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Structure of Plankton and Bentos Communities in Bahorok River in Bahorok District, Langkat Regency, North Sumatra

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ABSTRACT
This study analyzed the diversity and abundance of plankton and benthos in the Bahorok River, Bukit Lawang, Langkat Regency, North Sumatra Province. This study was conducted on May 25, 2024. Sampling was done by collecting filtered water using a plankton net and substrate using a surber net to collect benthos from two points in the river. Identification of plankton and benthos using a microscope and laboratory analysis for physicochemical parameters. The value of plankton diversity in the Bahorok River was indexed well with a value of 3.01 as well as good evenness with a value of 0.95 however, benthos diversity was indexed low with a value of 0.68 and evenness was indexed moderate with a value of 0.62. The highest type of plankton is *Raphidiopsis raciborskii*. The highest type of benthos is *Progomphus* sp.
Keyword: Abundance, Benthos, Plankton, Structure composition.

ABSTRAK
Penelitian ini menganalisis keragaman dan kelimpahan plankton serta benthos di Sungai Bahorok, Bukit Lawang, Kabupaten Langkat, Provinsi Sumatera Utara. Penelitian ini dilaksanakan pada tanggal 25 Mei 2024. Pengambilan sampel dengan cara pengumpulan air yang disaring menggunakan *plankton net* dan substrat menggunakan *surber net* untuk pengambilan benthos dari dua titik di sungai. Identifikasi plankton dan benthos menggunakan mikroskop serta analisis laboratorium untuk parameter fisikokimia. Nilai keanekaragaman plankton di Sungai Bahorok terindeks baik dengan nilai 3,01 begitu juga dengan kemerataan yang baik dengan nilai 0,95 namun, keanekaragaman benthos terindeks rendah dengan nilai 0,68 dan kemerataan terindeks sedang dengan nilai 0,62. Jenis plankton tertinggi yaitu *Raphidiopsis raciborskii*. Jenis benthos tertinggi yakni *Progomphus* sp.
Keyword: Kelimpahan, Benthos, Plankton, Komposisi struktur,

1. Introduction

Plankton are microscopic organisms that drift in water and have very weak swimming abilities, with their movement influenced by water currents. The decline in river water quality can be assessed through biological parameters, such as plankton diversity, as they serve as bioindicators due to their tolerance limits to certain substances [1]. Phytoplankton, microscopic organisms floating in water, are unicellular and contain chlorophyll, enabling them to photosynthesize with sunlight. During photosynthesis, phytoplankton absorb carbon to produce carbohydrates for energy. Despite their microscopic size, the net amount of carbon absorbed by river phytoplankton is nearly equivalent to that absorbed by terrestrial plants [2]. Makrozoobenthos are organisms larger than 1.0 mm, living by being sessile, crawling, or burrowing. Based on their habitat, zoobenthos are classified into two types: infauna, which live within the substrate of aquatic environments, and epifauna, which live on top of the substrate. Makrozoobenthos play a crucial role in

ecosystems, as they help break down large organic materials into smaller particles, making them easier for microbes to decompose [3].

Biodiversity is distributed across various ecosystems on Earth, one of which is the river ecosystem. The river ecosystem serves as a habitat for aquatic organisms influenced by its surrounding environment, including physical parameters such as water and air temperature, current speed, light penetration, TDS, and TSS. Chemical parameters include dissolved oxygen, pH, DO, COD, phosphate, and nitrate. Rivers also function as breeding grounds, habitats, and feeding areas for aquatic life. The food sources for aquatic organisms consist of organic matter from upstream, fallen leaves, and decaying waste from the land, which become food for various organisms [4]. Rivers are one of the most important freshwater ecosystems for the survival of organisms. They play a crucial role in the hydrological cycle and serve as catchment areas for surrounding regions, making the condition of a river highly influenced by environmental characteristics. A wide variety of organisms live in rivers, using them as habitats, nursery grounds, feeding grounds, and spawning grounds. Not only do aquatic organisms depend on rivers, but humans also rely on them [5].

The Bahorok River is one of the main rivers flowing around Gunung Leuser National Park (TNGL), one of the largest conservation areas in Indonesia. According to the 2013-2023 Urban Land use Plan of Langkat Regency, Bukit Lawang is designated as a priority tourist destination and a natural conservation area within the region. The preservation of the Gunung Leuser National Park ecosystem significantly impacts the economic value of Bukit Lawang. The tourism and conservation activities in Bukit Lawang are based on different principles, thus requiring proper management to maximize their benefits [6].

2. Method

2.1 Field collection

The research, conducted on May 25, 2024, at the Bahorok River in Bahorok District, Langkat Regency, North Sumatra Province, involved plankton and benthos sampling as part of an aquatic ecology practicum. The identification process was carried out at the PSDAL Unit 10 Laboratory, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara, Medan, while chemical parameter measurements were performed at Shafera Enviro Laboratory.

For plankton sampling, water was collected using a 5-liter bucket and poured into a plankton net five times, then transferred into film bottles with three drops of Lugol solution. These bottles were sealed, placed in a coolbox, and taken to the laboratory for identification, where plankton samples were examined under a microscope using at least 10 drops from each sample bottle. Plankton species were identified and counted. For benthos sampling, substrate was collected from two points to a depth of 10 cm using a surber net, then sorted with tweezers and brushes. The sorted samples were placed into bottles filled with 70% alcohol, sealed, and transported to the PSDAL Laboratory for identification.

The physical and chemical parameters measured in this aquatic ecology research include temperature, using a mercury thermometer; current velocity, measured with a 10-meter line, styrofoam, and stopwatch; light intensity, measured using a lux meter; and light penetration, determined with a Secchi disk. Coordinates were recorded using a GPS device, while dissolved oxygen (DO) and biological oxygen demand (BOD5) were analyzed to assess water quality.

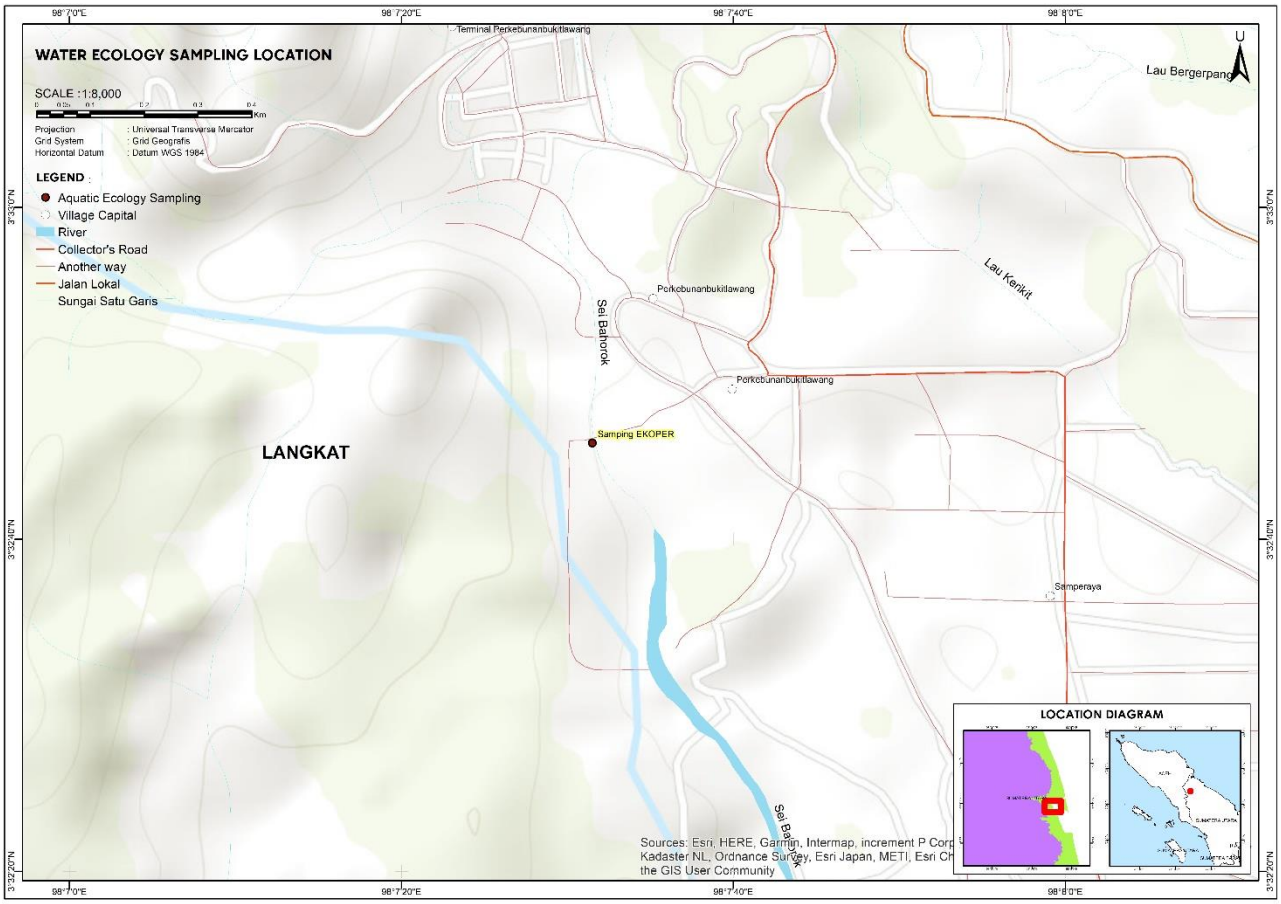

Figure 1. Map of sampling point in the Bahorok River, Bahorok District, Langkat Regency, North Sumatra.

2.2 Data analysis

The data analysis includes presenting the plankton and benthos species in terms of morphological descriptions, images, and classification. Key parameters analyzed are population density, relative density, frequency of occurrence, diversity index, and evenness index. Population density refers to the number of individuals of a species per unit area or volume, while relative density represents the proportion of a species' individuals relative to the total number of individuals. Frequency of occurrence measures how often a species appears in the sampling plots. The diversity of species is assessed using the Shannon-Wiener diversity index, which categorizes diversity as high, moderate, or low. Evenness index is also calculated to understand the uniformity of species distribution in the ecosystem.

3. Results and Disccusion

3.1 Physical and Chemical Data

Table 1. Water quality in Bahorok River in Bahorok District, Langkat Regency, North Sumatra

Parameter	Measuring Instrument	Value
Temperature (°C)	Termometer	20
Light Penetration (Cm)	Secchi Disk	65
Current Speed (m/s)	String and Styrofoam	17.37
pH	pH meter	6
Light Intensity (Cd)	Lux meter	16.78
Dissolved Oxygen (DO) mg/L	Winkler	9.18

Biochemical Oxygen Demand (BOD5) mg/L	Winkler	0,4

Based on Table 1, which provides data on the physicochemical conditions at the sampling site used for the practical work, it was found that the temperature at the site was 20°C. The water temperature obtained indicates that the condition is still good, because the lower the water temperature, the better the water condition. Light penetration at the site measured using the Secchi Disk is still clearly visible even to the bottom of the water substrate, which means that the water condition is still very clear and far from turbidity. The current speed obtained with 17.37 m/s is still in normal water current conditions without any obstacles to the water current. The DO (Dissolved oxygen) and BOD5 (Biological Oxygen Demand) conditions are still very good. The DO in the water is still high while the very low BOD5 indicates that the water conditions of the Bahorok River are still good and far from pollution.

3.2 Plankton and benthos diversity

From the research conducted in the Bahorok River, Bukit Lawang, Bahorok District, Langkat Regency, North Sumatra Province, a total of 24 plankton species were identified, including 21 species of phytoplankton, 3 species of zooplankton, and 3 species of benthos.

Table 2. Plankton and benthos diversity in Bahorok River in Bahorok District, Langkat Regency, North Sumatra

Family	Species
Phytoplankton	
Aphanizomenonaceae	*Raphidiopsis* sp
	Cylindrospermopsis raciborskii (Wolosz.) Seena. & Subbar.
Ceratiaceae	*Ceratium* sp
Chlamydomonadaceae	*Chlamydomonas* sp
Cryptomonadaceae	*Cryptomonas* sp.
	Cryptomonas curvata Ehrenberg
Desmidiaceae	*Pleurotaenium kayei* (W.Archer) Rabenhorst
	Euastrum ansatum Ehrenberg ex Ralfs
	Desmidium swartzii C.Agardh ex Ralfs
	Closterium lanceolatum Kützing ex Ralfs
Euglenaceae	*Euglena* sp
	Euglena gracilis G.A.Klebs
Gonyaulacaceae	*Gonyaulax* sp
Gymnodiniaceae	*Gymnodinium* sp
Oscillatoriaceae	*Plectonema* sp
	Oscillatoria sp
Peridiniaceae	*Peridinium* sp
	Peridinium cinctum (O.F.Müller) Ehrenberg
Scenedesmaceae	*Actinastrum hantzschii* Lagerheim
Selenastraceae	*Coelastrum sp*
Ulotrichaceae	*Ulothrix zonata* (F.Weber & Mohr) Kützing
Zooplankton	
Amoebidae	*Amoeba* sp
Brachionidae	*Keratella quadrata* Müller
	Keratella cochlearis Gosse
Benthos	
Gomphidae	*Progomphus* sp.
Pleuroceridae	*Pleurocera acuta* Rafinesque
Thiaridae	*Thiara scabra* O. F. Müller

Table 2. Shows the details of the aquatic species identified in the research area. In aquatic biota, a total of 27 species were obtained with each. In aquatic biota, the types of phytoplankton obtained were more numerous compared to the zooplankton and benthos groups. This number is shown in percentage form in Figure 2. The composition of plankton and benthos in the Bahorok River, Bahorok District, Langkat Regency, the number of phytoplankton is 78% of the total aquatic biota, but when viewed from the number

of species obtained, this number is still within reasonable limits so that it can still be used as a good environmental indicator. The types of zooplankton found in aquatic biota can also be good indicators and energy distributors to higher levels of biota.

According to Dewanti [7], phytoplankton affects the presence of zooplankton because phytoplankton serve as a primary food source for zooplankton. The presence of organisms in aquatic environments, particularly plankton, is heavily influenced by the physical and chemical parameters of the water, as plankton are among the first to respond to changes in water quality. Complex water conditions caused by various human activities and the influx of organic matter into coastal areas affect water quality and subsequently the presence of plankton. Insects, particularly dragonflies (Odonata), which are highly diverse in Indonesia, can serve as indicators of water quality and environmental pollution. Dragonfly nymphs are directly beneficial to humans as they prey on mosquito larvae [8].

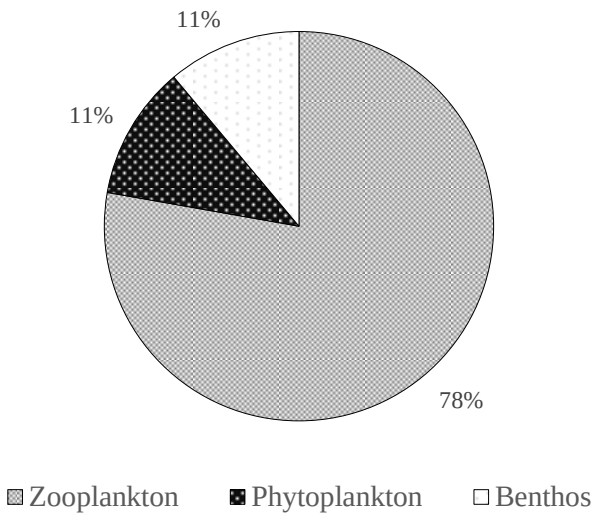

Figure 2. Species composition of plankton and benthos in the Bahorok River, Bahorok District, Langkat Regency, North Sumatra.

3.2 Plankton and benthos structure

Table 3. Spesies abundance of Plankton and Benthos in Bahorok River in Bahorok District, Langkat Regency, North Sumatra

Species	Number of individuas	Abundance (%)	PD	RD (%)	FA (%)
Phytoplankton					
Raphidiopsis sp	3	8.3	16.67	8.33	100
Cylindrospermopsis raciborskii	5	13.9	27.78	13.89	100
Ceratium sp	1	2.8	5.56	2.78	50
Chlamydomonas sp	3	8.3	16.67	8.33	100
Cryptomonas sp.	1	2.8	5.56	2.78	50
Cryptomonas curvata	1	2.8	5.56	2.78	50
Pleurotaenium kayei	2	5.6	11.11	5.56	50
Euastrum ansatum	1	2.8	5.56	2.78	50
Desmidium swartzii	1	2.8	5.56	2.78	50
Closterium lanceolatum	1	2.8	5.56	2.78	50
Euglena sp	1	2.8	5.56	2.78	50
Euglena gracilis	1	2.8	5.56	2.78	50
Gonyaulax	1	2.8	5.56	2.78	50

Gymnodinium	1	2.8	5.56	2.78	50
Plectonema sp	1	2.8	5.56	2.78	50
Oscillatoria	2	5.6	11.11	5.56	50
Peridinium sp	1	2.8	5.56	2.78	50
Peridinium cinctum	1	2.8	5.56	2.78	50
Actinastrum hantzschii	3	8.3	16.67	8.33	100
Coelastrum sp	1	2.8	5.56	2.78	50
Ulothrix zonata	1	2.8	5.56	2.78	50
Zooplankton					
Amoeba sp	1	2.8	5.56	2.78	50
Keratella quadrata	1	2.8	5.56	2.78	50
Keratella cochlearis	1	2.8	5.56	2.78	50
Benthos					
Progomphus sp.	7	77.8	38.89	77.78	100
Pleurocera acuta	1	11.1	5.56	11.11	50
Thiara scabra	1	11.1	5.56	11.11	50

Exp: PD: Population Density; RD: Relative Density; FA: Frequency of attendance

Table 3. presents species abundance data for plankton and benthos in the Bahorok River, North Sumatra. The class of phytoplankton obtained was *Cylindrospermopsis raciborskii*, which was the most abundant type and was present at both points. The class of zooplankton obtained were all the same and were present at each point, but were not present at both points simultaneously. The class of benthos present in the Bahorok River was *Progomphus* sp. With its presence at both sampling points.

Phytoplankton are vital at the base of aquatic food chains, relying on sunlight for photosynthesis, which is affected by seasonal changes. Their abundance tends to decrease during the rainy season due to lower sunlight, with recent unpredictable weather patterns from El Niño and La Niña also impacting light and temperature [9]. As primary producers in estuarine ecosystems, phytoplankton depend on physical and chemical water parameters, such as nutrients, temperature, and salinity. Their distribution and abundance are closely linked to these environmental factors and vary with changes in conditions [10].

According to Sidik *et al.*, [11], high benthos density at a location is attributed to the high organic content of the substrate, which supports benthos growth due to the availability of organic material for their food. Pelealu *et al.*, [12], describe macrozoobenthos as organisms living at the bottom of aquatic environments, and they are an integral part of the food chain, dependent on the populations of lower trophic levels. The abundance and diversity of macrozoobenthos are influenced by their tolerance and sensitivity to environmental conditions. Factors affecting macrozoobenthos include physical properties of the water such as depth, current speed, color, turbidity, and temperature, as well as chemical properties like dissolved gases, organic matter, pH, and nutrient levels. Biological factors, including the presence of producers (food sources) and predators, also impact the abundance and diversity of macrozoobenthos.

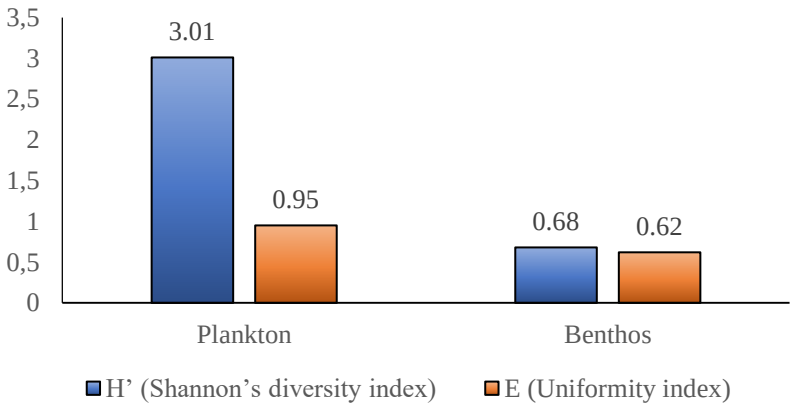

Figure 3. Bar plot of the Shannon's diversity index (*H'*) and uniformity index (*E*) of plankton and benthos in the Bahorok River, Bahorok District, Langkat Regency, North Sumatra.

Based on Figure 3. the phytoplankton diversity index (H') is 3.01, and the evenness index (E) is 0.95, indicating high diversity and evenness. For benthos, the diversity index (H') is 0.68, and the evenness index (E) is 0.62, reflecting lower diversity and evenness. This lower diversity and evenness in benthos may be due to less favorable environmental conditions, which affect the organisms' ability to thrive and maintain their populations.

Density is expressed as the number of individuals per unit area. Analyzing species density in a community aims to calculate the population or number of individuals within a specific area at a given station. Species diversity refers to the number of species relative to the total number of individuals in the community. A community is considered to have high species diversity if it consists of many species, while low diversity indicates fewer species. Evenness measures how evenly individuals are distributed among species within a community. A high evenness index suggests a more uniform distribution of species, meaning that no single species dominates [13]. The abundance of phytoplankton is significantly influenced by environmental factors, including physical and chemical parameters, as well as seasonal changes. During the rainy season, phytoplankton abundance tends to be lower due to reduced light intensity, while it increases during the dry season when light is more intense. Water quality affects the life of aquatic organisms, including primary producers like phytoplankton. Additionally, the presence and abundance of these organisms can serve as indicators of pollution [9].

4. Conclusion

Based on the study conducted in the Bahorok River, Bahorok District, Langkat Regency, North Sumatra, it was found that the water quality is still good, as indicated by a temperature of 20°C, high light penetration of 65 cm, normal current speed of 17.37 m/s, and a slightly acidic pH of 6. The high dissolved oxygen (9.18 mg/L) and low BOD5 (0.4 mg/L) levels further suggest minimal pollution. The aquatic community comprised 27 species, dominated by phytoplankton (78% of the total biota), indicating a healthy primary producer base and good water quality. The Shannon diversity index (H') for phytoplankton was high (3.01) with a balanced distribution (E = 0.95), while benthos diversity was lower (H' = 0.68, E = 0.62), suggesting less favorable conditions for benthic organisms. Overall, the diverse and abundant phytoplankton and zooplankton communities indicate that the Bahorok River is in good ecological condition, with minimal anthropogenic impacts and favorable environmental parameters.

References

[1] S.S. Dewi, dan Mawardi, "Kelimpahan Plankton Di Perairan Sungai Pelawi Kecamatan Babalan Kabupaten Langkat Provinsi Sumatera Utara," *Jurnal Jeumpa,* 7(2): 414-421, 2020.

[2] S. Harahap, dan Arman, "Analisis Keragaman Fitoplankton Di Sungai Barumun Kecamatan Panai Tengah Kabupaten Labuhanbatu," *Bioscientist : Jurnal Ilmiah Biologi,* 11(1): 64-74, 2023.

[3] S. Ananta, dan A. Harahap, "Distribusi Dan Keanekaragaman Makrozoobenthos," *BIOEDUSAINS: Jurnal Pendidikan Biologi dan Sains,* 5(1): 286-294, 2022.

[4] K. Umam, E. Wahyuningsih, "Keanekaragaman Gastropoda Di Sungai Logawa Banyumas," *Jurnal Pendidikan Biologi,* 5(1): 81-94, 2022.

[5] T.E. Kinanti, S. Rudiyanti, F. Purwanti, "Kualitas Perairan Sungai Bremi Kabupaten Pekalongan Ditinjau Dari Faktor Fisika-Kimia Sedimen Dan Kelimpahan Hewan Makrobentos," *Diponegoro Journal Of Maquares,* 3(1): 160-167, 2014.

[6] B.P.J. Van, H.S. Cesar and M.A. Janssen, "Economic valuation of the Leuser national park on Sumatra, Indonesia," *Ecological economics,* 44(1): 43-62, 2023.

[7] L.P.P. Dewanti, I.D.N.N. Putra, E. Faiqoh, "Hubungan Kelimpahan dan Keanekaragaman Fitoplankton dengan Kelimpahan dan Keanekaragaman Zooplankton di Perairan Pulau Serangan, Bali," *Journal of Marine and Aquatic Sciences,* 4(2): 324-335, 2018.

[8] S. Sumarni, "Keanekaragaman Jenis Capung (Odonata) Di Desa Nibung Kecamatan Selimbau Kabupaten Kapuas Hulu," *Jurnal PIPER,* 26(4): 253-266, 2018.

[9] M. Zainuri, N. Indriyawati, W. Syarifah, A. Fitriyah, "Korelasi Intensitas Cahaya Dan Suhu Terhadap Kelimpahan Fitoplankton Di Perairan Estuari Ujung Piring Bangkalan," *Jurnal Buletin Oseanografi Marina,* 12(1): 20-26, 2023.

[10] M.F. Samawi, A. Tahir, R. Tambaru, K. Amri, M. Lanuru, N.K. Armi, "Phytoplankton and Physics Chemical Parameters in Estuary Waters, West Coast of South Sulawesi, Indonesia" *Journal of Fisheries and Marine Science,* 3(2): 61-70, 2020.

[11] R.Y. Sidik, I. Dewiyanti, C. Octavina, "Struktur Komunitas Makrozoobentos Dibeberapa Muara Sungai Kecamatan Susoh Kabupaten Aceh Barat Daya" *Jurnal Ilimiah Mahasiswa Kelautan dan Perikanan Unsyiah,* 1(2):287-296, 2016.

[12] G.V.E. Pelealu, R. Koneri, R.R. Butarbutar, ”Kelimpahan Dan Keanekaragaman Makrozoobentos Di Sungai Air Terjun Tunan, Talawaan, Minahasa Utara, Sulawesi Utara,” *Jurnal Ilmiah Sains,* 18(2): 97-102, 2018.

[13] Ambeng, F. Ariyanti, N. Amati, D.W. Lestari, A.W. Putra, A.E.P. Abas, ”Struktur Komunitas Gastropoda Pada Ekosistem Mangrove Di Pulau Pannikiang,” *Jurnal Bioma,* 8(1): 7-15, 2023.