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Study of Water Quality and Macrozoobenthos Community Structure in the Meduri River, Pekalongan Regency

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ABSTRACT
Disposal of batik waste into the environment without treatment causes pollution. Liquid waste from batik production contains pollutants and causes a decrease in the quality of river water. The decrease in water quality affects the life of macrozoobenthos. The purpose of this study was to determine the structure of the macrozoobenthos community in the Meduri River. This study used a quantitative descriptive method. Sediment was taken using an ekman grab. Macrozoobenthos were identified, and community structure analysis was carried out. The results obtained showed that there were two genera of macrozoobenthos found in the Meduri River, including Melanoides and Bithynia. The level of diversity and evenness was relatively low; there was a dominance of species in the community.

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INTRODUCTION

The growth of the batik industry provides excellent economic benefits. The amount of batik production in Indonesia has an economic value of 407.5 billion rupiah per month, equivalent to 4.89 trillion per year (Siregar et al. 2020). The Ministry of Industry prioritizes the growth of the batik industry because of its potential to drive national economic growth; this is proven by the export achievement for the January-July 2020 period worth USD 21.54 million, an increase compared to the previous year. The export destination countries include Japan, the United States, and Europe (Pramono et al., 2023). Java Island is the center of the batik industry in Indonesia. There are quite large and well-known batik centers in several areas, such as Surakarta, Garut, Indramayu, Banyumas, and Pekalongan (Hendrawati et al., 2021). Pekalongan is known as the largest batik producer in Indonesia, and it is estimated to have developed since the 18th century. Batik production produces waste that has the potential to pollute the environment because it uses various chemicals.

Disposal of batik waste into the environment without treatment can cause pollution. Liquid waste from the batik processing process containing pollutants is discharged into drainage channels and enters the river body, causing a decrease in water quality. The decrease in water quality affects the life of macrozoobenthos. Macrozoobenthos are organisms that live at the bottom of the water (sediment). The habitat of macrozoobenthos is relatively fixed, and its movement is limited; its diversity is influenced by the level of tolerance and sensitivity to environmental conditions (Bai'un et al., 2021). Macrozoobenthos can be used as a bioindicator of water quality. Tulandi's research (2022) shows that the decrease in water quality of Lake Sineleyan Tomohon causes an imbalance in the structure of the macrozoobenthos community. Another study by Maulana and Kuntjoro (2023) shows that the parameters DO, BOD, COD, turbidity, depth, and current speed affect the macrozoobenthos diversity index.

Meduri River is a river with a length of ± 7 km that passes through 4 sub-districts in Pekalongan Regency and two sub-districts in Pekalongan City. Industrial activities and domestic waste disposal along the river have decreased water quality. Meduri River, which flows in Samborejo Village, is a place to dispose of the waste from the batik industry. The purpose of this study was to determine the structure of the macrozoobenthos community in the Meduri River located in Samborejo Village, Tirto District, Pekalongan Regency.

LITERATURE REVIEW

Characteristics of Batik Waste

Waste is a residual material (by-product) from an industrial activity or process that has lost its original function. Batik production produces waste that has the potential to pollute the environment. The use of starch in the fabric washing stage causes waste to contain suspended solids. In the bleaching process, waste containing dyes is thrown away. The use of chemicals with stable molecular structures makes waste challenging to decompose, making it a pollutant in the environment that causes an increase in the value of Total Suspended Solid (TSS), Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) in waters. In addition, batik waste also contains heavy

metals with quite large concentrations. Research by Utami and Fitriani (2022) shows that the disposal of batik waste in the Bedog River, Bantul Regency, causes degradation of water quality. BOD and COD values do not meet quality standards.

The Impact of River Pollution on Macrozoobenthos

Macrozoobenthos are aquatic organisms that live in sediment. They are sensitive to environmental conditions influenced by the physical and chemical parameters of the water. Therefore, macrozoobenthos can be used as bioindicators. Community structure is an ecological term that indicates the organisms found in an ecosystem and their interactions. Community structure can be seen through ecological indices that can reflect diversity, species dominance, and evenness (Suryatini et al., 2022).

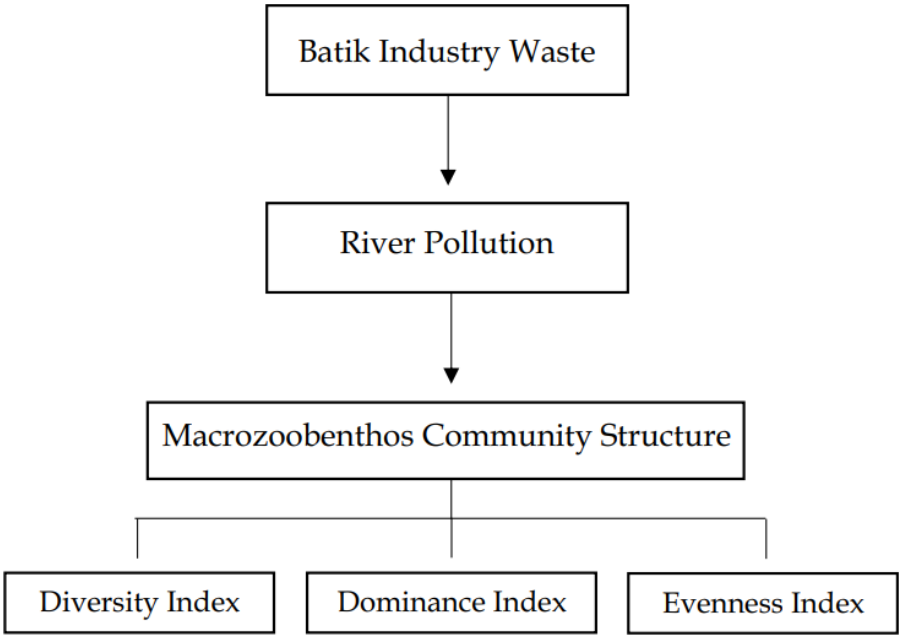

Figure 1. Conceptual Framework

METHODOLOGY

This research was conducted in Samborejo Village, Tirto District, Pekalongan Regency. This research used a quantitative descriptive method. The locations for water and macrozoobenthos sampling were divided into three stations:

a. Station-1: upstream (before the waste outlet)
b. coordinate points: LS 06^{o} 53’55.244” and BT 109^{o} 38’43.681”
c. Station-2: middle of the river (at the waste outlet)
d. coordinate points: LS 06^{o} 53’51.864” and BT 109^{o} 38’44.001”
e. Station-3: downstream (after the waste outlet)
f. coordinate points: LS 06^{o} 53’51.692” and BT 109^{o} 38’44.265”

The sediment was taken using an Ekman grab and then filtered to collect the macrozoobenthos in the sediment. The macrozoobenthos were put into plastic bottles filled with a 70% alcohol solution. All Macrozoobenthos found in

the field were identified. Community structure was analyzed based on the Shannon-Wiener diversity index (H'), Simpson dominance index (D), and evenness index (E).

Diversity Index Formula

$$H' = - (\Sigma \frac{ni}{N} \ln \frac{ni}{N}) \quad \text{..... (1)}$$

H′ = Diversity Index
ni = number of individuals of species-i
N = total individuals

Dominance Index Formula

$$D = \sum_{i=1}^{s} (Pi)^2 \quad \text{..... (2)}$$

D = Dominance Index
Pi = proportion of important values

Evenness Index Formula

$$E = \frac{H'}{lnS} \quad \text{..... (3)}$$

E = Evenness Index
H′ = Diversity Index
S = number of species

RESEARCH RESULT

Water Quality

Table 1 shows the results of the analysis of the physical and chemical parameters of the Meduri River water in this study.

Table 1. Results of Physical and Chemical Parameters of River Water

Parameters	**Value**			**Standards**
	St-1	**St-2**	**St-3**	
Temperature (°C)	31,8	31,7	31,37	Dev 3
TSS (mg/L)	163,33	215	136,67	50
Color (Pt-Co)	548,6	596,67	611	50
pH	7	7,3	7,67	6-9
DO (mg/L)	0,93	0,26	0,26	≥ 4
BOD (mg/L)	11,33	13,67	13,67	3
COD (mg/L)	76,67	72	76,67	25
Cr^{2+} (mg/L)	0,097	0,083	0,1	0,05

The study's results showed that the TSS, color, DO, BOD, COD, and Cr2+ values at the three stations did not comply with the quality standards. This is caused by wastewater disposal activities. Large-scale industries have WWTPs (Wastewater Treatment Plants) that are monitored regularly. Medium and small-scale industries do not have wastewater treatment facilities, so waste from batik production is directly discharged into the environment.

Macrozoobenthos Community Structure

The study's results showed that two genera of macrozoobenthos, Bythinia and Melanoides, which are classified into the Gastropod class, were found in the Meduri River sediment.

Table 2. Number of Macrozoobenthos in the Meduri River

Family	Genus	Station 1	Station 2	Station 3
Thiaridae	Melanoides	7	1	3
Bithyniidae	Bithynia	11	4	5
	Number of Individuals	18	5	8
	Number of Genus	2	2	2

Based on the research results, Station 1 has the most significant number of macrozoobenthos, 18 individuals. At Station 1, 7 Melanoides and 11 Bithynia were found. At Station 2, 1 Melanoides and 4 Bithynia were found. At Station 3, 4 Melanoides and 5 Bithynia were found.

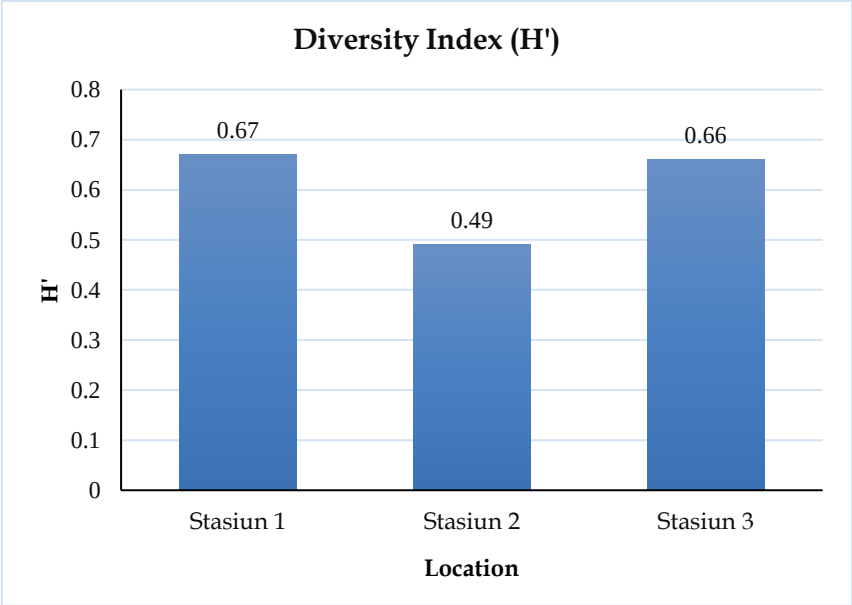

Figure 2. Diversity Index

The diversity index value of macrozoobenthos in the Meduri River ranges from 0.49-0.67. The diversity index value at Stations 1-3 is classified as low because its value is <1. The diversity index can be used to estimate water conditions.

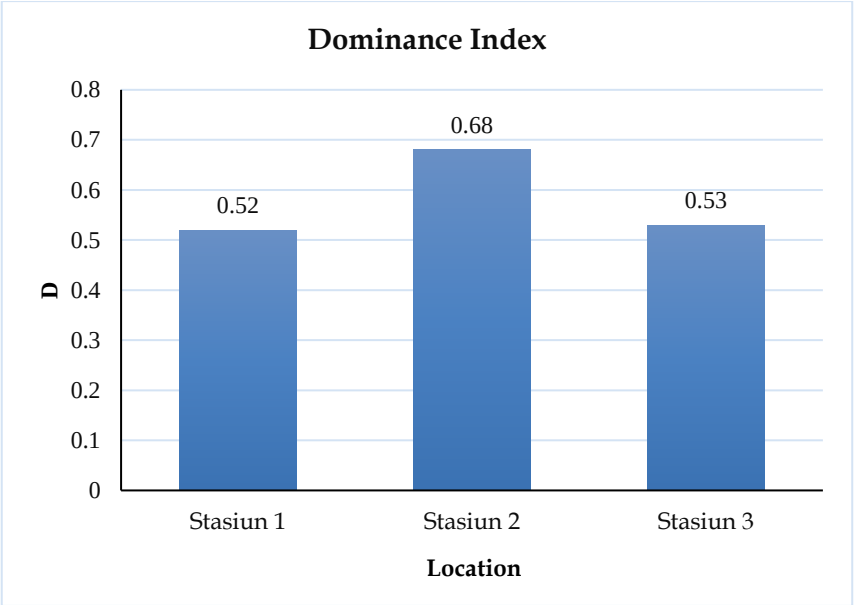

Figure 3. Dominance Index

The macrozoobenthos dominance index value in the Meduri River ranges from 0.52 to 0.68. The dominance index at Stations 1-3 is close to 1, indicating the presence of a dominant species. The dominant species at all three stations is Bythinia. A high dominance index indicates a population imbalance in the ecosystem.

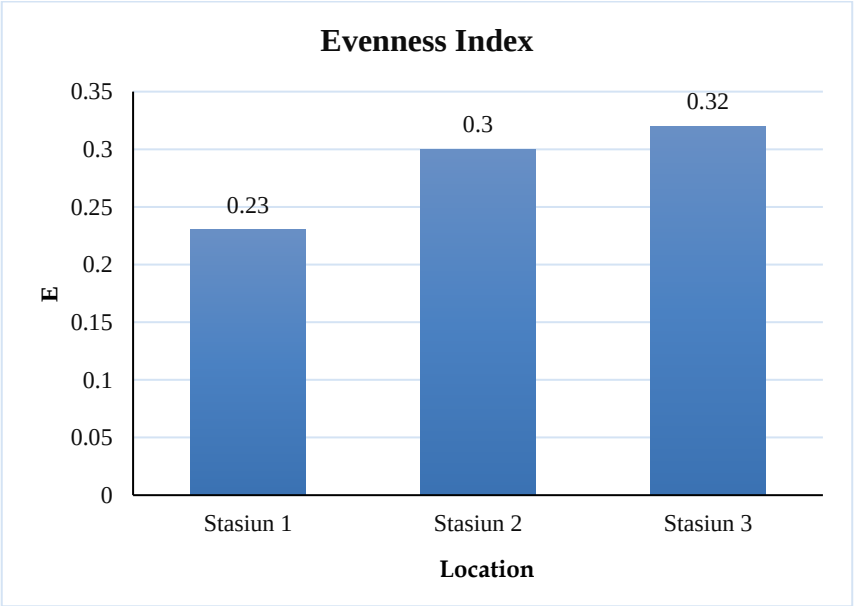

Figure 3. Evenness Index

The evenness index value in the Meduri River ranges from 0.23-0.32. The evenness index at Stations 1-3 is classified as low because the value is <0.4. This indicates that the distribution pattern of individuals in the community is uneven, and there are dominant species.

DISCUSSION

The batik industry that discharges liquid waste with various pollutants can increase the COD value in the water because the amount of oxygen needed for chemical oxidation is quite large. Polluted water also has a high BOD value because microorganisms absorb dissolved oxygen to break down organic matter (Sompotan and Sinaga, 2022). In addition, the decline in water quality also affects the life of macrozoobenthos. Macrozoobenthos are organisms that live at the bottom of the water. Macrozoobenthos can be used as biological indicators to determine the quality of water. The diversity of macrozoobenthos is influenced by the level of tolerance and sensitivity to environmental conditions (Bai'un et al., 2021). The substrate in the Meduri River is mud with a thick black color, originating from the accumulation of dyes in batik waste that has occurred for years.

Gastropods are soft-bodied animals covered by a hard shell. Gastropods belong to the Mollusca phylum, whose body shape has undergone modifications in the form of torsion events. Gastropods can be biological indicators because they live on the bottom of the substrate and can live in habitats with low oxygen levels (Hadi, 2023). Melanoides and Bithynia found in the Meduri River belong to the Gastropod class. Melanoides are freshwater snails belonging to the Thiaridae family and have elongated and brown shells. The shell surface is wavy and forms vertical lines. According to Prabandini et al. (2021), Melanoides can live in waters with low dissolved oxygen levels. Bithynia is a freshwater snail whose shell is oval but has a sharp conical peak. Bithynia is a tiny snail measuring 4-6 mm and has a brown shell, generally found in waters with muddy substrates. Research by Mrozinska and Bakowska (2020) shows that Bithynia can live in waters with unstable conditions (influenced by domestic waste and industrial waste).

The number of genera found is relatively low due to the condition of the river water, which is polluted by batik waste. Research by Kinanti et al. (2014) shows that batik waste that enters the waters affects the life of macrozoobenthos. The Bremi River is one of the rivers in Pekalongan Regency, and it is used as a place to dispose of batik waste. Four species of macrobenthos were found: Tubifex, sp., Nereis, sp., Chironomus, sp., and Lymnaea sp. Another study by Zammi et al. (2018) showed that the water of the Simbangkulon River in Pekalongan Regency did not meet quality standards due to waste disposal activities. Only one species of macrozoobenthos, Pila polita, was found, and it is included in the Gastropod class. As a comparison, research by Janah et al. (2024) showed that in the Paneki River, which was not polluted by industrial waste, eleven families of macrozoobenthos were found. The results of the study by Cipriani et al. (2020) showed that 17 species of macrozoobenthos were found, with a total of 86 individuals in the Senggarang River, Bintan Island. The water conditions were relatively stable, with high dissolved oxygen concentrations.

Ecological pressure causes an imbalance in community structure characterized by low levels of diversity and species dominance. The activity of disposing of batik waste into rivers causes a decrease in water quality. High TSS values affect the life of macrozoobenthos. Suspended solids from batik waste

settle at the bottom of the waters, causing changes in the composition of the river substrate. Muddy substrates have low oxygen content, so macrozoobenthos need to develop adaptation mechanisms (Suryatini et al., 2022).

CONCLUSIONS AND RECOMMENDATIONS

There are two genera of macrozoobenthos found in the Meduri River, namely Melanoides and Bithynia. The level of diversity and evenness is relatively low; there is a dominance of species in the community. The imbalance of community structure is caused by the physical and chemical parameters of the waters, which do not comply with quality standards. The decline in water quality is caused by industrial activities that produce liquid waste. Batik waste treatment needs to be carried out to reduce pollution.

ADVANCED RESEARCH

Further research on the impact of batik waste on the morphology and physiology of macrozoobenthos is needed to obtain more comprehensive data.

REFERENCES

Apriadi, T., Muzammil, W., Melani, W.R., & Safitri, A. (2022). Struktur Komunitas Makrozoobentos di Aliran Sungai di Senggarang, Pulau Bintan, Kepulauan Riau. *Jurnal Ilmu-Ilmu Perairan, Pesisir, dan Perikanan*, 9(1), 119-130. https://doi.org/10.13170/depik.9.1.14641

Askara, A.B., Idris, F., Putra, R.D., & Nugraha, A.H. (2020). Kandungan Logam Berat (Pb) pada Stombus canarium Linneaus, 1758 (Mollusca: Gastropoda) di Perairan Malang Rapat dan Tanjung Siambang Provinsi Kepulauan Riau. *Jurnal Kelautan Tropis*, 23(3), 299-304. https://doi.org/10.14710/jkt.v23i3.7229

Bai'un, N.H.I., Riyantini, Y., Mulyani, & Zallesa, S. (2021). Keanekaragaman Makrozoobentos Sebagai Indikator Kondisi Perairan di Ekosistem Mangrove Pulau Pari, Kepulauan Seribu. *Journal of Fisheries and Marine Research*, 5(2), 227-238. http://dx.doi.org/10.21776/ub.jfmr.2021.005.02.7

Hadi, I. (2023). Struktur Komunitas Gastropoda Sebagai Bioindikator Pencemaran Air Sungai Gorong Kabupaten Lombok Tengah dalam Upaya Penyusunan Petunjuk Praktikum Biologi. *Biocaster: Jurnal Kajian Biologi*, 3(2), 86-101. https://doi.org/10.36312/biocaster.v3i2.175

Hendrawati, S., Ramadhan, R., Chaerunisa, N., & Limayucha, S.A. (2021). Pengenalan Perkembangan Batik Tedjo di Era Globalisasi. *Indonesian Collaboration Journal of Community Services*, 1(4):185-196. https://doi.org/10.53067/icjcs.v1i4

Janah, N.K.F., Rauf, A., & Bustamin. (2024). Makrozoobenthos Sebagai Bioindikator Kualitas Air di Sungai Paneki Desa Pombewe Kabupaten

Sigi. *Bioscientist: Jurnal Ilmiah Biologi*, 12(1), 858-864. https://doi.org/10.33394/bioscientist.v12i1.11002

Kinanti, T.E., Rudiyanti, S., & Purwanti, F. (2014). Kualitas Perairan Sungai Bremi Kabupaten Pekalongan ditinjau dari Faktor Fisika-Kimia Sedimen dan Kelimpahan Hewan Makrobentos. *Diponegoro Journal of Maquares*, 3(1), 160-167. https://doi.org/10.14710/marj.v3i1.4433

Prabandini, F.A., Rudiyanti, S., & Taufani, W.T. (2021). Analisis Kelimpahan dan Keanekaragaman Gastropoda Sebagai Indikator Kualitas Perairan di Rawa Pening. *PENA Akuatika*, 20(1), 93-101. https://doi.org/10.31941/penaakuatika.v20i1.1267

Pramono, R.A., Trisnapradika, G.A., Adhy, B.B., Prawesty, G.F.D., Sutrisno, H., & Putra, R.P. (2023). Penyuluhan Peningkatan Ekspor Batik Menuju Pasar Global Berkelanjutan di Kampung Rejomulyo. *Jurnal Abdi Masya*, 4(2), 212-218. http://dx.doi.org/10.52561/abma.v4i2.308

Siregar, A.B., Raya, A.B., Nugroho, A.D., Indana, F., Prasada, I.M.Y., Andiani, R., Simbolon, T.G.Y., & Kinasih, A.T. (2020). Upaya Pengembangan Industri Batik di Indonesia. *Dinamika Kerajinan dan Batik: Majalah Ilmiah*, 37(1), 79-92. https://doi.org/10.22322/dkb.v37i1.5945

Sompotan, D.D & Sinaga, J. (2022). Pencegahan Pencemaran Lingkungan. *Sainteks:Jurnal Sains, Teknologi, dan Kesehatan*, 1(1), 6-16. https://doi.org/10.55681/saintekes.v1i1.2

Suryatini, K.Y., Dharmadewi, A.A.I.M., & Widana, I.N.S. (2022). Penggunaan Makrozoobentos sebagai Bioindikator Pencemaran Logam Berat pada Ekosistem Lamun. *Jurnal Edukasi Matematika dan Sains*, 11(2),1-7. https://doi.org/10.5281/zenodo.7525714

Maulana, M.A & Kuntjoro, S. (2023). Hubungan Indeks Keanekaragaman Makrozoobentos dengan Kualitas Air Kali Surabaya, Wringinanom, Gresik. *Lentera Bio,* 12(2), 219-228. https://journal.unesa.ac.id/index.php/lenterabio/index

Mrozinska, N & Bakowska, M. (2020). Effect of Heavy Metals in Lake Water and Sediments on Bottom Invertebrates Inhabiting the Brackish Coastal Lake Lebsko on the Southern Baltic Coast. *International Journal of Environmental Research and Public Health*, 17,1-19. https://doi.org/10.3390/ijerph17186848

Tulandi, S.S. (2022). Analisis Kualitas Air Danau Sineleyan Tomohon Berdasarkan Struktur Keanekaragaman Makrozoobentos. *Majalah InfoSains*, 3(1),27-37. https://doi.org/10.55724/jis.v3i1.47

Wahyuningsih, E., Rahayu, N.L., & Zaenuri, M. (2022). The Effect of Rock Mining on the Macrozoobenthos Community in the Logawa River. *Jurnal Multidisiplin Madani (MUDIMA),* 2(2),1047-1066. https://doi.org/10.54259/mudima.v2i2.488

Zammi, M., Rahmawati, A., & Nirwana, R.R. (2018). Analisis Dampak Limbah Buangan Pabrik Batik di Sungai Simbangkulon Kabupaten Pekalongan. Walisongo *Journal of Chemistry*, 1(1), 1-5. https://doi.org/10.21580/wjc.v2i1.2667