AES
Applied Environmental Science
AES 2(1): 49–68
ISSN 3025-0412

Institute for Advanced Science, Social and Sustainable Future
MORALITY BEFORE KNOWLEDGE

Structure of the macrozoobenthos community in Buai River, Pulau Tengah, Keliling Danau District, Kerinci Regency, Jambi Province

Nadya Juaninda[1*]
[1] *Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Sriwijaya; Palembang, 30128, Indonesia.*
*Correspondence: nadyajuaninda00@gmail.com

Received Date: May 15, 2024 Revised Date: July 20, 2024 Accepted Date: July 22, 2024

ABSTRACT
Background: Buai River is a river located in the village of Jembatan Merah Pulau Tengah, Keliling Danau District, Kerinci Regency, Jambi. Buai River with topographic conditions in the form of a hilly highland area, surrounded by mountains and dense forests so that it has a heterogeneous microhabitat and is still natural for macrozoobenthos. Therefore, a study was conducted on the presence and structure of macrozoobenthos in the Buai River area of Central Island. This study aims to analyze the structure of the macrozoobenthos community based on the composition of the macrozoobenthos species, density, diversity, dominance and distribution of macrozoobenthos in the waters of the Buai River. This research is expected to provide information in the form of scientific data and knowledge about the structure of the macrozoobenthos community in the waters of the Buai River to be used as comparative data for future research. This research was conducted from January to February 2022. **Methods:** The research method used is a quantitative descriptive method, which is to describe and evaluate a symptom or event that appears systematically. Determination of research stations is done by purposive sampling method, which is taken five stations based on environmental baseline. Data analysis was carried out by calculating the composition, macrozoobenthos density, Diversity Index, Dominance Index and Community Similarity Index between stations. **Findings:** The results showed that there were 5 classes, 11 orders, 26 families and 42 genera. Diversity values ranged from 1.4 to 2.45 which was classified as moderate, the dominance ranged from 0.1 to 0.45, and the similarity of the macrozoobenthic community in Buai River 60.71% - 82.54% the similarity of the macrozoobenthos was relatively the same with little organic pollution. **Conclusion:** Based on the structure of the macrozoobenthos community in the Buai River, Central Island, it can be concluded that the Buai Pulau Tengah River, Keliling Danau District, Kerinci Regency, Jambi Province is still classified as very good. **Novelty/Originality of this Study:** This study presents novel findings by revealing the structure of the macrozoobenthos community in a relatively undisturbed highland river surrounded by dense forests, which provide a unique heterogeneous microhabitat. It contributes original data on the species composition, density, diversity, and distribution of macrozoobenthos in this specific region, offering a baseline for future comparative studies.

KEYWORDS: Buai River; community structure; macrozoobenthos.

1. Introduction

Kerinci Regency is one of the regions in Jambi Province, located on the highlands of Mount Kerinci. This area is flanked by hills and tropical mountains, allowing a diverse range of plants and animals to thrive in Kerinci Regency. The region is bordered by the Barisan Mountains and is surrounded by dense forest, which is part of the Kerinci Seblat National Park. Kerinci Regency has the Buai River, which originates from the Pancuran Raya waterfall within the Kerinci Seblat National Park (TNKS) and flows into Lake Kerinci (Kerinci, 2020).

Cite This Article:
Juaninda, N. (2024). Structure of the macrozoobenthos community in Buai River, Pulau Tengah, Keliling Danau District, Kerinci Regency, Jambi Province. *Applied Environmental Science, 2*(1), 49-68. https://doi.org/10.61511/aes.v2i1.2024.905

The Buai River is located in the village of Jembatan Merah Pulau Tengah, Keliling Danau District, Kerinci Regency, Jambi. Geographically, Kerinci Regency is situated between 101° 08' - 101° 50' East Longitude and 1° 40' - 2° 26' South Latitude. The upstream part of the Buai River is untouched by human activities, remaining natural with a strong current and predominantly rocky substrate. In contrast, the downstream part of the Buai River has been impacted by various human activities, including local farming and residential areas. Residents in the Buai River Basin frequently dispose of waste and extract stones for construction materials, resulting in the downstream section of the Buai River no longer being in its natural state.

The topographic condition of the Buai River is relatively heterogeneous, featuring various types of microhabitats such as rocky, gravel, sandy, and leaf litter substrates. The type of substrate at the bottom of the water influences the structure of the macrozoobenthos community. As benthic organisms, macrozoobenthos play a crucial role in the decomposition of organic matter that enters the water and occupy several trophic levels within the food chain. According to the food chain pyramid, macrozoobenthos occupy the first and second consumer levels, making them prey for higher-level consumers.

The Buai River is dominated by large boulders and a strong current, which influences the presence of macrozoobenthos. The presence of macrozoobenthos communities can be observed from their living habitats. In rivers with fast currents and rocky substrates, macrozoobenthos from the phylum Arthropoda are more frequently found. According to Hynes (1976), boulders and small stones provide suitable shelter for aquatic insect organisms. The structure of the macrozoobenthos community in a water body can be identified based on the composition of macrozoobenthos species, their density within a community, species diversity, and their dominance in an area. The environmental conditions that affect the structure of macrozoobenthos communities include physical, chemical, and biological factors. Studies on macrozoobenthos in the Buai River are still relatively scarce, highlighting the need for research on the macrozoobenthos community as a basis for further studies in the Buai River.

Research conducted by Ika Gustina (2001) in the Air Ijuk River, Isau-Isau Pasemah Wildlife Sanctuary, Lahat Regency, which has natural conditions similar to those of the Buai River, found 9 orders comprising 30 families and 62 species of macrozoobenthos. The total density of aquatic insects on rocky substrates was 1969 individuals/m^2, with a Shannon-Wiener diversity index value of 3.1, which was higher compared to other substrates. The Buai River originates from the natural area of Kerinci Seblat National Park (TNKS), characterized by relatively diverse topographic conditions, resulting in a variety of microhabitat types.

The downstream part of the Buai River has been affected by various human activities such as local farming, residential areas, organic waste disposal, and the extraction of river stones for construction materials, which have impacted the structure of the macrozoobenthos community in the Buai River water. There is limited information available regarding the structure of the macrozoobenthos community in the Buai River, emphasizing the need for research on this topic in Buai River, Pulau Tengah, Keliling Danau District, Kerinci Regency, Jambi Province.The research on the macrozoobenthos community structure in the Buai River aims to analyze various aspects including composition, density, Shannon-Wiener Diversity Index, Dominance Index, and Community Similarity Index. This study will focus on Buai River in Pulau Tengah, Keliling Danau District, Kerinci Regency, Jambi Province.

2. Methods

2.1 Time, location, tools and materials

This research was conducted from January to April 2022, with sampling locations at the Buai River waters in Jembatan Merah Village, Pulau Tengah, Kerinci Regency, Jambi Province. The observation and identification of macrozoobenthos samples were carried out at the Ecology Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Sriwijaya University. Physical and chemical parameter measurements were conducted directly during sampling in the field, while BOD and organic material testing were performed at the Research and Standardization Laboratory in Palembang City.

The tools and materials used in the research are detailed in Table 1. The equipment includes various instruments such as alcohol for preserving samples, microscopes for observation, and GPS for determining observation locations. The tools play a crucial role in sample collection, storage, sorting, and identification, particularly for research involving biological specimens like Chironomidae larvae and macrozoobenthos.

Table 1. Tools and materials along with their functions used for research

No	Tools and Materials	Function
1.	70% Alcohol	Preserves samples for long-term storage
2.	Sample Bottles	Stores samples after sorting
3.	Petri Dish	Places samples during identification
4.	Current Velocity Meter	Measures water flow velocity at sampling points
5.	DO Meter	Determines dissolved oxygen levels
6.	Bucket	Used to rinse samples to remove formalin
7.	GPS (Global Positioning System)	Determines observation locations
8.	Glycerin	Facilitates observation of specimens under themicroscope
9.	Camera	Documentation
10.	10% KOH	Dissolves chitin in Chironomidae larvae during boiling
11.	Stove	Boils Chironomidae samples
12.	Labels	Marks samples
13.	Binocular Microscope	Observes samples for identification
14.	Stereo Microscope	Observes samples for identification
15.	Tray	Holds samples for sorting
16.	Pot	Boils Chironomidae samples
17.	Pencil	Writing tool
18.	Forceps	Facilitates sample retrieval or sorting
19.	Plastic bags	Temporary sample storage
20.	Benthos sieve	Filters samples
21.	Brush	Detaches macrozoobenthos adhering to rocks
22.	Surber net	Sampling tool
23.	Thermometer	Determines temperature values

2.2 Research procedure

2.2.1 Determination of sampling locations

Based on the pre-survey results on September 2, 2021, in the Buai River waters, sampling locations were selected based on the environmental conditions of the macrozoobenthos community. Station determination was carried out using purposive sampling method, considering areas that represent the research locations. Four stations were selected from predetermined locations: natural or untouched areas, agricultural fields, upstream residential areas, and downstream residential areas with human activities.

Station I located at the upstream of Buai River, with enviromment untouched by human activity and still in its natural habitat. The distance between Station I and II is approximately 375 meter. Coordinates: 2°10′34′′S 101°27′21″E. Station II located in a field dominated by cinnamon plants, inhabited by residents. The between Station I and Stationn II is approximately 1,115 meters. Coordinates: 2°10′04′′S 101°27′40″E. Station III located upstream of Jembatan Merah Village, in an area with a sparse population. The distance between Station III and IV is approimately 460 meters. The coordinates are 2°10′18′′S 101°27′35″E. Station IV located downstream of Jembatan Merah Village, in a residential area with activities such as public baths and the collection of river stones for construction materials. The distance between Station IV and Station V is approximately 780 meters. The coordinates area 2°10′04′′S 101°27′40″E.

(a) (b) (c) (d)

Fig. 1. Station determination of Buai River: (a) Station 1. (b) Station II. (c) Station III. (d) Station IV.

2.3 Field procedures

The sampling of macrozoobenthos is conducted by collecting substrate from the water body. Samples are collected from the substrate at each of the 4 stations, once from each type of substrate: rocky, sandy, gravel, and leaf litter, with two repetitions, totaling 48 samples. Macrozoobenthos samples from sandy, gravel, and leaf litter substrates are taken using a Surber net. The Surber net is placed on the riverbed facing upstream. Sand and gravel around the net are disturbed and left for 3 minutes, while leaf litter is filtered using the Surber net before the net is lifted from the water.

The material collected in the net is gradually poured into a sieve with a 500µm mesh, allowing benthic macrozoobenthos to pass through the sieve and be collected in a container placed below it. The remaining material in the sieve is then placed into sample bottles containing 10% formalin and labeled. Rock substrates from the riverbed, which serve as habitats for macrozoobenthos, are taken and placed into a bucket, then water is poured over them. The rocks are cleaned to collect benthic macrozoobenthos attached to them by scrubbing with a wire brush. The water mixed with the sample is then filtered using a sieve, and the samples are placed into bottles filled with water up to ¾ of their volume, then 10% formalin is added and labeled.

The physical and chemical parameters of the Buai River water are measured at each research station. The measurements include recording environmental conditions at the research sites, which cover temperature, current velocity, water depth, pH, and dissolved oxygen (DO). Additionally, a 1-liter water sample is collected for the analysis of organic materials and biochemical oxygen demand (BOD) at the Research and Standardization Laboratory in Palembang.

2.4 Laboratory procedures

The samples collected from the field are re-sorted using a testing sieve with a 1 mm mesh size. The samples are filtered with the sieve slightly tilted inside a basin filled with water up to 3/4 of its capacity to remove formalin, then placed in a tray for further sorting. After sorting, the samples are transferred to sample bottles filled with 70% alcohol. The use of alcohol is to preserve the samples for a long time without freezing.

The identification of samples obtained from the field is conducted at the Ecology Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Sriwijaya University. For small insect larvae such as Chironomidae, they need to be boiled in a 10% KOH solution for about 20 to 25 minutes before identification. This process is aimed at dissolving the muscle tissue in the larvae, leaving only the chitin layer visible, making identification easier. The boiled samples are then placed on a microscope slide with the vertical part of the capsule or head facing up and glycerin is added, before being observed under a microscope.

The identification process of *macrozoobenthos* samples will use the following identification books as follows. First, *An Introduction to the Aquatic Insects of North America, 3rd Edition* (Merritt and Cummins, 1996). Second, *Fresh-Water Invertebrates of the United States, 2nd* Edition (Pennak, 1978). Third, *Chironomidae of the Holarctic Region, Part 1. Larva*

(Key and Diagnosis) (Wiederholm, 1996). Fourth, *Siput dan Kerang Indonesia* (Dharma, 1988).

2.5 Data analysis

The density of macrozoobenthos is analyzed using the Shannon-Wiener index with the following formula. The analysis of macrozoobenthos data encompasses several key indices. Firstly, the “density of macrozoobenthos” is calculated using the formula $D = \frac{N}{A}$ where D represents density (individuals/m^2), N is the number of individuals collected, and A is the area of observation (m^2). This provides a measure of population concentration within a given area.

For biodiversity assessment, the “Shannon-Wiener diversity index” is employed. The formula is $\mathrm{H} = -\sum Pi \ln Pi$ where Pi represents the proportion of individuals for each species (ni/N), and N is the total number of individuals. The diversity is categorized into three levels: low diversity (H' < 1), moderate diversity (1 < H' < 3), and high diversity (H' > 3).

Additionally, the “Simpson’s dominance index” is utilized to understand the dominance of species within the ecosystem. The formula $C = \sum \left(\frac{ni}{N}\right)^2$ calculates the likelihood of species dominance, where values close to 0 indicate no dominance and values near 1 signify species dominance. Lastly, the “Sorensen similarity index evaluates the similarity between macrozoobenthos communities at different locations. The formula $S = \frac{2C}{A+B}$ assesses similarity based on species overlap, where C is the number of common species, and A and B are the species numbers in samples A and B, respectively. A similarity index above 50% indicates high community resemblance, while a value below 50% suggests significant community differences.

3. Results and Discussion

Based on the research conducted on the Community Structure of Macrozoobenthos in Buai River, Pulau Tengah, Subdistrict of Keliling Danau, Kerinci Regency, Jambi Province, the following results were obtained. This table presents the composition and average density of macrozoobenthos (organisms living on the bottom of water bodies) in Buai River, Pulau Tengah, in the subdistrict of Keliling Danau, Jambi Province. The data includes various taxonomic groups of arthropods, such as insects from the Coleoptera, Odonata, and Diptera orders, with species like Stenelmis, Amphizoa, and Tanytarsus. The table is structured to show the distribution of these species across different sampling stations (St. I to St. IV), detailing their density in individuals per square meter (ind/m^2).

Table 2. Composition and average density (ind/m2) of macrozoobenthos in Buai River, Pulau Tengah, Subdistrict of Keliling Danau, Kerinci Regency, Jambi Province

	Average Density (ind/m2)															
	St. I				St. II				St. III				St.IV			
Taxonomic Group	B	K	P	S	B	K	P	S	B	K	P	S	B	K	P	S
ARTHROPODA																
INSECTA																
COLEOPTERA																
Amphizoidae																
Amphizoa sp.							4									
Dytiscidae																
Dytiscus sp.														4		
Elmidae																
Stenelmis sp.	15			4	4			4	4		4	15				
Lara sp.									4	4						
Zaitzeviaria sp.	4															
Psephenidae																
Psephenus sp.	4				7				4				4			
Hydrophilidae																
Diboloceus sp.	4	19		4				4								22
ODONATA																
Gomphidae																
Ghompus sp.														4		
DIPTERA																
Chironomidae																
Chironominae																
Tanytarsini			7	7	19	7	22	16			15	70	37	60	15	
Tanytarsus sp.																
Rheotanytarsus	22		11	17	4		22	4	26		37	122		74	144	

Chironomini																
Polypedilum sp.	81		19	30	56	67	70	89	4	96	41	81	33	44	89	52
Microtendipes sp.	4	22	37	33	37	156	111	241	37	19	119	178	111	115	189	144
Orthocladiinae																
Orthocladius sp.			4		11	78	59	4	7		144	48	41	44	44	52
Empididae																
Hemerodromia sp.	4			4									22	11	4	7
Ephydridae																
Pelina sp.				78				11								
Simuliidae																
Simulium sp.	174			4		7										
Tipulidae																
Antocha sp.	4		4	4												
Pedicia sp.	11			33				4								
HEMIPTERA																
Corixidae																
Hesperocorixa sp.		11		11												
Naucoridae																
Pelocoris sp.									11	7	9					
EPHEMEROPTERA																
Tricorythidae		7			4										7	
Leptophlebiidae																
Paraleptophlebia sp.		4						7								
Farrodes sp.						7	4									
Baitidae																
Baetis sp.	181	4	70	19	7	7		22	4	48	26	30	37	48	56	4
Cloeon sp.			4							4						
Barbaetis sp.		7			4					7						
Acentrella sp.	37	7			15	63	19	4					33		26	78

Procloeon sp.						30										
Heptageniidae																
Ecdyonurus sp.	70	11	7	4	30	4	4	15	7	7	7	30		4	4	
Epeorus sp.	763	7	296	7	178	304	148	111	122	263	130	178	159	144	104	122
Heptagenia sp.	4				7				4	4						
Ephemerellidae																
Ephemerella sp.	44				7	44	4				104	293		137	111	4
Plecoptera																
Chloroperlidae																
Hastaperla sp.		7		4					11			11				
Perlodidae																
Isoperla sp.	7	4			30	11		4	4	4	4		26		4	4
Trichoptera																
Hydropsychidae																
Cheumatopsyche sp.	11	7	15		41	26	11	15	11	7	4	4	48	11	7	4
Limnephilidae																
Eocosmaecus sp.						33										
Rhyacopilidae																
Ceraclea sp.				4				4				4		7		
Rhyacophila sp.									11		4		11			
ARACHNIDA																
ACARINA																
Acarina sp.				7		4										
MOLLUSCA																
GASTROPODA																
MESOGASTROPODA																
Viviparidae																
Filopaludina sp.			4													
ANNELIDA																

OLIGOCHAETA																
TUBIFICIDA																
Tubificidae																
Limnodrillus sp.													4			
PLATYHELMINTHES																
TURBELLARIA																
Tricladida																
Planaridae																
Dugesia sp.	4				4											
Number of Genera	20	13	12	14	18	15	13	16	16	11	13	13	12	13	13	10
Total Density	1448	117	474	274	461	848	478	559	271	470	648	1064	562	707	804	493
Diversity Index	1,64	2,4	1,4	2,1	2,18	2	1,93	1,73	2	1,39	2	2,1	2,09	2,13	2,1	1,79
Dominance	0,1	0,1	0,4	0,2	0,19	0,2	0,19	0,27	0,24	0,37	0,2	0,16	0,16	0,14	0,15	0,2

Explanation:
St. I = Upstream of the River (B for Rocks)
St. II = Agricultural Fields (K for Gravel)
St. III = Upstream of Residential Areas (P for Sand)
St. IV = Downstream of Residential Areas (S for Leaf Litter)

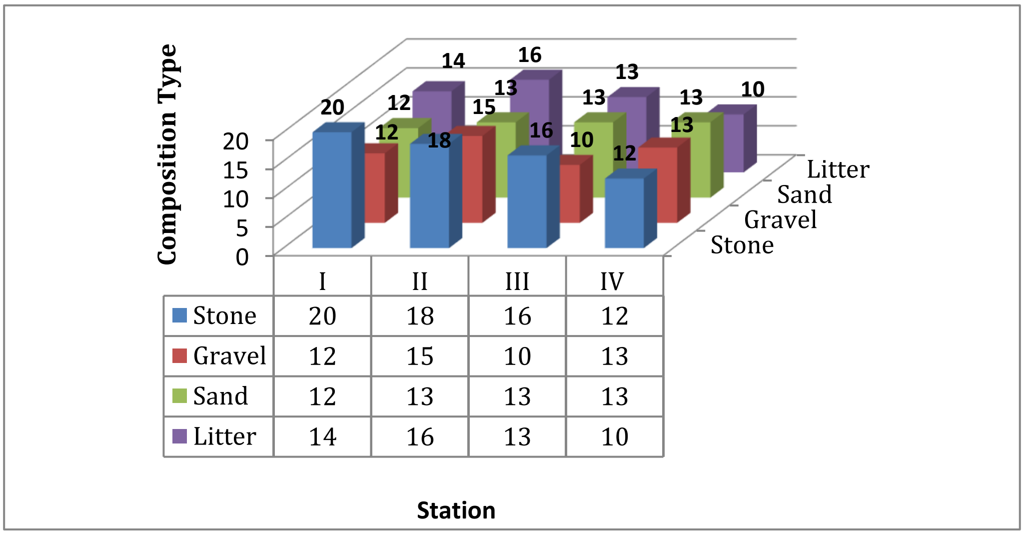
3.1 Composition of macrozoobenthos

Based on the identification conducted at 4 stations in Buai River, Pulau Tengah, Subdistrict of Keliling Danau, Kerinci Regency, Jambi Province, the following findings were obtained. There are 4 phyla of macrozoobenthos: Arthropoda, Mollusca, and Annelida. The study identified 5 classes of macrozoobenthos: Gastropoda, Insecta, Oligochaeta, Turbellaria, and Arachnida. A total of 11 orders were found: Mesogastropoda, Coleoptera, Odonata, Diptera, Hemiptera, Ephemeroptera, Plecoptera, Trichoptera, Tubificida, Tricladida, and Acarina. The samples yielded 26 families and 40 genera of macrozoobenthos.

The class Insecta was the most frequently encountered in Buai River, Pulau Tengah, Subdistrict of Keliling Danau, Kerinci Regency, Jambi Province. The Insecta class in Buai River exhibits significant diversity due to the river's natural state and strong currents. Within the class Insecta, 7 orders were identified, with Coleoptera, Odonata, Diptera, Hemiptera, Ephemeroptera, Plecoptera, and Trichoptera being the most prevalent.

Insecta class inhabits all microhabitats consisting of rocky, gravel, sandy, and leaf litter substrates in Buai River. The highest density of macrozoobenthos was found on rocks due to their stable nature and ability to provide oxygen-rich cavities essential for aquatic insects, serving as habitats and refuge from predators, thereby facilitating their reproduction (Hanafiah & Harmida, 2001). The most diverse and abundant orders were Ephemeroptera and Diptera, which were nearly ubiquitous across all research stations from upstream to downstream.

Ephemeroptera exhibited the highest diversity with 12 identified species, including Epeorus sp., Baetis sp., and Ecdyonurus sp., showcasing their adaptability across various station areas. Ephemeroptera's structural adaptations allow them to thrive in swiftly flowing waters by using claws and hiding under substrate surfaces (Mar'i, 2018). Diptera, particularly the family Chironomidae, dominated the order and increased in abundance downstream. Five species were identified: Polypedilum sp., Microtendipes sp., Orthocladius sp., Tanytarsus sp., and Rheotanytarsus sp. Diptera are known for their high tolerance across freshwater systems and widespread distribution, making them the most abundant and diverse group of macroinvertebrates in aquatic ecosystems (Kawirian et al., 2020).



	I	II	III	IV
Stone	20	18	16	12
Gravel	12	15	10	13
Sand	12	13	13	13
Litter	14	16	13	10

Fig. 5. Bar graph of total composition of macrozoobenthos species based on substrate types at 4 stations in Buai River, Pulau Tengah, Keliling Danau Subdistrict, Kerinci Regency, Jambi Province

Based on the bar graph above, the species composition from stations I to IV, categorized by riverbed substrates including rock, gravel, sand, and leaf litter, reveals that rock substrates exhibit the highest species composition. Station I shows 20 species, station II has 18 species, station III has 16 species, and station IV has the lowest with 12 species.

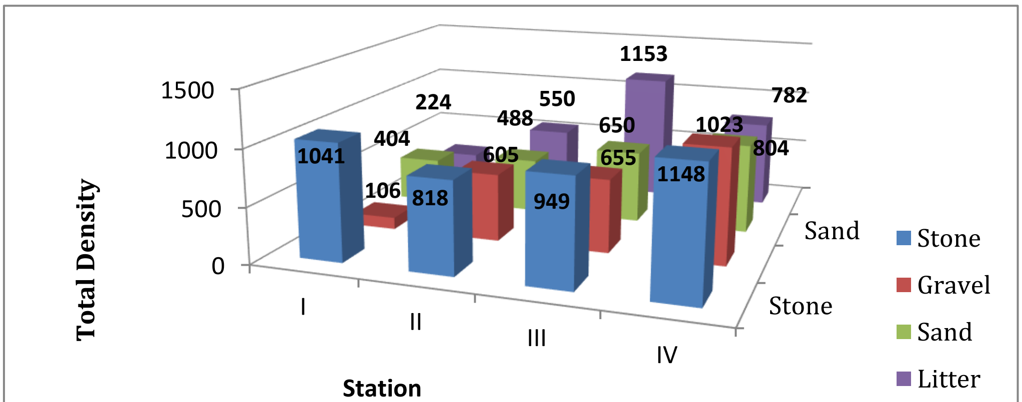
According to Rachman et al. (2016), upstream river sections with rocky substrates typically exhibit the highest productivity and diversity of macrozoobenthos. Substrates such as rocks provide shelter from water currents, which supports macrozoobenthos habitat.

Gravel substrates show a species composition range of 10 to 15 species, with station II having the highest composition of 15 species and station III the lowest with 10 species. Sand substrates exhibit a consistent species composition across stations, with 12 species at station I and 13 species at stations II, III, and IV. Leaf litter substrates vary in species composition from 10 to 16 species, with station II having the highest composition of 16 species and station IV the lowest with 10 species.

The downstream part of Buai River shows a lower species composition due to the influence of human activities, where species found upstream are not commonly found downstream, and vice versa. Station IV shows the presence of Tubificida, indicating high organic content and less vigorous currents. According to Odum (1971) as cited in Fisesa (2014), sediment deposition in riverbeds depends on current velocity; slower currents favor the settling of fine sand particles and higher organic content. The variation in macrozoobenthos species found in Buai River is influenced by environmental conditions and organic input at each station along the river. According to Fisesa (2014), increasing human activities such as household and agricultural waste inputs continuously introduce organic pollutants into the water, affecting the distribution and abundance of macrozoobenthos.

3.2 Species density of macrozoobenthos

The total density of each station based on riverbed substrate types such as rock ranges from 818 to 1148 individuals/m^2, with the lowest total density at station II and the highest at station IV. The high density of macrozoobenthos on rock substrates at station IV is due to the presence of orders Ephemeroptera and Diptera, which cling and crawl on rock boulders. According to Pennak (1989), Insecta prefer habitats with rocks, gravel, sand, and leaf litter, normal levels of dissolved oxygen, and normal water pH. Substrate type on the riverbed determines the abundance and species composition of Arthropoda.



	I	II	III	IV
Stone	1041	818	949	1148
Gravel	106	605	655	1023
Sand	404	488	650	804
Litter	224	550	1153	782

Fig. 6. Bar graph of total density of macrozoobenthos based on substrate types at 4 stations in Buai River, Pulau Tengah, Keliling Danau Subdistrict, Kerinci Regency, Jambi Province

The density values for gravel and sand substrates range from 106 to 1023 individuals/m^2 and 404 to 804 individuals/m^2, respectively, from stations I to IV. Leaf litter substrate ranges from 224 to 1153 individuals/m^2 across stations, with the lowest density at station I and the highest at station III. The variation in density values among research stations closely relates to differences in available riverbed substrates and human activities in each water area.

Based on the density data obtained, the total density from upstream to downstream shows an increase. The most abundant class found is Insecta, with the highest density in orders Ephemeroptera and Diptera in Buai River, Pulau Tengah, Kerinci Regency. These three orders are most commonly found on rocky, gravelly, sandy, and leaf litter substrates.

3.3 Percentage density of macrozoobenthos

In Buai River, Pulau Tengah, Keliling Danau Subdistrict, Kerinci Regency, Jambi Province, the density of macrozoobenthos at stations I-IV shows that the highest relative density percentage is found in the class Insecta. The total amount is 99.68% compared to other classes which range from only 0.11% to 0.23%. According to Barus (2019), a community can be considered to have a high percentage in a class if there are many orders and species found within it.

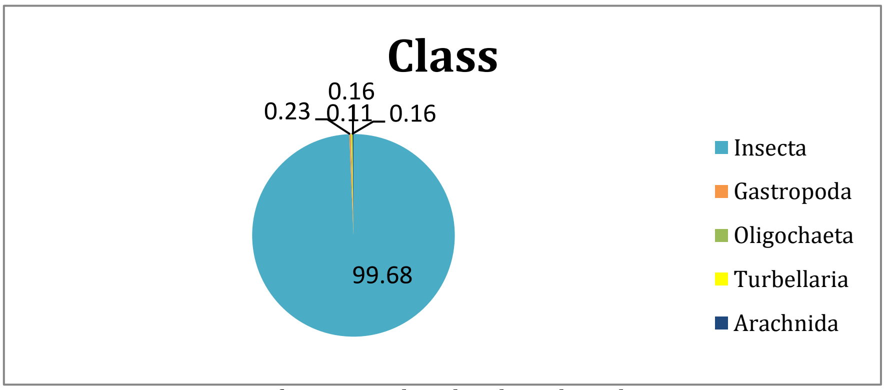


Fig. 7. Precentage of macrozoobenthos based on class at stations I-IV

Based on the percentage presence of orders in Buai River's waters, the results show that the highest percentage is for the order Ephemeroptera at 48.4879%, while the lowest values are for the orders Tubificida and Odonata, each at 0.08891%. Ephemeroptera is most abundant in Buai River due to the presence of large boulders in the river, along with clear and cold water conditions. According to Chu & Cutkomp (1992), Ephemeroptera insects thrive in clean and cold waters and are highly sensitive to environmental changes in aquatic habitats. Substrates like rocks or gravel support a wide variety of organisms.

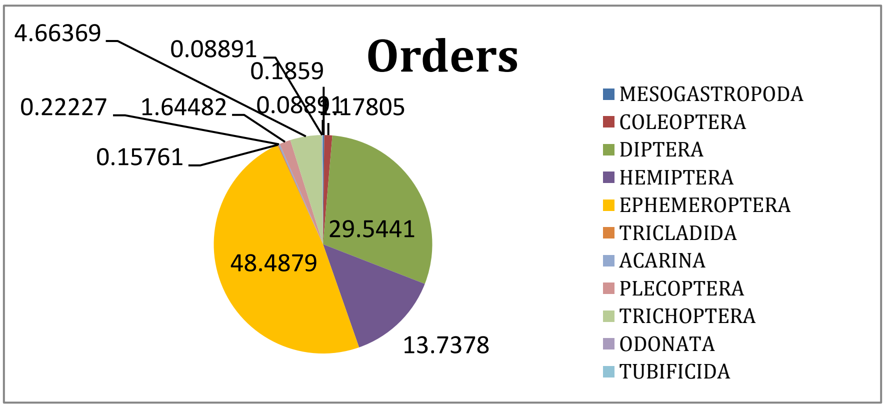


Fig. 8. Percentage presence of orders in Buai River's waters

The percentage density of macrozoobenthos can be observed from the pie chart based on orders at stations I to IV, revealing that the most commonly found orders are Ephemeroptera and Diptera. Station I has Ephemeroptera percentages of 58.52%, station II 49.84%, station III 63.19%, and station IV 58.26%. Diptera percentages at each station are as follows: station I (29.46%), station II (40.8%), station III (35.24%), and station IV (40.71%). The class Insecta is predominantly found in each observation station with a high percentage compared to other classes.

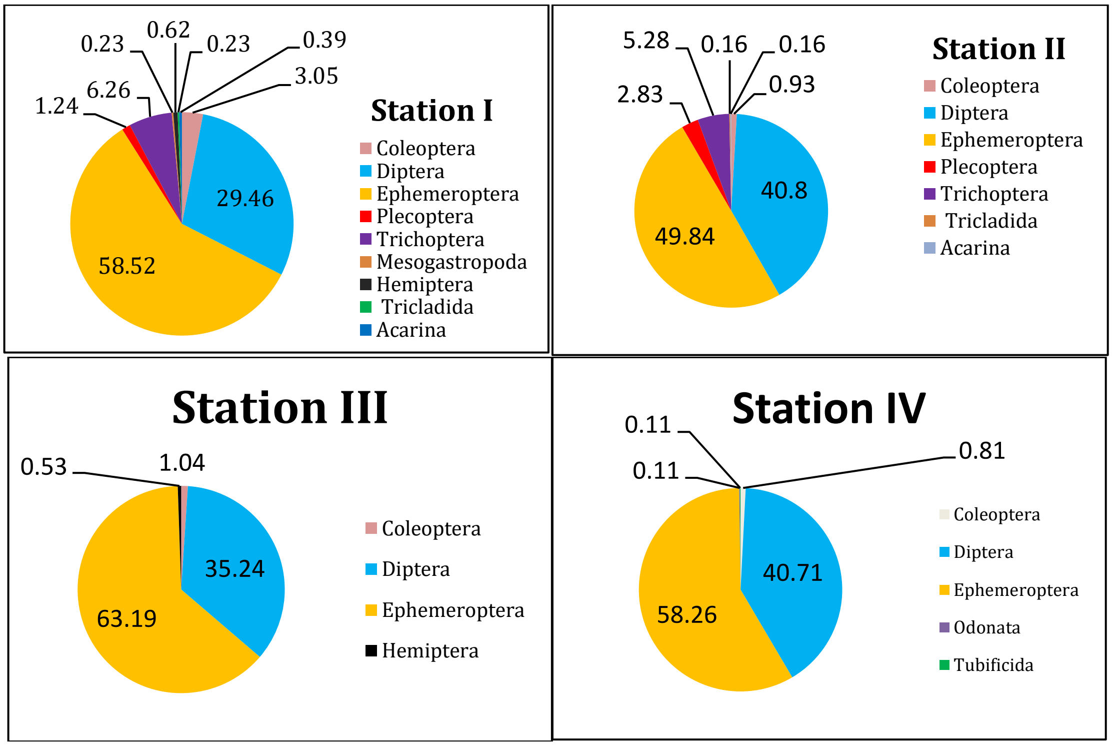
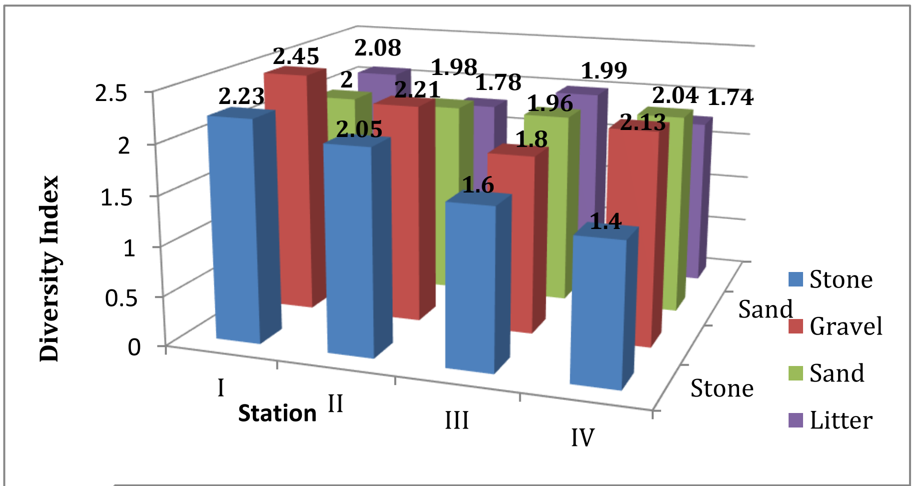


Fig. 9. Percentage density of macrozoobenthos in 4 stations in Buai River, Pulau Tengah, Keliling Danau District, Kerinci Regency, Jambi Province

The highest percentage of the Ephemeroptera order is due to Buai River being dominated by large rock formations from upstream to downstream and strong currents. According to Susanti and Rahardyan (2017), the EPT group (Ephemeroptera, Plecoptera, and Trichoptera) are often found in flowing and rocky waters because Ephemeroptera and Trichoptera prefer clear waters and are intolerant to pollution. Diptera orders are found in almost all stations, with the highest percentage at station II, which is surrounded by agricultural fields as Buai River is characterized by diverse natural topography and abundant trees along its course. According to Arisandi (2012), shading and detritus from fallen leaves in the water provide a primary food source for aquatic insects living in upstream areas. Additionally, flat or pebbly rocky substrates often support a diverse community of aquatic insect organisms. According to Husamah et al. (2016), higher species diversity values in natural habitats are supported by the presence of vegetation or trees that contribute substantial leaf litter.

3.4 Diversity of macrozoobenthos

Based on the bar graph, examining substrates as influences on diversity indices at the four research stations reveals that substrates of rocks have a diversity index ranging from 1.4 to 2.23, categorized as moderate. According to Laraswati et al. (2020), a community with a moderately categorized diversity index suggests interactions among species resulting in competition, sufficient productivity, a relatively balanced ecosystem condition, and moderate ecological pressures. The bar of macrozoobenthos diversity index as follows.



	I	II	III	IV
Stone	2.23	2.05	1.6	1.4
Gravel	2.45	2.21	1.8	2.13
Sand	2	1.98	1.96	2.04
Litter	2.08	1.78	1.99	1.74

Fig. 10. Bar graph of macrozoobenthos diversity index based on bottom substrates at 4 stations in Buai River, Pulau Tengah, Keliling Danau District, Kerinci Regency, Jambi Province

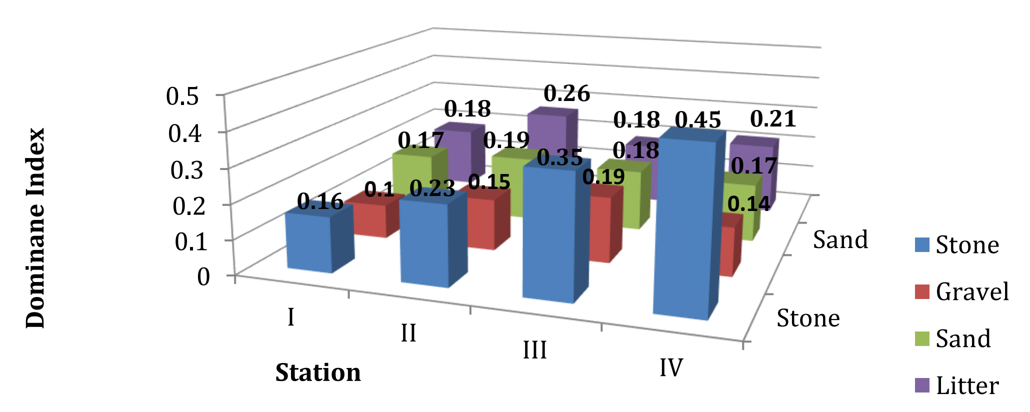
Gravel substrates exhibit a diversity index also categorized as moderate, ranging from 1.8 to 2.45. The highest diversity index on sandy substrates was found at station I, with the lowest index observed at station III, which is located upstream near residential areas. According to Nurfitriani (2017), variations in diversity index values are influenced by the number of species obtained. Station I recorded twelve species, while station III only found ten species, indicating higher diversity at station I compared to station III.

The diversity index values for sandy substrates show minimal differences across stations, ranging from 1.96 to 2.04. Station I recorded a diversity index of 2, station II at 1.98, station III at 1.96, and station IV at 2.04. Pelealu et al. (2018) add that communities composed of species with similar or nearly equal densities tend to have higher diversity. Leaf litter substrates at each sampling station have diversity index values ranging from 1.74 to 2.08, categorized as moderate diversity. Station I shows the highest diversity index, while station IV shows the lowest. According to Odum (1993), lower diversity levels indicate uneven distribution of individual species and lower community stability, possibly due to environmental disturbances in the surrounding areas.

The line graph of diversity index from macrozoobenthos at each station decreases from the upstream to downstream of the river but remains within a stable diversity category. A stable community structure indicates high species diversity when the community is composed of many species with similar or nearly equal abundance. Conversely, low species diversity occurs when there are few dominant species, potentially leading to ecosystem imbalance due to environmental disturbances.

3.5 Dominance index of macrozoobenthos

The graph illustrates the dominance index values in the Buai River based on bottom substrates: rock, gravel, sand, and leaf litter. Stone consistently demonstrates the highest dominance, particularly in Stations III and IV, indicating its prevalence in these locations. Litter and sand also show significant dominance in some stations, such as Station II for litter and Station IV for sand, while gravel consistently exhibits the lowest dominance across all stations. This distribution suggests variability in substrate composition across the stations, with stone being the predominant substrate overall.



	I	II	III	IV
Stone	0.16	0.23	0.35	0.45
Gravel	0.1	0.15	0.19	0.14
Sand	0.17	0.19	0.18	0.17
Litter	0.18	0.26	0.18	0.21

Fig. 11. Dominance index bar graph based on bottom substrates in Buai River, Pulau Tengah, Keliling Danau District, Kerinci Regency, Jambi Province

It shows that the highest dominance index value is found at Station IV with rock substrate, which is 0.45, while the lowest dominance index value is at Station I with gravel substrate. According to Ridwan et al., (2016), dominance occurs due to highly favorable environmental conditions that support the growth of specific macrozoobenthos species, which are considered as the richness of a community and the balance of the number of individuals of each species. The dominance index values in the Buai River from Station I to IV range from 0.069 to 0.147, indicating low dominance or no dominant species in the river water areas. According to Soegianto (1994), when the dominance index value or C approaches 0 (<0.5), there is no dominant species or low dominance, whereas if C approaches 1 (>0.5), there are dominant species or high dominance.

3.6 Community similarity index of macrozoobenthos

Based on the community similarity index below, it is used to indicate the similarity of macrozoobenthos species that make up the community of each species. The community similarity index in Buai River waters shows a high level of similarity index ranging from 60.71% to 82.54%, which is above 50%, indicating high community similarity. According to Soegianto (1994), if the similarity index value > 50%, then the community is nearly the same or there is a high similarity of species, whereas if the similarity index value < 50%, then the community is different or the similarity of species is low.

Table 3. Community similarity index values of macrozoobenthos at each station in Buai River, Pulau Tengah Subdistrict, Keliling Danau District, Kerinci Regency, Jambi Province

Station	I	II	III	IV
I		82.54 %	70.18%	64.15%
II			60.71%	61.54%
III				65.22%
IV				

Station I and Station II have the highest similarity index of 82.54%, indicating that Station I and II have a high community similarity. Station I is located at the river headwaters with abundant trees, while Station II, which is an agricultural field cultivated with cotton and cinnamon trees, shares similar environmental conditions, resulting in a high similarity index between these stations. According to Suin (2002), relatively homogeneous

 https://doi.org/10.61511/aes.v2i1.2024.905

microhabitat conditions will have a high community similarity because they are occupied by individuals of the same species that have naturally developed adaptation and tolerance mechanisms to their habitat.

The community similarity index of macrozoobenthos in Buai River waters is lowest at Station II and III, with values of 60.71%. This is is still considered high, indicating that macrozoobenthos at Station II and III do not differ significantly in composition. According to Wirabumi et al. (2017), a high level of community similarity indicates that the species composition in a water body is nearly identical due to similar environmental conditions between compared stations, resulting in shared species found in both.

3.7 Factors of aquatic physics

Based on the results obtained from the conducted research, the physical and chemical factors of the water can be seen in Table 4. The results of current velocity measurements in Buai River using a Current Velocity Meter placed at a height of 3 cm above the water substrate, it was found that the highest current velocity was on rocky substrate, ranging from 50 to 96 cm/s, classified as fast current. According to Mason (1981) cited in Wijaya (2009), river current velocities can be classified into five categories: >100 cm/s as very fast, 50-100 cm/s as fast, 25-50 cm/s as moderate, 10-25 cm/s as slow, and <10 cm/s as very slow. Current velocities on gravel, sand, and leaf litter substrates were significantly lower, ranging from 10 to 30 cm/s, classified as slow to moderate currents.

Table 4. Measurement results of physical and chemical factors in Buai River, Pulau Tengah, Keliling Danau District, Kerinci Regency, Jambi Province

Parameters	Station							
	Station I				Station II			
	B	S	K	P	B	S	K	P
Flow Velocity (m/s)	0.96	0.13	0.1	0.13	0.67	0.1	0.16	0.13
Temperature (°C)	18	18	18	18	18	19	19	19
Depth (cm)	35	27,3	9	55.6	32.3	14.6	22.6	24.6
Parameters	Station							
	Station III				Station IV			
	B	S	K	P	B	S	K	P
Flow Velocity (m/s)	0.13	0.93	0.3	0.23	0.16	0.5	0.2	0.16
Temperature (°C)	19	19	19	19	19	20	20	20
Depth (cm)	24.6	24.3	12.3	31	14.6	18	8.6	14

Based on the bar graph above regarding the depth of each substrate in Buai River, it was found that the depth of each water substrate ranged from 9 to 56 cm, indicating that Buai River's depth is not very deep or shallow. It can be observed from the depth graph that as we move downstream, the water depth decreases. According to Muntchar and Abdullah (2017), activities in the upstream area can impact downstream areas in terms of fluctuations in discharge, sediment transport, and dissolved material in the water flow system. Temperature measurements in Buai River using a submerged thermometer yielded a temperature range from 18 to 20°C from the upstream to downstream, indicating Buai River is located in a mountainous region. According to Barus (2004), the temperature range of 20-27°C is generally considered normal for aquatic life, especially macrozoobenthos. Temperature fluctuations in tropical waters typically exhibit relatively minor fluctuations throughout the year.

3.8 Water chemistry factors

Based on the results obtained from the conducted research, the physical and chemical factors of the water can be observed in Table 5. Measurement of Dissolved Oxygen (DO) in Buai River waters was conducted using a DO Meter, yielding a range of 9.5 – 11.1 mg/L. The highest DO measurement was recorded at Station I with 11.1 mg/L, while the lowest was at Station IV with 9.5 mg/L, indicating unpolluted water conditions. According to Lee et al. (1978), dissolved oxygen levels <2 mg/L indicate heavy pollution, 2-4.4 mg/L indicate moderate pollution, 4.5-6.4 mg/L indicate mild pollution, and >6.5 mg/L indicate non-polluted water.

Table 5. Results of chemical factor measurements in Buai River, Pulau Tengah Subdistrict, Keliling Danau District, Kerinci Regency, Jambi Province

Parameters	Station			
	I	II	III	IV
DO (mg/L)	11.1	10.6	10.2	9.5
pH	7.9	7.8	7.5	7.3
BOD5 (mg/L)	1,1	1.9	3.6	1.5
Nitrat (mg/L)	0.2	0.2	0.1	0.2
Nitrit (mg/L)	0.005	0.004	0.002	0.002
TSS(mg/L)	1.2	1.1	2.6	2.2
Fosfat (mg/L)	0.04	0.07	0.06	0.06
N-Total(mg/L)	8.4	6.9	6.9	14.4

pH values in Buai River ranged from 7.3 to 7.9. The highest pH was recorded at Station I (7.9), followed by Station II (7.8), Station III (7.5), and the lowest at Station IV (7.3). According to Cech (2005), river water pH typically ranges from 4 to 9, influencing water properties as acidic or basic, thereby affecting biological life in water. The ideal pH range for organisms is generally 7-8.5. Biochemical Oxygen Demand (BOD5) measurements conducted at the Balai Riset dan Standarisasi Industri Palembang yielded values ranging from 1.1 to 3.6 mg/L. BOD5 levels in Buai River indicate low pollution levels, with the lowest at Station I (1.1 mg/L) and the highest at Station III (3.6 mg/L). According to Rumanti et al. (2014), BOD5 values affect oxygen requirements for organisms in water bodies. Values of 0-10 mg/L indicate low water pollution, 10-20 mg/L indicate moderate pollution, and >25 mg/L indicate high pollution levels. Nitrate measurements in Buai River ranged from 0.1 to 0.2 mg/L. Stations I, II, and IV recorded 0.2 mg/L, while Station III recorded 0.1 mg/L. According to Putri et al. (2019), nitrate levels in water bodies are influenced by nitrate input from river bodies, primarily from household and agricultural waste, including human and animal waste.

Nitrite concentrations in Buai River ranged from 0.002 to 0.005 mg/L, with the highest at Station I (0.005 mg/L) and the lowest at Stations III and IV (0.002 mg/L). According to Government Regulation No. 22 of 2021 on Water Quality Management and Pollution Control, the maximum standard for nitrite in Class II river water quality is 0.06 mg/L. Total Suspended Solids (TSS) in Buai River ranged from 1.1 to 2.6 mg/L, indicating low levels. The highest TSS was recorded at Station III, and the lowest at Station II. According to Government Regulation No. 22 of 2021, the maximum limit for TSS in river water is 50 mg/L.

Phosphate levels in Buai River ranged from 0.04 to 0.07 mg/L, with the highest phosphate concentration at Station II (0.07 mg/L). According to Putri et al. (2019), agricultural and plantation areas contribute significantly to phosphate pollution due to domestic waste inputs. Based on Government Regulation No. 22 of 2021, phosphate levels of 0.02 mg/L already indicate fertile water conditions. Total Nitrogen (N-Total) in Buai River ranged from 6.9 to 14.4 mg/L, with the highest at Station IV (14.4 mg/L) and the lowest at Stations II and III. According to Government Regulation No. 22 of 2021, the maximum limit for total nitrogen in Class II river water quality is 15 mg/L.

4. Conclusions

Based on the conducted research on the macrozoobenthos community structure in Buai River, Pulau Tengah, Keliling Danau District, Kerinci Regency, Jambi Province is a follows. First, the total composition of macrozoobenthos in the waters of Buai River, Pulau

Tengah, Keliling Danau District, Kerinci Regency, Jambi Province consists of 5 classes, 11 orders, 26 families, and 42 genera. Second, density of macrozoobenthos on each substrate type in Buai River ranges from 224 to 1041 ind/m2, with the highest density found on rock substrate. Then obtained the diversity index of macrozoobenthos in Buai River waters falls into the moderate diversity category, with values ranging from 1.4 to 2.45.

The dominance index of macrozoobenthos in Buai River waters falls into the category of no dominant species, with low dominance values ranging from 0.1 to 0.45. Furthemore, the community similarity index of macrozoobenthos in Buai River waters is consistent across all stations, ranging from 60.71% to 82.54%. Based on this research, research related to the structure of macrozoobenthos communities should be continued as a bioindicator of water quality, which is essential for biological scientists to investigate.

Acknowledgement

The author would like to express gratitude to the Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Sriwijaya.

Author Contribution

This work was solely conducted by J. N., who was responsible for the conceptualization, methodology, data collection, analysis, and writing of the manuscript.

Funding

This research received no external funding.

Ethical Review Board Statement

Not available.

Informed Consent Statement

Not available.

Data Availability Statement

Not available.

Conflicts of Interest

The authors declare no conflict of interest.

Open Access

References

Adriyanto, W. (2001). Macrozoobenthos Community in the Rapid Waters of Piring River, Kerinci Seblat National Park, in Napal Licin Village (*Undergraduate thesis*). Faculty of Mathematics and Natural Sciences, Universitas Sriwijaya.

Arisandi, P. (2012). Water Quality Measurement of the Upper Brantas River Basin Based on the Taxonomic Diversity of Ephemeroptera, Plecoptera, and Trichoptera. In *Proceedings of the National Seminar on Chemistry*, Universitas Negeri Semarang, 298-

309.

Azhari, N., & Nofisulastri. (2018). Identification of Annelid Species in the Jangkok River Habitat, Mataram City. *Bioscientist: Scientific Journal of Biology*, *6*(2), 130-137. https://doi.org/10.33394/bioscientist.v6i2.2392

Barnes, R. S. K. & K. H. Mann. (1994). *Fundamental Of Aquatic Ecology*. Backwell Scientific Publications.

Barus, B. S., Aryawati, R., Putri, W. A. E., Nurjuliasti, E., Diansyah, G., Sitorus, E. (2019). he Relationship Between Total N and Organic C in Sediments and Macrozoobenthos in Payung Island Waters, Banyuasin, South Sumatra. *Journal of tropical marine, 22*(2), 147-156. https://doi.org/10.14710/jkt.v22i2.3770

Cappenberg, Hendrik. (2002). *Gastropod Mollusk Collection in the Reference Collection Room of the Research Center for Oceanography LIPI.* LIPI.

Cech, T.V. (2005). *Principles of Water Resources: History, Development, Management, and Policy*. (2nd ed.). John Wiley & Sons.

Chu, H. F., & Cutkomp, L.K. (1992). *How to Know the Immature Insects*. (2nd ed.). Wm. C. Brown Company Publisher.

Cummins, K. W. (1995). Macroinvertebrates, in Whitton, B. A. (Ed.), *River Ecology* (Vol. 2). Blackwell Scientific Publications.

Desmawati, I., Adany, A., & Java, C. A. (2019). Preliminary Study of Macrozoobenthos in Surabaya Tourism Area. ITS *Journal of Science and Arts,* *8*(2), 19-22. http://dx.doi.org/10.12962/j23373520.v8i2.49929

Fachrul, M. R. (2007). *Bioecology Sampling Methods*. Bumi Aksara.

Hanafiah, Z., & Harmida. (2001). Composition of Aquatic Insects in the Upper Endikat River. *Jurnal Penelitian Sains*, (10), 96-102. https://doi.org/10.56064/jps.v0i10.356

Hynes, H. B. N. (1976). *The Ekologi With Of Running Water*. Liverpool University Press.

Izimiarti. (2021). Macrozoobenthos Diversity at Kulu Waterfal. *Journal of Resources and Environment,* *2*(1), 261–272. https://jsla.ejournal.unri.ac.id/index.php/ojs/article/view/41

Kamaliyah. (2001). Aquatic Insect Community in the Hyporheic Zone of Piring River, Kerinci Seblat National Park, Musi Rawas Regency (*Undergraduate thesis*). Biology, FMIPA, Universitas Sriwijaya.

Kawirian, R. R., Nurcahyanto, A., Abdillah, D., Panggabean, G. T., Arif, M. I., Pulungan, A., A, C. Q., Rahman, A., Ishak, M., & Krisanti. (2020). Secondary Productivity of Benthic Organisms (Diptera Order) in Cigambreng River, Tapos Village, Tenjolaya District, Bogor Regency, West Java. *Journal of Tropical Fisheries Management, 4*(1), 43-48. http:///journal.ipb.ac.id/jurnalppt

Kerinci, D.P. (2020). Kerinci Regency Profile. RPI2JM Document, Kerinci Regency.

Makri. (2018. Structure and Abundance of the Macrozoobenthos Community. *Journal of Fisheries and Aquaculture Sciences,* *13*(1), 9–13. https://garuda.kemdikbud.go.id/documents/detail/1593748

Cummins, K., & Merrit, R. W. (1996). An Introduction on The Aquatic Insect of North America. *Journal of the North American Benthological Society, 28* (1), 266-267. https://doi:10.2307/1467288

Mushthofa, A., Rudiyanti, S., & Muskanonfola, M. R. (2014). Analysis of Macrozoobenthos Community Structure as a Bioindicator of Water Quality in Wedung River, Demak Regency.*Diponegoro Journal of Maquares Management of Aquatic Resources. 3*(1), 81–88. https://doi.org/10.14710/marj.v3i1.4289

Ningrum, D. K. (1995). Macrozoobenthos Community Study in the Musi River, Palembang. FMIPA Undergraduate Thesis, Universitas Sriwijaya.

Odum, E. P. (1993). *Fundamentals of General Ecology*. Gadjah Mada University Press.

Odum, E.P. (1996). *Fundamentals of Ecology.* Gadjah Mada University Press.

Pelealu, G. V. E., Koneri, R., & Butarbutar, R. R. (2018). Abundance and Diversity of Macrozoobenthos in Tunan Waterfall River, Talawaan, North Minahasa, North Sulawesi. *Scientific Journal of Science,* *18*(2), 97-102. https://doi.org/10.35799/jis.18.2.2018.21158

Putri, W. A. E., Purwiyanto, Fauziyah. (2019). Nitrate, Nitrite, Ammonia, Phosphate, and BOD Conditions at the Banyuasin River Estuary, Sumatra. *Journal of Tropical Marine Science and Technology, 11*(1), 65 – 74. https://doi.org/10.29244/jitkt.v11i1.18861

Rachman, H., Priyono, A., & Wardianto, Y. (2016). Makrozoobenthos Sebagai Bioindikator Kualitas Air Sungai Di Sub Das Ciliwung Hulu. *Media Konservasi*, *21* (3), 261-269. http://repository.ipb.ac.id/handle/123456789/83695

Ramly, N. (2016). Diversity and Characteristics of Macrozoobenthos in the Water of Tompe River (A Study from Indonesia). *International Journal of ChemTech Research*, *9* (11), 71–79. https://sphinxsai.com/2016/ch_vol9_no11/1/(71-79)

Ridwan, M., Fathoni, R., Fatihah, I., & Pangestu, D. A. (2016). Macrozoobenthos Community Structure in Four Estuaries of Pulau Dua Nature Reserve, Serang, Banten. *Al-Kauniyah: Journal of Biology, 9(*1) *9 (*1), 57–65. https://doi.org/10.15408/kauniyah.v9i1.3256

Riwayati. (1994). Study of Ciliwung River Water Quality Based on Macrozoobenthos Community Structure. (*Master's thesis*). Postgraduate School, Institut Teknologi Bandung.

Rosmawati. (2011). *Aquatic Ecology*. Hiliana Press.

Sitorus, A. K. (2021). Sitorus, A. K. (2021). Macrozoobenthos Community Structure as a Bioindicator of Water Quality in the Upper Ogan River, Baturaja, Semidang Aji District, South Sumatra. (*Undergraduate thesis*). Department of Biology, Universitas Sriwijaya.

Suin, N.M. (2002). *Ecological Methods*. Universitas Andalas.

Sulistiyanto, Y. A., Endrawati, H., Zainuri, M. (2012). Macrozoobenthos Community Structure in the Waters of Morosari, Sayung District, Demak Regency. *Journal of Marine Research, 1*(2), 235–242. https://doi.org/10.14710/jmr.v1i2.2042

Surtikanti, H. K. & Bahabazi, U. (2013). Study on the Ecology and Habitat of Planaria sp. in Subang: Abundance and Biomass as Indicators of Clean Water Quality. *Biosphere, 30*(2), 65 - 68. https://journal.bio.unsoed.ac.id/index.php/biosfera/article/view/128

Wirabumi, P., Sudarsono, dan Suhartini. (2017. Plankton Community Structure in the Waters of Wadaslintang Reservoir, Wonosobo Regency. *Journal of Biology Program, 6*(3), 174-184. https://doi.org/10.21831/kingdom.v6i3.6815

Biographies of Author

Nadya Juaninda, Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Sriwijaya; Palembang, 30128, Indonesia.

- Email: nadyajuaninda00@gmail.com
- ORCID: N/A
- Web of Science ResearcherID: N/A
- Scopus Author ID: N/A
- Homepage: N/A