = Species diversity index
pi = ni/N
ni = Number of periphyton from each -each type (cells/cm^2)
N = Total number of periphyton from all types.

Result and Discussion

Jangkok River Periphyton Species

Table 1. Number of Jangkok River Periphyton

Species	Total
cuspidata	41
Pinnularia diatom	6
Pinnularia opulenta	2
Pinnularia major	1
Gyrosigma acuminatum	2
Navicula cuspidata	2
Diadesmis sp.	1
Aulacoseira granulata	7
Aulacoseira accincta	1
Synedra sp.	3
Diatoma auritum	1
Surirela spiralis	9
Oocystis sp.	41
Anabaena sp.	11
Cosmarium botrytis	11
Stephanodiscus sp.	1

Ancar River Periphyton Species

Table 2. Number of Ancar River Periphyton

Species	Total
Gyrosigma acuminatum	1
Navicula cuspidata	3
Pinnularia diatom	4
Pinnularia opulenta	2
Cymbella agardh	1
Synedra acus	1
Nitzschia palea	1
Eunotia sp.	2
Craticula cuspidata	1
Aulacoseira granulata	2
Surirela spiralis	4
Tetraedron sp.	1

Comparison of Average Abundance Value and Diversity Index at the Jangkok and Ancar River estuarie

Table 3. Average abundance value and

Estuary	Average Abundance value (cell/cm²)	Average Diversity Index value (cell/cm²)
Jangkok	30,116	2,021
Ancar	4,948	2,329

Temperature and pH values

Table 4. Average temperature and pH

	Jangkok	Ancar	Literature
Temperature (⁰C)	22	25	20-30
pH	8.3	7.8	6.6-8.5

Abundance Jangkok and Ancar Rivers

At the estuary of the jangkok river, 16 species were found, of which the most common species were *Craticula cuspidata*and *Oocystis sp.* Meanwhile, few other species were found, namely *Pinnularia major, Diadesmis sp. Aulacoseira accincta, Diatoma auritum*and *Stephanodiscus sp.* This is consistent with the abundance value, that the species *Craticula cuspidata* and *Oocystis sp* have the highest abundance value of 8,820 cells/cm². The high species of *Craticula cuspidata* and *Oocystis sp* can be caused by pollution that occurs in these waters. This is in accordance with the opinion of Prygiel and Horne (1999) which states that species that are tolerant of polluted materials such as *Nitzschia palea, Craticula accomoda, Navicula atomus* and *Navicula cryptocephala* are dominant in polluted waters. It is suspected that the large number of human activities is the main cause of the emergence of pollution in the jangkok river area so that it also affects the type and number of abundance values. So it can be said that only certain species can adapt to these water conditions.

At the mouth of the Ancar river, 12 species of periphyton were found, of which the most common species were *Pinnularia diatom*and *Surirela spiralis.* This is consistent with the abundance value, that *Pinnularia diatom*and *Surirela spiralis species* have the highest abundance value of 860 cells/cm². The discovery of this Pinnularia species is in line with research that *Cocconeis placentula, Cyclotella sp, Cymbella sp Meridion sp, Navicula sp, Nitzschia sp., Pinnularia sp* and *Synedrasp*are the common types of periphyton found in clean waters. Although in this study only 4 *Pinnularia* . This study also found *Nitzschia* and *Navicula species,* both of which are species that can live in polluted water environments (Rosyidi and Wimbaningrum, 2006).

The abundance of species found indicates that these species are easy to adapt to polluted waters. So it can be concluded that *Navicula sp, Nitzschia sp.*, have tolerance to pollutants. Kurteshi et al. (2008) also found that *Navicula sp, Nitzschia sp.*, in the Sitnica river, Kosovo can be used as periphyton bioindicators. Aprisanti (2013) stated that the diatom *Nitzschia sp*is cosmopolitan, has a wide tolerance for organic matter contamination, and can act as an indicator of moderate to heavily polluted waters.

Diversity Index of Jangkok and Ancar River

Diversity Index Based on the Diversity Index value, the Jangkok River (2.021) and the Ancar River (2.329) are included in the category of light pollution or unpolluted, fertility can be utilized.

When compared to the jangkok river, the ancar river has a higher diversity index but much lower abundance. It can be concluded that the quality of the Ancar River is better than the Jangkok River. This is in accordance with the statement "*Waters of good quality*

usually have a high diversity value and a low number of individuals, and vice versa".

The difference in the value of this abundance and diversity index, apart from being influenced by pollution factors, can also be influenced by physical factors such as temperature and pH. River water is said to be more affected by seasonal temperature changes than sea water (Nybakken, 1992). Temperature is a limiting factor for aquatic organisms. An increase in temperature of 10^0C (in a temperature range that can still be tolerated) will cause the metabolic rate of organisms in the water to increase by 2-3 times. As a result of the increased metabolic rate, it will cause the consumption of organisms on oxygen to increase (Susanti, 2010). The results showed that the temperature in the jangkok river flow ranged from 21-22^{0}C and in the Ancar River it ranged from 25-27 ^{0}C. Referring to Efendi (2016) the maximum temperature for microalgae growth ranged from 20-30 ^{0}C. It can be seen that periphyton is able to live in this temperature range.

In measuring pH, the pH range of the Jangkok river is 8.1 - 8.5, while the pH range of the Ancar river is 7.5-8.0. This is in accordance with PP No. 82 of 2001 concerning water quality management and environmental pollution control and Ministerial Decree No. 02 of 1988 which states that the pH range that can still be tolerated is 6-9. Based on this, the pH value at the estuaries of the Jangkok and Ancar rivers is still relatively good and supportive for aquatic organisms such as periphyton to live. Apart from temperature and pH factors, salinity (Ruswahyuni, 2012), nitrogen, phosphate, conductivity, DO (Brown and Alan, 2009) can also be factors that can affect the abundance value and diversity index of periphyton.

Social Factors

When analyzed using environmental ethics theory, the activity of throwing garbage into rivers by the community causes coastal pollution is a form of anthropocentrism ethics that is oriented to meeting human needs alone, without paying attention to environmental sustainability (Lubis et al., 2018).

If we look at the large population and high growth rate, it is the most important factor in environmental problems. These two challenges, both the population and the high rate of population growth, try to be overcome by development in all sectors. The environmental aspect has become one of the emphasis in the concept of sustainable development in Indonesia and to achieve these development goals, it is necessary to have a clear picture of the conditions and problems that occur in the environment so that environmental management can be carried out optimally.

The negative impacts that have been caused by this pollution can not only endanger the life of biota and the marine environment, but can also endanger human health or even cause death, reduce or damage the aesthetic value of the coastal and oceanic environment and cause socio-economic losses (Lubis et al., 2018).

Socio-Economic Impacts

Social and economic conditions impact to the poor waste management. This condition will create an unpleasant environment for the community, unpleasant odors and bad views. Because garbage is scattered everywhere. Social and economic conditions also provide a negative impact on tourism, inadequate waste management leads to low levels of public health. The important thing here is the increase in direct financing (to treat the sick) and indirect financing (not coming to work, low productivity).

Disposal of solid waste into water bodies can cause flooding and will have an impact on public service facilities such as roads, bridges, drainage , and others. Other infrastructure can also be affected by inadequate waste management, such as the high costs involved in water management. If the waste collection facilities are less or less efficient, people will tend to throw their garbage on the street. This means that the road needs to be cleaned or repaired more often. So that the community must be placed as an object of development and not as a subject of development, thus high attention and desire are needed to advance coastal communities as resource managers.

Conclusion

Based on the results of the study, it is concluded that the data obtained were then calculated with the Abundance Value and Diversity Index in order to obtain a value in determining the Quality of River Pollution. Periphyton abundance value in Ancar River flow is 4.948 cells/cm2, then the Ancar River periphyton species diversity index is 2.329. Periphyton found in abundance is from the class Bacillariophyceae. Water quality of the Jangkok and Ancar River based on the index value of species diversity, is categorized in light pollution or unpolluted which means that fertility can be utilized.

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