The Impact of Ilegal Gold Mining to Water Quality of the Batang Masumai River Seen from Diversity Phytoplankton and Macrozoobenthos

Refia Febri Zawarni [*1)], Nurhaviza Dwi Ananda [*2)], Zuli Rodhiyah [3)], Freddy Ilfan [4)]

ORCHID IDs: https://orcid.org/0009-0004-9508-1807

[1,2,3,4)]*Environmental Engineering Study Program, Faculty of Science and Technology, Jambi University*

email: [1]*rfebrizawarni@gmail.com*, [2]*vizadwanda@gmail.com*

Abstract

Illegal gold mining carried out by the community in the Batang Masumai River is increasingly disturbing. As a result of the dredging carried out by miners, the river flow looks murky and the water quality decreases. This research aims to determine the water quality of the Batang Masumai River using biological, physical and chemical parameters. Sampling was carried out using a purposive random sampling method at 3 research location points. For the results of measurements of physico-chemical parameters at the three locations, namely average temperature 30°C, average pH 8, turbidity ranging from 252.18-577.33 NTU, brightness ranging from 6-8 cm, DO ranging from 0.3-0. .4 mg/L, BOD ranges from 9-13 mg/L. The results of phytoplankton research show that the phytoplankton composition obtained is 3 (three) classes, namely Cyanophyceae, Chlorophyceae, Bacillariophyceae. The phytoplankton diversity index (H') at the three locations ranges from 0.4505-1.0251 and the phytoplankton dominance index (D) ranges from 0.4650-1. Meanwhile, the results of this research show that the macrozoobenthos composition obtained is 8 families, including 7 families from the Insecta class and 1 family from the Gastropoda class. The macrozoobenthos diversity index (H') at the three locations ranged from 0.451 to 1.992. The evanness index (E) of macrozoobenthos ranges between 0.650-0.968 and the dominance index (D) of macrozoobenthos ranges from 0.148-0.722. Based on measurements of physical and chemical and biological parameters using phytoplankton and macrozoobenthos as bioindicators, the results show that the Batang Masumai River water is classified as heavily polluted.

Keywords: *Batang Masumai River, Diversity, Phytoplankton, Macrozoobenthos*

1. Introduction

The Batang Masumai River is a component of the aquatic ecosystem playing a crucial role in hydrological cycles and serving as a water catchment area for its surroundings (Suwondo *at al*, 2004). Despite local communities relying on the river for daily needs, unauthorized gold mining activities (locally known as PETI) in the upstream pose a threat to water quality, which serves as a vital source for drinking water and irrigation [13].

This study highlights the concerning PETI activities conducted without permits, particularly in the vicinity of the river's headwaters. The Batang Masumai River, besides being a source of drinking water, is utilized for irrigation of surrounding fields. Water quality monitoring is undertaken through various methods, including biological assessments utilizing bioindicators such as phytoplankton and macrozoobenthos [1].

Phytoplankton, as part of the aquatic food chain, serves as a biological indicator for water quality through saprobity indices. Meanwhile, the presence of macrozoobenthos, observed from the substrate of the water body, plays a crucial role in the ecosystem as consumers and a food source for higher trophic levels [21].

Due to PETI activities, the water quality of the Batang Masumai River has deteriorated, evident in the visibly turbid water conditions. Consequently, this research aims to provide information on the presence of plankton as a bioindicator of water quality in the Batang Masumai River, a subject that has not been previously investigated. This study is anticipated to serve as foundational information regarding river water quality based on the abundance of phytoplankton and macrozoobenthos.

2. Research Methods

Time and place of research

The sampling and testing were conducted over a three-month period, spanning from February 2023 to May 2023. This research was carried out at the Unauthorized Gold Mining Site (PETI) in the Batang Masumai River, Batang Masumai District, Merangin Regency, Jambi Province (2º3'28.98" South Latitude and 102º13'30.15" East Longitude). Water sample quality testing took place at the Biology Laboratory of the Faculty of Science and Technology, University of Jambi.

Research procedure

2.1.1. Determination of sample point

The water sampling points in the Batang Masumai River consisted of three station points. The location determination was conducted using a survey method, namely the upstream (inlet), middle section (middlelet), and downstream (outlet) of the water. The illustration of the sampling points can be seen in Figure 1.

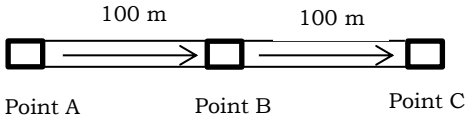


Figure 1. Ilustration of The Batang Masumai river water sampling

2.1.2. Sampling

According to the American Public Health Association (1995), river water sampling was conducted at 13:00 WIB. A total of 50 liters of water samples were collected and filtered through a plankton net with a mesh size of 40 µm for phytoplankton. The equipment and materials used in the sampling of macrozoobenthos included an Eckman grab sieve with a mesh size of 0.5 mm, plastic clips measuring 20 x 15 cm, 4% formalin, and rose bengal. Water samples were collected for various supporting parameters, including pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), nitrate, nitrite, turbidity, temperature, and brightness.

Data Processing

2.1.3. Plankton abundance.

According to Welch (1952), plankton abundance is calculated with the aim of determining the number of plankton individuals per unit volume (liter).

$$N = n \frac{1 \; x \; Vt \; x \; Ot}{Vd \; x \; Vcg \; x \; Og}$$

Where, N = abundance (cell/liter), n = number of cells enumerated, Vd = volume of filtered water sample (L), Vt = volume of filtered water (mL), Vcg = volume of cover glass, Ot = cover area (mm^2), Op = extent of observation (mm^2) .

Suryono's criteria 2011: 0-2000 cell/liter = low nutriens, 2000-15000 cell/liter= moderate nutriens, >15000 cell/liter= high nutriens.

2.3.2. Saprobic Index (SI)

The saprobic index includes indices used to calculate the number of organic pollutant species per category in aquatic environments, and the total saprobic index encompasses the status of inorganic pollutant groups in aquatic environments. To calculate the Saprobic Index (SI), the following equation is utilized:

$$SI = \frac{1\,C+3D+1B-3A}{1A+1B+1C+1D}$$

Where, SI = Saprobic index, A = number of polysaprobic organisms, B= number of α-mesosaprobic organisms, C = number of β-mesosaprobic organisms, D = number of oligosaprobic organism.

2.1.3. Indeks of Diversity, Evenness, and Donimance of Phytoplankton and Macrozoobenthos

The diversity index (H') depicts the population status of organisms mathematically to facilitate the analysis of information on the number of individuals of each species in a community. To achieve this, the diversity of plankton is calculated using the equation from Shannon-Wiener [10]:

$$H' = -\sum\frac{ni}{N}\,\text{In} = \frac{ni}{N}$$

Where, H = diversity index by Shannon-Wenner, N = number total of individuals, Ni = number of species -i

Tabel 1. Diversity index *Shannon-Wiener*

H’	Diversity level	Level of water pollution
H’ < 1,0	Low level of diversity	Heavily polluted
1,0 < H’ > 3,0	Moderate level of diversity	Moderately polluted
H’ > 3,0	High level of diversity	Not polluted

Evenness refers to the composition of the number of individuals in each genus within the community. Low evenness indicates an uneven distribution of each species.

$$E = \frac{H'}{H\,maks} \quad \text{or} \quad \frac{H'}{In(s)}$$

Where, E = Evenness index, H’ = Diversity index, H maks = Indeks keanekargaman of maximum species. The evenness value of a population ranges from 0-1 to category:

Tabel 2. Evenness index Shannon-Wienner

Evenness index	Level of evenness
E > 0,6	High evenness
0,4 < E < 0,6	Moderate evenness
E< 0,4	Low evenness

The dominance index can be determined using the Simpson dominance index with equation:

$$D = \sum (ni / N)^2$$

Where, Ni : importance value for each type (number of individuals of each spesies), N : total interest value (the number of all individuals of each spesies).

Tabel 3. Dominance index *Simpson*

Dominance index (C)	Category
0,60 < C ≤ 1,00	High dominance
0,30 < C ≤ 0,60	Moderate dominance
00,0 < C ≤ 0,30	Low dominance

3. Result and Discussion

In this study, sampling was conducted for the physical and chemical parameters of the water in the Batang Masumai River. The following are the results of the research.

3.1. Physical Factors

The physical parameters measured during the study included temperature, turbidity, and brightness. Temperature was measured using a thermometer, turbidity was measured using a turbidimeter, and brightness was assessed using a Secchi disk. These measurements were conducted directly on-site (in-situ) at each sampling point in the Batang Masumai River. The laboratory test results from the study can be seen in Table 4 as follows:

Tabel 4. Physical factors that influence waters

No	Parameter	Point A		Point B		Point C		Quality Standards
		1	2	1	2	1	2	
1.	Temperature (ºC)	30	30	30	30	30	30	20-30
2.	Turbidity	252,18	270,2	325,1	415,7	549,23	577,33	25

	(NTU)							
3.	Brightness (cm)	8	8	7,5	7	6	6	50

Source : Primary data, 2023

3.1.1. Watertemperature

The results of water temperature measurements in the Batang Masumai River indicate that the water temperature at all points is constant, measuring 30ºC. This condition signifies temperature stability throughout the measurement area, including the water inlet area (point A), the mining location (point B), and the river water outlet area (point C). The recorded temperature falls within the optimal range (20-30℃) for the growth of plankton, both phytoplankton and zooplankton. Therefore, it can be concluded that the overall water conditions in the Batang Masumai River are favorable for plankton life. Reference to Effendi (2003) cites this temperature range as an ideal condition for plankton growth.

3.1.2. Turbidity

The turbidity values obtained range between 252.18 – 549.23 NTU. At point A,1, the lowest turbidity is recorded at 252.18 NTU, while point B ranges between 325.06 - 415.7 NTU. Point C,3 exhibits the highest turbidity value at 577.33 NTU. The turbidity values in the Batang Masumai River, based on measurement results, have exceeded the threshold limit (MAB), which is known to potentially disrupt the life and growth of aquatic organisms such as plankton. High turbidity can disturb the visual system of aquatic organisms and impede the penetration of light into the water.

3.1.3. Brightness

The brightness measurements at each station during the study in the waters of the Batang Masumai River range from 6.0 to 8.0 cm. The highest brightness is recorded at point A, measuring 8.0 cm, while the lowest brightness is at point C, measuring 6.0 cm. The brightness values in the Batang Masumai River are not conducive to the life and growth of aquatic organisms, especially plankton.

3.2. Chemical factors

The chemical parameters measured directly (in-situ) included pH using a pH meter and dissolved oxygen (DO) using a DO meter at each sampling point in the water. The laboratory test results from the study can be seen in Table 3 below:

Tabel 5. Chemical factors that affect waters

No	Parameter	Point A		Point B		Point C		Quality Standards
		1	2	1	2	1	2	
1.	DO (mg/L)	0,4	0,4	0,3	0,3	0,3	0,3	4
2.	BOD (mg/L)	9	9	13	13	13	13	4
3.	pH	8,6	8,6	8,6	8,7	8,7	8,7	6-9

Source : Primary data, 2023

3.2.1. Dissolved Oxygen (DO)

The research on dissolved oxygen (DO) measurements in the Batang Masumai River indicates low values, with results below 1 at some points, specifically 0.4 mg/L at point A and 0.3 mg/L at points B and C. Table 3 shows that the DO values in the Nibung village are below 4 mg/L at each measurement point location. These results indicate that the DO values in the Batang Masumai River do not meet the established quality standards, which require a minimum DO value of 4 mg/L based on PP No. 22 of 2021. Salmin (2005) also states that DO values <4 mg/L indicate a high level of pollution in the water.

3.2.2. BOD

The Batang Masumai River experiences the highest Biochemical Oxygen Demand (BOD) levels at points B and C, measuring 13 mg/L each, situated in the gold mining area. The lowest value, 9 mg/L, is recorded at point A. The increase in BOD concentration from the upstream to downstream of the river indicates the presence of organic waste from human activities along the river. The high BOD values in the middle and downstream parts of the river are attributed to the contamination of organic substances, presumed to originate from household waste and unauthorized gold mining (PETI). The rise in BOD concentration in a water body reflects signs of water pollution.

3.2.3. pH

The research on the pH of the Batang Masumai River water yielded values between 8.6-8.7 at each measurement point (8.6 at point A and 8.7 at points B and C). Organisms in water

have pH tolerance limits that vary depending on factors such as temperature, dissolved oxygen, and ionic salt content. Most natural waters have a pH range between 6-9. Although the pH of the Batang Masumai River falls within this range, the slightly elevated values (8.6-8.7) may create abnormal conditions, particularly since many aquatic organisms, such as plankton, are more sensitive to pH changes and prefer pH values around 7-8.5. An alkaline environment (high pH) can also lead to high concentrations of toxic ammonia. Therefore, the pH values of the Batang Masumai River may indicate abnormal water conditions.

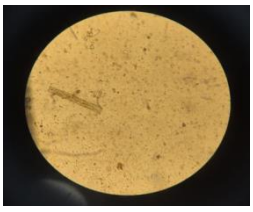
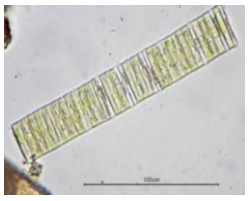
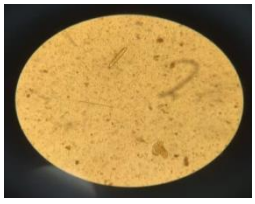
3.3. Types of Phytoplankton in Batang Masumai River

The research results in the waters of Sungai Batang Masumai revealed the presence of phytoplankton, comprising 3 classes and consisting of 5 species. The identified classes of phytoplankton in this study are as follows:

Class of *Bacillariophyceae*

The identification results of phytoplankton in the class *Bacillariophyceae* consist of 4 species. These species are *Fragiaria sp, Navicula sp,* and *Pleurosigma sp*. The images of these 3 species in the class Bacillariophyceae can be seen in the table 6 below :

Table 6. Class of *Bacillariophyceae*

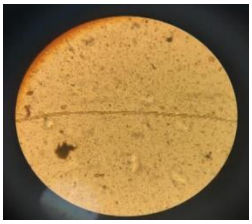
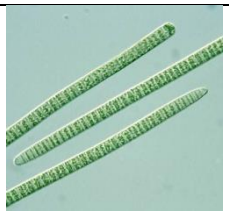
No.	Result	*Literature*
1.	 *Fragilaria, sp*	 (Sulastri, 2018)
.2.	 *Navicula, sp*	 (Sulastri, 2018)

No.	Result	*Literature*
3.		
	Pleurosigma, sp	(Botes, 2001)

Class of *Cyanophyceae*

The identification results of phytoplankton in the class Cyanophyceae consist of 1 species. This species is Oscillatoria sp. The image of the species in the class Cyanophyceae can be seen in the table 7 below:

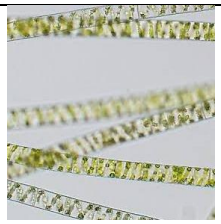
Table 7. Class of *Cyanophyceae*

No.	Result	*Literature*
1.		
	Oscillatoria, sp	(Rani, 2016)

Class of *Chlorophyceae*

The identification results of phytoplankton in the class Chlorophyceae consist of 1 species. This species is Spirogyra sp. The image of the species in the class Chlorophyceae can be seen in the table 8 below:

Table 8. Class of *Chlorophyceae*

No.	Result	*Literature*
1.		
	Spirogyra, sp	(Ramaraj, 2015)

Result of phytoplankton identification in the Batang Masumai River

The results of the phytoplankton testing in the waters of Sungai Batang Masumai include a report containing the names of species, the number of each species, the total taxa, and the values of phytoplankton diversity and evenness for each sampling point. The laboratory test results can be observed in the following Table 8:

Table 8. Result of phytoplankton identification in the Batang Masumai River

No.	Parameter	Phytoplankton					
		Point A		Point B		Point C	
		I	2	I	2	I	2
	Bacillariophyceae						
1.	*Fragilaria, sp*	134	-	51,7	-	103	-
2.	*Navicula, sp*	31	51,7	-	-	-	62
3.	*Pleurosigma, sp*	20,7	-	-	-	20,7	-
	Cyanophyceae						
1.	*Oscillatoria, sp*	-	41,3	10,3	-	-	-
	Chlorophyceae						
1.	*Spirogyra, sp*	20,7	-	-	93	-	-
	Abundance (Ind/L)	206,4	93	62	93	123,7	62
	Taxa (S)	4	2	3	1	2	1
	Diversity (H')	1,0251	0,4505	0,7963	0	0,4506	0
	Dominance (D)	0,4650	0,7222	0,5510	1	0,7222	1

Saprobic coeficient value of phytoplankton in Batang Masumai river

This index is used to determine the level of pollution in a water body by establishing its saprobity coefficient, indicating whether it is α-meso saprobic, poly saprobic, or oligo saprobic. The saprobity index formula is calculated using the equation from Maresi et al. (2015), and the results can be found in the following table 9:

Table 9. Saprobic Index of Phytoplankton

Kode	Class	Number of types
A	Cyanophyta	1
B	Chlorophyta, Bacillariophyta	4
C	Dinophyta	0
D	Chrysophyta	0

$$x = \frac{C + 3\,D - B - 3\,A}{\mathrm{A} + \mathrm{B} + \mathrm{C} + \mathrm{D}}$$

$$x = \frac{0 + 3(0) - 4 - 3\,(1)}{1 + 4 + 0 + 0}$$

$$x = \frac{-7}{5}$$

$$x = \frac{-7}{5}$$

$$x = -1{,}4$$

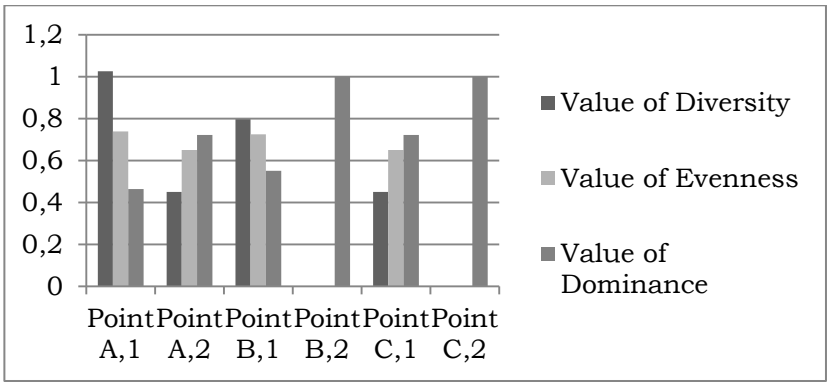
The saprobity index values obtained from the analysis above, based on the relationship between the saprobity coefficient of water (X) and the level of water pollution (Suwondo et al, 2004), related to the phytoplankton community, are classified as indicating relatively heavy pollution or α-meso/polysaprobic, with a saprobic value of -1.4.

The Value of Diversity, Evenness and Dominance of Phytoplankton in The Batang Masumai River

From the calculations at point A, the sampling location in the Batang Masumai River, four (4) taxa and two (2) taxa were obtained with different values for the number of individuals of each species (ni) and abundance (N) values of 20 and six (6). The final diversity index (H') values were 1.025094 and 0.450561, with evenness (E) values of 0.739449 and 0.650022. The dominance values (C) were 0.465 and 0.7222.

In the calculations at point B, the sampling location in the Batang Masumai River, three (3) taxa and one (1) taxa were obtained with different values for the number of individuals of each species (ni) and abundance (N) values of seven (7) and nine (9) for plankton. The final diversity index (H') values were 0.796312 and 0. For phytoplankton, the evenness (E) value was 0.724834, and no evenness value was obtained for location B, point two (2), as it only had one (1) taxon. The dominance values (C) were 0.55102 and one (1) for the second location.

Based on the data analysis obtained at all research points, it is evident that the diversity, evenness, and dominance indices of plankton in the Batang Masumai River in Nibung Village have varying results. The diagram of diversity, evenness, and dominance values at each point is presented in Figure 2 below.



Gambar 2. The Value of Diversity, Evenness and Dominance of Phytoplankton in The Batang Masumai River research location, Nibung village

Referring to the classification of the Shannon-Wiener diversity index, the plankton diversity index in the Batang Masumai River in Nibung Village falls into the category of diversity, and the distribution of the number of individuals of each plankton type falls into the category of heavy pollution. This result is obtained from the analysis of the diversity index values of phytoplankton at each point, which has values ranging from 0.45 to 1.02.

The above evenness values indicate that the evanness of the population at all sampling points is consistent with relatively high values, exceeding 0.6. The high evenness at all sampling points is due to evenly distributed species, preventing a tendency toward a specific species. According to Fachrul (2006), when the E value approaches 0, the evenness between species is low. If the E value approaches 1 (>0.5 – 1), the evenness between species is relatively uniform.

The dominance value of plankton in the Batang Masumai River at each point has a value of $0.5 < C < 1$, meaning there is a dominant species at each point. Phytoplankton at each point is dominated by the class Bacillariophyceae with the species Fragillaria, with dominance values ranging from 0.465 to 0.7222. In zooplankton, points B and C have a dominance value of 1 because they only have 1 (one) species at those points.

3.4. Macrozoobenthos

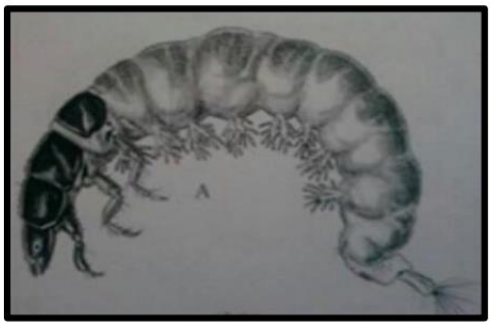
The macrozoobenthos found and identified in the waters of the Batang Masumai River in Merangin Regency amounted to 8 families, consisting of 5 orders. The macrozoobenthos found in each can be used to describe the macrozoobenthos present in the water. The macrozoobenthos found in the waters of the Batang Masumai River in Merangin Regency can be seen in Table 10 below:

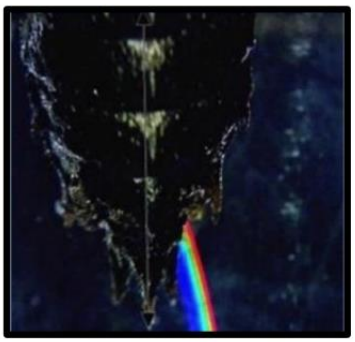
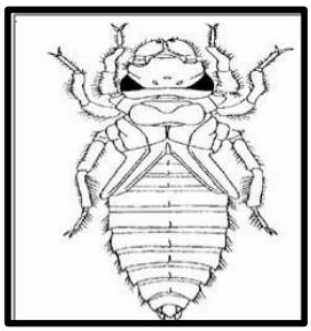
Tabel 10. Number of Macrozoobenthos Family

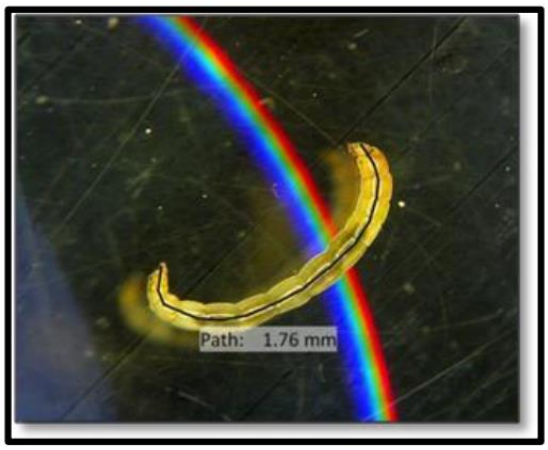
No.	Class	Ordo	Family	Point			Number of Individuals
				A	B	C	
1	Insekta	Tricopetra	Philopotamidae	1	1	0	2
2			Hydropcyshidae	2	1	1	4
3		Odonata	Gomphidae	0	1	0	1
4			Chironomidae	0	2	0	2
5		Ephemeroptra	Heptagenidae	2	2	0	4
6			Caenidae	2	3	0	5
7		Lepidoptera	Pyralidae	1	2	0	3
8	Gastropoda	Mesogastropoda	Thiaridae	1	1	5	7
Total	2	5	8	9	13	6	28

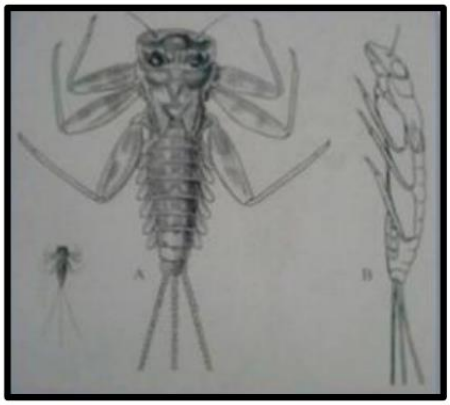
Types of macrozoobenthos species

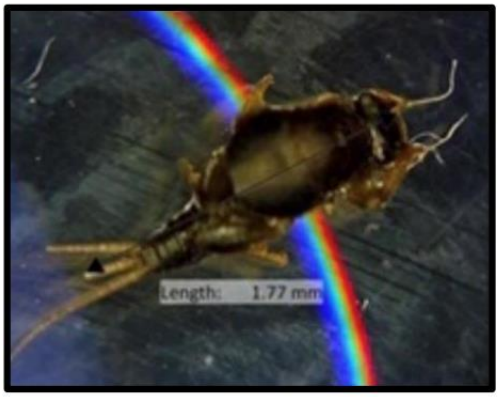
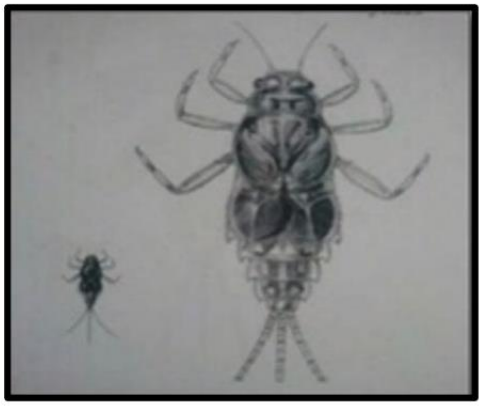
Hasil Pengamatan	**Hasil Literatur**
	
(Sumber : Dokumentasi Pribadi, 2023)	(Sumber : Borror, 1992)

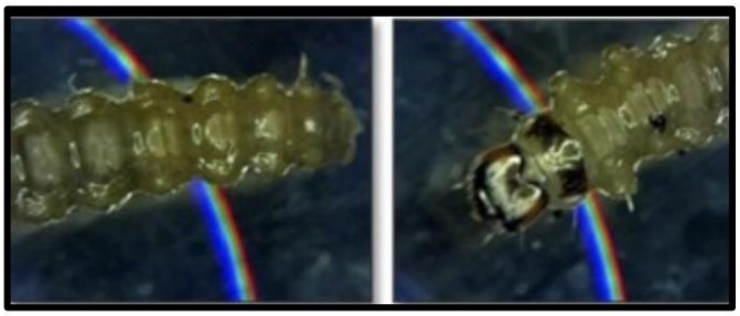
Hasil Pengamatan	Hasil Literatur
	
(Sumber : Dokumentasi Pribadi, 2023)	(Sumber : Borror, 1992)

Hasil Pengamatan		Hasil Litratur
		
(Sumber : Dokumentasi Pribadi, 2023)		(Sumber : Voshell, 2002)

Hasil Pengamatan	Hasil Literatur
	
(Sumber : Dokumentasi Pribadi, 2023)	(Sumber : Voshell, 2002)

Hasil Pengamatan	Hasil Literatur
	
(Sumber : Dokumentasi Pribadi, 2023)	(Sumber : Voshell, 2002)

Hasil Pengamatan	Hasil Literatur
	
(Sumber : Dokumentasi Pribadi, 2023)	(Sumber : Borror, 1992)

Hasil Pengamatan	Hasil Literatur
	
(Sumber : Dokumentasi Pribadi, 2023)	(Sumber : Zeller, 2018)

Hasil Pengamatan	Hasil Literatur
	
(Sumber : Dokumentasi Pribadi, 2023)	(Sumber : Bouchard, 2004)

The values of Diversity Index (H'), Evenness Index (E), and Dominance Index (D) of Macrozoobenthos. The calculated values of the diversity index (H'), evenness index (E), and dominance index (D) of macrozoobenthos overall, from all observation points, can be seen in Table 11 below.

Tabel 11. Diversity index (H') Macrozoobenthos

Point	Diversity index (H')	Criteria	Level of polluted
I	1,735	Moderate Diversity	Moderately polluted
II	1,992	Moderate Diversity	Moderately polluted
III	0,451	Low Diversity	Heavily polluted

(Source : Processed data, 2023)

Based on Table 11, the diversity index (H') values of macrozoobenthos in the Batang Masumai River can be observed. When ranked from high to low, they are in the following order: Point B (1.992), followed by Point A (1.735), and the lowest at Point C (0.451). The highest diversity index is found at Points A and B, where Point A is situated before the pollution source (PETI activities), and Point B is in the area used as a site for illegal gold mining. The lowest diversity index is found at Point C, where this location is situated after illegal gold mining activities (PETI)..

Evenness index (E) Macrozoobenthos

The results of the macrozoobenthos evenness index are presented in the table 12 below.

Tabel 12. Evenness index (E) Macrozoobenthos

Point	Evenness index (E)	Criteria
A	0,968	High evenness

B	0,958	High evenness
C	0,65	High evenness

(Source : Processed data, 2023)

Based on Table 12, it can be observed that the evenness values of macrozoobenthos in the Batang Masumai River do not show significant differences at each point. When ranked from high to low, they are in the following order: Point A (0.968), followed by Point B (0.958), and the lowest at Point C (0.650). At each point, it can be said that the evenness of macrozoobenthos falls within the moderate criteria. A high evenness index indicates an even distribution of macrozoobenthos species with no dominance by a single species. Relatively homogeneous physicochemical factors contribute to the high evenness of benthos (Yolanda et al., 2015). This suggests that the distribution of the macrozoobenthos population in the Batang Masumai River is quite good. The abundance of macrozoobenthos species found at each station, despite the presence of certain dominant species, is likely related to the varying habitat conditions in the water (Irmawan, 2010).

Dominance index (D)

The results of calculating the macrozoobenthos dominance index are presented in the table 13 below.

Tabel 13. Dominance index (D) Makcozoobenthos

Point	Dominance index (D)	Criteria
A	0,185	High dominance
B	0,148	Moderate dominance
C	0,148	Moderate dominance

Based on Table 13, it is evident that there are differences in the macrozoobenthos dominance index values in the Batang Masumai River. When sorted from high to low, they are in the following order: Point III (0.722), followed by Point I (0.185), and the lowest at Point II (0.148). The highest diversity index is found at Point III, where this location is situated after illegal gold mining activities (PETI). Point I is before the pollution source (PETI activities), and Point II is in the area used as a site for illegal gold mining.

The dominance index at Points A and B falls into the low dominance category, indicating no species that dominate. This suggests that the communities at Points I and II are stable, and there is no ecological pressure causing environmental changes. According to Purnama et al. (2001), the presence of dominance indicates a low species richness with uneven

distribution, meaning that in the observed community, a dominant species is not found. Thus, this condition reflects a community structure in a stable state. Meanwhile, at Point III, it falls into the high dominance category, where only one macrozoobenthos species dominates in that area. According to Sudarja (1987), when the dominance index approaches one, the population is dominated by a specific species.

4. Conclusion

The measurements of physicochemical parameters at the three locations yielded average temperatures of 30°C, average pH of 8, turbidity ranging from 252.18 to 577.33 NTU, brightness ranging from 6 to 8 cm, dissolved oxygen (DO) ranging from 0.3 to 0.4 mg/L, and BOD ranging from 9 to 13 mg/L. The research results using bioindicators indicated the presence of three classes of phytoplankton, namely Cyanophyceae, Chlorophyceae, and Bacillariophyceae. The phytoplankton diversity index (H') at the three locations ranged from 0.4505 to 1.0251, and the dominance index (D) ranged from 0.4650 to 1. The saprobity index values derived from the above analysis, based on the relationship between the saprobity coefficient of water (X) and the level of water pollution (Suwondo et al., 2004) related to the phytoplankton community, classified the pollution level as quite severe or α-meso/polysaprobic with a saprobic value of -1.4. As for macrozoobenthos, it comprised 7 families from the Insecta class and 1 family from the Gastropoda class. The macrozoobenthos diversity index (H') at the three locations ranged from 0.451 to 1.992. The evenness index (E) of macrozoobenthos ranged from 0.650 to 0.968, and the dominance index (D) of macrozoobenthos ranged from 0.148 to 0.722. Based on the measurements of physicochemical and biological parameters using phytoplankton and macrozoobenthos as bioindicators, the results categorize the water of the Batang Masumai River as heavily polluted.

References

[1]. Anggraini, A., Sudarsono, S., & Sukiya, S. (2016). Kelimpahan dan tingkat kesuburan plankton di Perairan Sungai Bedog. Biologi-S1, 5(6), 1-9.

[2]. Basmi, J. 1988. Perkembangan Komunitas Fitoplankton Sebagai Indikator Perubahan Tingkat Kesuburan Kualitas Perairan (Tidak Dipublikasikan). Makalah Pelengkap Mata Ajaran Manajemen Kualitas Air. Program Studi Manajemen Sourcedaya Perairan. Fakultas Perikanan dan Ilmu Kelautan. Institut Pertanian Bogor Dimenta, R. H., Riska, A., Rusdi, M. dan Khairul. 2020. Kualitas Sungai Bilah Berdasarkan Biodiversitas Fitoplankton Kabupaten

Labuhanbatu, Sumatera Utara. Jurnal Ilmu Alam dan Lingkungan. 11 (2) : 24–33

[3]. Borror. D. J, Triplehorn, C.A, Johnson, N. F. 1992. Pengenalan Pelajaran Serangga. Yogyakarta: Gadjah Mada University Press.

[4]. Bouchard. R. W. 2004. Guide to Aquatic Macroinvertebrata of the Upper Midwest. Water Resources center, University of Minnesota.

[5]. Delgado, G. A., Glazer, R. A., and McCarthy, K. 2007. Translocation as Strategy to Rehabilitate the Queen Conch (Strombus gigas) Population in The Florida Keys. Journal of National Marine Fisheries Service. Academic of Florida Fish and Wildlife Conservation Commission. Marine Research Institute. Miami.

[6]. Effendi, H. (2003). Telaah Kualitas Air bagi Pengelolaan Source Daya dan Lingkungan Perairan Cetakan Kelima. Yogjakarta: Kanisius.

[7]. Fitria Yeni Bahri. 2010. "Keanekaragaman Dan Kepadatan Komunitas Moluska Diperairan Sebelah Utara Danau Maninjau", Skripsi, Departemen Biologi Fakultas MIPA, Institut Petanian Bogor.

[8]. Gerber. A. 2002. Aquatic Invertebrates Of South African Rivers. Africa: Institute For Water Quality Studies.

[9]. Goi, C. L. 2020. The river water quality before and during the Movement Control Order (MCO) in Malaysia. Case Studies in Chemical and Environmental Engineering, 2, 100027.

[10]. Krebs, C.J. (1989). Experimental Analysis of Distribution and Abundanc. Third Edition. New York.

[11]. Manik, K.E.S. 2016. Pengelolaan Lingkungan Hidup. Prenadamedia Group. Jakarta.

[12]. Newell, G. E. & R. C. Newell, 1977. Marine Plankton, A Practical Guide. Hutchinson of London.

[13]. Oktarindo, M. F., Saptawan, A., & Marpaung, Z. S. (2018). Faktor-Faktor yang Mempengaruhi Implementasi Kebijakan Pengelolaan Lingkungan Hidup pada Penambangan Emas di Kabupaten Merangin Provinsi Jambi(Doctoral dissertation, Sriwijaya University).

[14]. Raymont, J. E. G. 1981. Plankton dan Produktivitas Bahari (diterjemahkan Koesbiono).

[15]. Sari, M. D., Zuhri, R., & Viza, R. Y. (2020). Analisis Tingkat Cemaran Bakteri Coliform di Sungai Batang Masuma Kabupaten Merangin. Biocolony, 3(1), 1-9.

[16]. Simamora. D.R. 2009. Studi Keanekaragaman Macrozoobenthos di Aliran Sungai Padang Kota Tebing Tinggi. Skripsi FMIPA USU. Medan (Tidak Diterbitkan).

[17]. Simamora. D.R. 2009. Studi Keanekaragaman Macrozoobenthos di Aliran Sungai Padang Kota Tebing Tinggi. Skripsi FMIPA USU. Medan (Tidak Diterbitkan).

[18]. Setyobudiandi. I. 1997. Makrozoobenthos (Definisi, Pengambilan Contoh Dan Penangannya). Laporan Penelitian. Laboratorium Manajemen Sourcedaya Perairan. Fakultas Perikanan Dan Ilmu Kelautan. Institut Pertanian : Bogor.

[19]. Uddin, M. G., Nash, S., & Olbert, A. I. 2021. A review of water quality index models and their use for assessing surface water quality. Ecological Indicators, 122, 107218.

[20]. Welch, P. S. (1952). Limnology. Second edition. New York: McGraw Hill International Book Company.
[21]. Zhang, Y., Wu, P., Zakem, E. J., & Dutkiewicz, S. (2020). Biomagnification of methylmercury in a marine plankton ecosystem. Environmental Science & Technology, 54(9), 5446-5455.