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Phytoplankton Community Structure In Banjaran River, Banyumas Regency

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ABSTRACT

Banjaran River is a river that is widely used by local people for their daily needs, including for bathing, drinking water, washing, and irrigation of agricultural land. These activities will cause changes in the quality of the waters of the Banjaran River so that it will cause water pollution, especially pollution from organic materials. This pollution will cause changes in the structure of the biota community, one of which is the phytoplankton in the Banjaran River. Phytoplankton are organisms that play a role in providing nutrients and maintaining the balance of aquatic ecosystems. The purpose of this study was to determine the structure of the phytoplankton community in the Banjaran River, Banyumas Regency. The method used in this research is purposive sampling, with 4 sampling points and 3 repetitions. Sampling was carried out in April-May 2021 with an interval of 2 weeks. Data analysis in this study includes the calculation of abundance, diversity index, and phytoplankton dominance index. The results showed that the abundance of phytoplankton in the Banjaran River was 453-720 individuals.L-1, the diversity index was 1.97-2.25, and the dominance index was 0.13-0.18. These results indicate that the structure of the phytoplankton community in the Banjaran River is in moderate diversity and there is no particular species that dominates in these river.

Keywords: *Phytoplankton, Banjaran River, Aquatic Ecosystem.*

Abstrak

Sungai Banjaran merupakan sungai yang banyak dimanfaatkan masyarakat setempat untuk kebutuhan sehari-hari, diantaranya adalah untuk kebutuhan mandi, air minum, mencuci, serta irigasi lahan pertanian. Kegiatan-kegiatan tersebut akan menyebabkan adanya perubahan kualitas perairan Sungai Banjaran sehingga akan menimbulkan pencemaran air khususnya pencemaran yang berasal dari bahan-bahan organik. Pencemaran tersebut akan menyebabkan perubahan pada struktur komunitas biota, salah satunya adalah fitoplankton di Sungai Banjaran. Fitoplankton merupakan organisme yang berperan dalam menyediakan nutrien dan menjaga keseimbangan ekosistem perairan. Tujuan dari penelitian ini adalah untuk mengetahui struktur komunitas fitoplankton di Sungai Banjaran, Kabupaten Banyumas. Metode yang digunakan pada penelitian ini adalah purposive sampling, dengan 4 titik pengambilan sampel dan 3 kali pengulangan. Pengambilan sampel dilakukan pada bulan April-Mei 2021 dengan interval 2 minggu. Analisis data pada penelitian ini meliputi perhitungan kelimpahan, indeks keanekaragaman, dan indeks dominansi fitoplankton. Hasil penelitian menunjukkan kelimpahan fitoplankton di Sungai Banjaran sebesar 453-720 individual/l, indeks keanekaragaman sebesar 1.97-2.25, dan indeks dominansi sebesar 0.13-0.18. Hasil tersebut mengindikasikan bahwa struktur komunitas fitoplankton di Sungai Banjaran termasuk dalam keanekaragaman sedang dan tidak terdapat spesies tertentu yang mendominasi.

Kata kunci: Fitoplankton, Sungai Banjaran, Ekosistem Akuatik

1. Introduction

The Banjaran River is a river located in Banyumas Regency and passes through seven sub-districts, namely Baturaden District, Kedungbanteng District, North Purwokerto District, West Purwokerto District, South Purwokerto District, East Purwokerto District, and Patikraja District. The flow of the Banjaran River is used by the local community as a turbine driver, irrigation of agricultural land, fish cultivation, drinking water sources, and toilet needs (Bhagawati et al., 2013). In addition to meeting human needs, the Banjaran River is also a place to live for various organisms, one of

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which is phytoplankton. An increase in the number and activity of residents along the Banjaran River can cause an increase in the input of pollutants into the waters. Water pollution is the entry or inclusion of pollutants or pollutants into the aquatic environment in excessive quantities so that the water in these waters is no longer suitable for consumption and community use (Olaniran, 1995).

Changes in water quality will disrupt the balance of the phytoplankton community. Phytoplankton are aquatic organisms that have photosynthetic pigments that play a role in the process of changing carbon dioxide in the water column into carbohydrate and protein molecules with the help of solar thermal energy (Suthers & Rissik, 2009). The existence of phytoplankton in a waters is influenced by the physical and chemical quality of the waters (Indrayani et al., 2014). So that if there is an increase in the input of pollutants into the waters, it will cause a decrease in the abundance and diversity of phytoplankton in these waters (Ilham et al., 2020). The purpose of this study was to determine the structure of the phytoplankton community in the Banjaran River, Banyumas Regency. This research needs to be done, considering that the Banjaran River is not only important for human life, it is also a habitat for various organisms.

2. Material and methods

2.1 Research Time and Place

This research was conducted in April-May 2021 with four sampling points. The sampling points were located in Kebumen Village, Beji Village, Bobosan Village, and Kober Village. The method used in determining the sample point is purposive sampling. Purposive sampling is a method of determining the sampling point based on the researcher's assessment that the selected point is the best point to describe the entire location, this method does not require theory or tools in the basis of determining the sampling point (Bernard, 2002).

Table 1. Phytoplankton Dominance Index Category

Index Value	Category
0<C≤0,5	Low dominance, no particular species extremely dominates other species
0,5≤C≤0,75	Moderate dominance
0,75≤C≤1,0	High dominance, there are species that dominate other phytoplankton species

Source: Odum, 1996

Table 2. Phytoplankton Diversity Category

Diversity Value	Category
H’ < 1	Low diversity
1 <H’< 3	Moderate diversity
H’ > 3	High diversity

Source : Odum, 1996

2.2 Phytoplankton Sample Analysis

Phytoplankton sampling was carried out by filtering 100 L of river water using a plankton net, the sample water stored in a plankton net bottle was then transferred to a 75 ml sample bottle and given lugol until the color of the sample water turned yellow-brown (Ramanda et al., 2017). Phytoplankton samples were then observed and identified using the Sachlan and Sani Iskandar identification book. Phytoplankton samples were observed under a microscope with a magnification of 4×10, with 30 fields of view and 3 repetitions. Observations and identification of phytoplankton samples were carried out at the Laboratory of the Faculty of Fisheries and Marine Sciences, Jenderal Soedirman University. Then the abundance, diversity index, and phytoplankton dominance index were calculated. Phytoplankton abundance was calculated based on APHA (2005) with the following modifications:

$$N = \frac{3Oi}{Op} \times \frac{Vr}{3Vo} \times \frac{1}{Vs} \times \frac{n}{3p}$$

Information :

N : Total number of planters (ind/l)
Oi : Cover glass area (324 mm^2)
Op : The area of one field of view (1,11279 mm^2)
Vr : Volume of sample water in container bottle (75 ml)
Vo : Volume of water sample one drop (0.05 ml)
Vs : Volume of filtered water with plankton net (100 l)
n : Number of individual plankton in the entire field of view
p : Total field of view (30)
3 : Repeat factor

Phytoplankton diversity index was calculated using the Shannon-Wiener index. The calculation of the Shannon-Wiener diversity index is as follows (Odum, 1996):

$$H' = -\sum_{i=1}^{S} Pi \ln Pi$$

Information :

H' : Shannon-Wiener diversity index
Pi : Number of individuals of each species (Pi= ni/N)

ni : Number of individuals of type i
N : The total number of individuals of all taxa in a community.

Phytoplankton dominance index is calculated using the Simpson dominance index formula as follows (Odum, 1996):

$$C = \sum \left(\frac{ni}{n}\right)^2$$

Information :
C : Dominance index
ni : Number of individuals i
n : Total number of individuals

Table 2. Phytoplankton Composition, Abundance, and Diversity in Banjaran River, Banyumas Regency

NO	SPECIES	Phytoplankton Abundance (individual/l)															
		Kebumen				Beji				Bobosan				Kober			
		R1	R2	R3	Mean	R1	R2	R3	Mean	R1	R2	R3	Mean	R1	R2	R3	Mean
	Bacillariophyta																
1	*Navicula* sp.	121	24	24	57	146	243	243	210	121	49	49	73	0	243	24	89
2	*Nitzschia* sp.	49	73	49	57	97	0	0	32	121	0	0	40	0	315	0	105
3	*Surirella* sp.	0	97	121	73	73	49	97	73	49	121	49	73	73	0	49	40
4	*Synedra ulna*	121	243	97	154	97	49	218	121	73	121	121	105	170	146	218	178
5	*Cymbella* sp.	0	121	0	40	0	170	24	65	49	97	0	49	24	73	49	49
6	*Pleurosigma* sp.	0	0	0	0	0	24	24	16	0	0	24	8	0	0	0	0
7	*Melosira varians*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	*Achanthes flexella*	24	24	0	16	24	0	0	8	0	0	24	8	0	0	0	0
9	*Fragilaria* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	*Pinnularia* sp.	0	24	0	8	0	0	0	0	0	0	0	0	0	0	0	0
	Chlorophyta																
11	*Closterium moniliferum*	0	0	0	0	0	0	24	8	0	0	0	0	0	0	0	0
12	*Closterium acerosum*	24	24	0	16	0	0	0	0	0	0	0	0	0	0	49	16
13	*Mougeotia* sp.	0	0	49	16	24	0	0	8	24	0	0	8	0	0	0	0
14	*Pediastrum simplex*	0	0	0	0	24	0	0	8	0	0	0	0	0	0	24	8
15	*Pediastrum gracillimum*	0	0	0	0	49	0	0	16	24	0	24	16	24	0	24	16
16	*Scenedesmus opoliensis*	0	0	0	0	0	0	24	8	0	0	0	0	0	0	0	0
17	*Coelastrum microporum*	0	0	0	0	73	49	170	97	97	49	0	49	121	24	97	81
18	*Pandorina* sp.	0	0	0	0	49	0	24	24	24	0	24	16	0	0	0	0
19	*Cladophora* sp.	24	0	0	8	24	0	0	8	0	0	0	0	24	0	0	8
	Cyanophyta																
20	*Oscillatoria limosa*	0	0	0	0	24	0	0	8	24	0	0	8	49	0	0	16
21	*Microcystis* sp.	0	0	0	0	24	0	0	8	24	0	0	8	24	0	0	8
22	*Phormidium* sp.	24	0	0	8	0	0	0	0	24	0	0	8	0	0	0	0
Abundance average total (ind/l)		453				720				469				615			
Diversity index		1.97				2.21				2.25				2.09			
Dominance index		0.18				0.16				0.13				0.16			

Table 3. Water Quality in Banjaran River

No	Parameter	Unit	Station				Water Quality Standard for River Class II*
			Kebumen	Beji	Bobosan	Kober	
1.	Temperature	°C	23.4	25.7	27.2	28.3	Deviation 3
2.	pH	-	7.9	8.0	8.2	8.1	6-9
3.	DO	mg/l	7.9	7.1	7.6	7.7	>4
4.	TSS	mg/l	2.75	3.42	7.75	6.75	50
5.	Nitrate	mg/l	0.2030	0.1570	0.1795	0.2112	10
6.	Total phospate	mg/l	0.3270	0.3290	0.3550	0.3490	0.2
7.	Current speed	m/s	0.4	0.3	0.4	0.2	-

*) Government Regulation No. 22 of 2021 concerning the Implementation of Environmental Protection and Management

3. Results and discussion

Based on the observation of phytoplankton, the composition of phytoplankton in the Banjaran River consists of 3 divisions, there are Bacillariophyta, Chlorophyta, and Cyanophyta. The division of phytoplankton that dominates is Bacillariophyta which consists of 10 species. Bacillariophyta is a cosmopolitan phytoplankton that has the ability to adapt to various aquatic environmental conditions. In addition, Bacillariophyta is a phytoplankton that acts as a primary producer in waters except in waters that have a mud substrate type (Aryani et al., 2020). The number of Bacillariophyta species found in the Banjaran River is a common thing, this is because in river ecosystems, phytoplankton are generally found from the divisions of Bacillariophyta (diatoms) and Chlorophyta (Pambudi et al., 2016). The highest average abundance is at station 2 which is 720 ind/l and followed by station 4 at 615 ind/l (Table 3). The high abundance of phytoplankton at the two stations can be caused by the high nutrient content and the slow current velocity so that many phytoplankton from the previous station are trapped at this station. At station 2 there is a resident's cattle pen which is located quite close to the water body, thus allowing the input of organic matter in the form of livestock manure which causes the abundance of phytoplankton at that station to be higher than other stations. This is supported by the opinion of Azzam et al (2018), that the abundance of phytoplankton can be caused by a large amount of nitrate content derived from organic matter in the waters. In addition, the condition of the waters at station 2 which has a slower current than the previous station (0.3 m/s) can cause phytoplankton to be found at this station more than the other three stations. The slower current causes the phytoplankton originating from the previous station to be stuck at station 2, so that more phytoplankton are caught in sampling.

Station 1 has the least average abundance of 453 ind/l (Table 3). This can happen because the current velocity at station 1 is faster than other stations, namely 0.4 m/s so that the phytoplankton at this station will be carried away by the current quickly to the next station. This is supported by Harsono et al (2011), which states that the abundance of phytoplankton will decrease in waters that have a current velocity of more than 25 cm/s. The dominant phytoplankton at this station is Synedra ulna and followed by Surirella sp. The number of Synedra ulna found at this station is due to the high content of nitrate so that it supports the growth of the phytoplankton. Soeprobowati et al (2020), stated that Synedra

Table 4. Sampling Location Coordinate

No	Sampling Point	Location	GPS Coordinates
1.	Station 1	Kebumen, Baturraden Districts	7°22’26.91” S, 109°13’22.54” E
2.	Station 2	Beji, Kedungbanteng Districts	7°23’40.00” S, 109°13’31.30” E
3.	Station 3	Bobosan, Purwokerto Utara Districts	7°24’29.00” S, 109°13’41.30” E
4.	Station 4	Kober, Purwokerto Barat Districts	7°25’15.71” S, 109°13’27.00” E

ulna which is found in many waters indicates that these waters are eutrophic waters, namely waters that are rich in nutrients. Station 3 has an average abundance of phytoplankton which is not much different from station 1, which is 469 ind/l (Table 3). The species that has the highest average abundance is Synedra ulna. then followed by Surirella sp. and Navicula sp. The average abundance of phytoplankton at station 3 which tends to be small can be caused by the swift currents of 0.4 m/s so that phytoplankton at station 3 can be quickly carried away by the current to the next station. Synedra ulna is found at this station because of the sufficient nutrient content and support for the growth of the phytoplankton, namely the nitrate content of 0.1795 mg/l. Soeprobowati et al (2020), stated that Synedra ulna which is found in many waters indicates that these waters are eutrophic waters, namely waters that are rich in nutrients.

Station 4 is the station with the highest average abundance after station 2, which is 615 ind/l. The species with the highest average abundance at this station were Synedra ulna and Nitzschia sp. This station has a slow water current (0.2 m/s) and a high nitrate content of 0.2112 mg/l so that it allows a lot of phytoplankton to be found. This is supported by Harsono et al (2011), which states that the abundance of phytoplankton will decrease in waters that have a current velocity of more than 25 cm/s. In addition, the average abundance of phytoplankton at station 4 which is lower than station 2 can be caused by the activity of taking or mining sand carried out by residents so that the existing phytoplankton can be taken during these activities, especially phytoplankton attached to sand or rocks. Bacillariophyta tend to be found at all four stations because these phytoplankton have a good ability to adapt to the environment, even in extreme conditions, so Bacillariophyta can be found in fresh waters to marine waters. Bacillariophyta also have good adaptability to slow water currents to strong currents, this is because Bacillariophyta have attachments that allow them to stick to substrates such as rocks and plant stalk surfaces which are generally carried away by river currents (Rahayu et al., 2018).

The diversity index is an index that describes the diversity of species at the research station, while the dominance index is an index that states the presence or absence of phytoplankton species that dominate at the research station. Based on the results of the study, the highest diversity index was obtained at station 3, which was 2.25 and the lowest was at station 1, which was 1.97 (Table 3). Phytoplankton diversity index in the Banjaran River is moderate. This indicates that the biota community in these waters has moderate stability and the water quality is at a moderate level of pollution. The current speed of a water is a limiting factor for the diversity of phytoplankton, this is because phytoplankton are microorganisms whose distribution depends on water currents. According to Darmawan et al (2018), the speed of the current will determine the types of aquatic plants or phytoplankton that can occupy these waters, so that in general only phytoplankton species that have adhesive devices that will be able to withstand the current and do not suffer physical damage.

The dominance index at the four stations was 0.18; 0.16; 0.13; and 0.16 (Table 3) which indicates that the four stations have low dominance where there is no particular species that dominates the waters in an extreme way. From the four stations, many Bacillariophyta phytoplankton were found. The number of Bacillariophyta species found indicates that these waters contain sufficient nutrients that support the growth of phytoplankton. In addition, Bacillariophyta is a phytoplankton that has a high level of adaptation to almost all water conditions including extreme conditions. Kumaji et al (2019) stated that the large number of Bacillariophyta in the waters is due to their high reproductive power and this species tends to be adaptive to water conditions. The results of the measurement of the water quality of the Banjaran River show that the water quality level is still within the specified quality standard limits (Table 4). The high total phosphate level at station 3 can be caused by the use of river flow for washing clothes and bathing activities. Leftover detergent or soap will increase the phosphate ion content in the water. Hema et al (2021), stated that the high levels of phosphate in the waters can be influenced by domestic waste sourced from residual detergent or waste disposal. If a water has a nitrate and phosphate content that is too high, it will cause the waters to experience algae blooms (eutrophication). The high TSS at station 3 can be caused by erosion of the river body by currents. In Table 6. the results show that the value of the current velocity at station 3 is 0.4 m/s so that this relatively fast current allows erosion of the river body. The high content of TSS in waters can be sourced from mud, fine sand, organic matter, or soil erosion carried by currents into water bodies. Based on the value of nitrate content and total phosphate, the Banjaran River is classified as oligotrophic waters or waters with low fertility

4. Conclusions

Based on the research that has been done, found 3 divisions of phytoplankton in the Banjaran River consisting of 10 species of Bacillariophyta, 9 divisions of Chlorophyta, and 3 divisions of Cyanophyta. The average abundance of phytoplankton ranged from 453-720 ind/l, diversity index between 1.97-2.25, and dominance index between 0.13-0.18. Most of the phytoplankton found in the Banjaran River is the Bacillariophyta division because Bacillariophyta is a cosmopolitan phytoplankton that can be found in various water conditions. The results of the measurement of water quality indicate that the water quality of the Banjaran River is still at the predetermined quality standards.

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