



IDENTIFICATION AND ABUNDANCE OF PLANKTON IN THE BAH BOLON RIVER, SIMALUNGUN

IDENTIFIKASI DAN KELIMPAHAN PLANKTON DI SUNGAI BAH BOLON SIMALUNGUN

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Meiva Wulandari^a, Suri Purnama Febri^{a*}, Andika Putriningtias^a

^a Aquaculture Study Program, Faculty of Agriculture, Samudra, Jl. Prof. Dr. Syarif Thayeb, Meurandeh, Langsa, Aceh

Abstract

Plankton are aquatic organisms that are highly influenced by environmental conditions. This study aimed to identify plankton species in the Bah Bolon River, Simalungun, and to analyze plankton abundance, diversity, dominance, and evenness indices. The study was conducted from February to June 2024. Sampling was carried out using a survey method, with samples collected directly in the field. The results showed that a total of 15 plankton species were found in the Bah Bolon River, Simalungun, consisting of 12 phytoplankton species and 3 zooplankton species. The abundance index values at the upstream and downstream stations were classified as moderate, whereas the middle station was classified as low. The diversity index values at all three stations were classified as moderate, while the dominance index values were classified as low. The evenness index values were classified as high at all three stations. Several dominant species, namely *Maugeotia scalaris* and *Synedra* sp., exhibited relative abundance (RA) values of more than 10% at all stations, indicating that the habitat conditions of the Bah Bolon River were suitable for these species. Meanwhile, several other species were classified as minor species, with relative abundance values substantially below 10% at all stations.

Keywords: Abundance, Plankton, Bah Bolon River, Diversity

1. Introduction

Rivers are a form of open aquatic ecosystem that is also vulnerable to pollution. Pollution in a river is usually caused by environmental conditions and human activities around the river (Nursaini & Harahap, 2022).

The Bah Bolon River flows through Pematangsiantar City and Simalungun Regency, North Sumatra, with a length of ± 118 km and a width of 20 – 25 m (BPS Kota Pematang Siantar, 2014). Various human activities take place around the Bah Bolon River, including domestic

Abstrak

Plankton merupakan organisme perairan yang sangat dipengaruhi oleh kondisi lingkungan. Penelitian ini bertujuan mengidentifikasi jenis plankton di sungai Bah Bolon Simalungun dan menganalisis indeks kelimpahan, keanekaragaman, dominansi dan keseragaman plankton yang terdapat di Sungai Bah Bolon. Penelitian ini dilakukan pada bulan Februari sampai Juni 2024. Pengambilan sampel menggunakan metode survei (pengambilan secara langsung dilapangan). Hasil penelitian dapat disimpulkan bahwa jumlah jenis plankton yang terdapat di sungai Bah Bolon Simalungun sebesar 15 jenis (12 Fitoplankton dan 3 zooplankton). Nilai indeks kelimpahan stasiun hulu dan hilir termasuk dalam kategori sedang, sedangkan stasiun tengah dalam kategori rendah, nilai indeks Keanekaragaman pada ketiga stasiun termasuk kedalam kategori sedang, nilai indeks dominansi pada ketiga stasiun termasuk kedalam kategori rendah, dan nilai indeks keseragaman termasuk dalam kategori tinggi. Beberapa spesies dominan, yaitu *Maugeotia scalaris* dan *Synedra* sp., memiliki nilai kelimpahan relatif (KR) >10% di seluruh stasiun, yang mengindikasikan bahwa kondisi habitat Sungai Bah Bolon sesuai bagi kedua spesies tersebut, sementara sejumlah spesies lain tergolong minor dengan KR jauh di bawah 10% di semua stasiun.

Kata Kunci : Kelimpahan, Plankton, Bah Bolon, Keanekaragaman

activities (residential settlements), industry (ice factories and cigarette factories), and agriculture, which consistently generate waste that is discharged into the Bah Bolon River.

The discharge of this waste can alter the physicochemical parameters of the water, which in turn affects aquatic biodiversity, particularly plankton (Sumanto, 2019). Plankton, as microscopic organisms that drift in the water, have limited swimming ability, and their movement depends heavily on currents. Plankton consist of two types, namely phytoplankton and zooplankton. Phytoplankton are autotrophic and serve as the primary producers that provide energy for other aquatic

* Correspondence: Aquaculture Study Program, Faculty of Agriculture, Samudra, Jl. Prof. Dr. Syarif Thayeb, Meurandeh, Langsa, Aceh
Email:suripurnamafebri@unsam.ac.id

organisms, whereas zooplankton are heterotrophic and depend on phytoplankton as producers to meet their energy needs (Wiyarsih et al., 2019).

Phytoplankton are autotrophic and serve as the primary producers that provide energy for other aquatic organisms, whereas zooplankton are heterotrophic and depend on phytoplankton as producers to meet their energy needs (Wiyarsih et al., 2019).

Plankton abundance in a body of water is influenced by environmental parameters, including water quality and physiology. Plankton abundance and composition can change at various levels in response to changes in the physical, biological, and chemical conditions of the water. There are three main factors that affect the growth response of plankton, namely temperature, light, and nutrients. When temperature, light, and nutrients are in optimum condition, plankton will grow rapidly (Desmawati et al., 2020).

Plankton not only serve as the base of the food chain but also function as bioindicators of water quality. Changes in the abundance, diversity, and species composition of plankton can reflect the level of fertility, ecosystem stability, and even the level of pollution of a body of water (Widiyanti et al., 2020). An abundant presence of plankton directly affects the availability of food resources for fish. Therefore, a study is needed on the identification of plankton species and the analysis of plankton abundance, diversity, dominance, and evenness indices in the Bah Bolon River, Simalungun, in order to understand the important role of plankton in freshwater ecosystems.

2. Materials and Methods

Time and Location

This study was conducted from February to June 2024 in the Bah Bolon River, Simalungun Regency, North Sumatra Province, and the identification was carried out at the Food Crops and Horticulture (TPH) Pest and Disease Observation Laboratory, Peureulak.

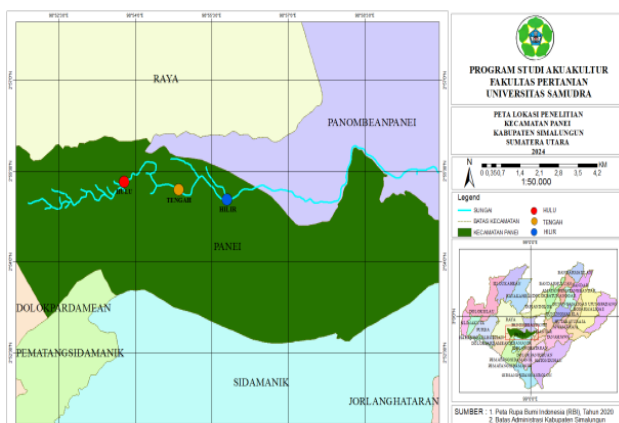


Figure 1. Research Location

Tools and Materials

The tools and materials used during the study are listed in Table 1.

Table 1.

Tools and materials used in the study

No	Tools and materials	Quantity	Function
1	Plankton Net	1 unit	Filtering plankton
2	Sample bottle	18 units	Holding samples
3	Dropper pipette	2 units	Taking samples from the film bottles
4	Microscope	1 unit	Observing plankton
5	Water quality tester	1 unit	Measuring temperature, pH
6	Tide staff	1 unit	Measuring river depth
7	Secchi disk	1 unit	Measuring water brightness, clarity, or transparency
8	Drift float	1 unit	Measuring current velocity
9	Bucket	1 unit	Collecting water samples
10	Stationery	1 unit	Recording data
11	Camera	1 unit	Documentation
12	Lugol 1%	1 bottle	Preserving plankton samples
13	Styrofoam	1 unit	Storing samples
14	Aluminum foil	1 roll	Wrapping samples

RESEARCH METHOD

This study used a survey method, namely direct sampling in the field. Sampling was carried out using a plankton net with a diameter of 20 cm and a mesh size of No. 25, and the water depth at the sampling sites ranged from 0 to 0.5 meters.

Sampling was conducted at 3 stations (Upstream, Middle, Downstream) of the Bah Bolon River, Simalungun. Each sampling station consisted of 3 points. The locations of the sampling stations were determined by purposive sampling (deliberately placing the points/stations) (Pradana *et al.*, 2019). The observation sites were divided into three stations. The first site (upstream) is an area that has not yet been polluted by human activities and remains well preserved. At the second site (middle), there are human activities and heavy equipment that have begun to pollute the water owing to the many activities such as sand and stone extraction. The third site (downstream) has a current that is not too swift and a rocky and sandy substrate.

Sampling Technique

Water sampling in the field was carried out in one day using the purposive sampling method by determining the observation stations, which were then adjusted to the research needs and the expected results (Wirabumi *et al.*, 2017). Surya *et al.*, (2019) explained that sampling can be carried out daily (morning, midday, and afternoon).

Plankton and water quality sampling was carried out by survey at 3 stations (upstream, middle, downstream) in the Bah Bolon River. Three sampling points were determined at each station, giving a total of 9 sampling points across all stations. At each point, plankton samples and water quality samples were collected simultaneously, yielding 2 sample bottles per point, or a total of 18 sample bottles for the entire study.

Plankton samples were collected by taking 5 liters of water with a bucket, which was then filtered through a plankton net, and 10 ml of the filtrate was placed into a prepared sample bottle. Water quality samples were collected with a pail, and 1 liter was poured into a bottle, wrapped in aluminum foil, and sent to Labkesmas Medan, North Sumatra, for analysis.

Sample Preservation Technique

For plankton preservation, 10 ml of the water that had passed through the filter into the collecting tube (bucket) of the plankton net was placed into a sample bottle, then preserved with three drops of 1% Lugol's solution using the prepared dropper pipette, covered with aluminum foil, and labeled with paper indicating the station (Risidian *et al.*, 2023).

Plankton Observation Technique

The 18 water sample bottles were observed under a microscope at 10 x 10 magnification as follows (Risidian *et al.*, 2023).

- 1) Drop 1 ml of the plankton water sample into the Sedgwick-Rafter chamber, then cover it with a cover glass.
- 2) Observe the water sample under the microscope, then count the individuals of each plankton species observed.
- 3) Record the number and species/individuals of plankton (phytoplankton and zooplankton).

The data in this study were analyzed descriptively in the form of tables and figures. The plankton abundance in the Bah Bolon River, Simalungun, was determined using the following data:

A. Plankton Species Found

Plankton are divided into two types, namely phytoplankton and zooplankton. Phytoplankton are autotrophic organisms capable of direct photosynthesis and serve as a source of natural food for aquatic life, whereas zooplankton are heterotrophic, meaning that they cannot produce their own organic matter from inorganic matter (Sari *et al.*, 2017).

The plankton species found were highly diverse, encompassing both phytoplankton and zooplankton. Several plankton species serve as the main food of the jurung fish (*Tor* sp.), such as those from the classes *Bacillariophyceae* (*Bacteriastrum*), *Chlorophyceae* (*Oedogonium*, *Zygnema*), and *Cyanophyceae* (*Gonatozygon*) (Mawardi & Yusrizal, 2017).

B. Plankton Diversity Index (H')

The diversity index aims to determine the diversity of fish species in the waters. The diversity of plankton species can be calculated using the formula of Ludwig and Reynold (1988) in Novrilianty *et al.*, (2022).

$$H' = - \sum_{i=1}^n p_i \ln p_i$$

Where:

H' = Shannon-Wiener diversity index;
 ni = Number of individuals of the i-th species
 N = Total number of individuals
 Pi = ni/N

C. Plankton Dominance Index (C)

This analysis serves to determine the dominance of particular species. The dominance index was calculated using the Simpson (1949) formula in Novrilianty *et al.*, (2022).

$$C = \sum_{i=0}^n \left[\frac{n_i}{N} \right]^2$$

Where:

C = Simpson dominance index
 ni = Number of individuals of the i-th species
 N = Total number of individuals

D. Plankton Evenness Index (E)

Plankton evenness is used to determine the distribution of plankton in a body of water (Mariyati *et al.*, 2020).

$$E = \frac{H'}{H'_{\max}}$$

Where:

E = Evenness index
 H' = Shannon-Wiener diversity index
 H_{max} = Maximum diversity index

E. Abundance Index

Plankton abundance was calculated based on the Sedgwick-Rafter Counting Cell (SRCC) sweep method. Abundance is expressed as the number of cells/liter and was calculated using the formula (Madjid *et al.*, 2025).

$$N = n \times \frac{V_r}{V_o} \times \frac{1}{V_s}$$

Where:

N = Number of cells per liter
 n = Number of cells observed
 Vr = Volume of filtrate (ml)
 V0 = Volume of water observed (in the Sedgwick-Rafter)
 Vs = Volume of water filtered (ml)

F. Relative Abundance (RA)

$$RA = \frac{\text{Density of a species}}{\text{Total density of all species}} \times 100\%$$

Thus, a habitat is considered suitable and appropriate for the development of an organism if the RA value is > 10% (Dewil & Mawardi, 2020).

G. Measurement of Water Parameters

The water quality parameters measured in the Bah Bolon River were pH, temperature, transparency, current velocity, and DO.

3. Results and Discussion

The plankton found in the Bah Bolon River, Simalungun, consisted of 2 types, namely phytoplankton and zooplankton. The plankton found are presented in Table 2.

Table 2.

Counts of all plankton species found in the Bah Bolon River, Simalungun.

Species Name	Upstream	Middle	Downstream	Total
Phytoplankton				
<i>Maugetia scalaris</i>	97	63	104	264
<i>Synedra</i> sp.	81	51	88	220
<i>Nitzschia</i> sp.	72	33	74	179
<i>Oocystis</i>	8	6	19	33
<i>Rhizosolenia longiseta</i>	20	12	22	54
<i>Peridinium</i> sp.	1	0	1	2
<i>Synedra ulna</i>	15	13	19	47
<i>Bacillaria</i>	6	2	17	25
<i>Microcystis</i> sp.	2	2	6	10
<i>Mougeotia</i> sp.	30	8	30	68
<i>Cyclotella</i> sp.	60	51	87	198
<i>Merismopedia tenuissima</i>	2	0	6	8
TOTAL	394	241	473	1108
Zooplankton				
<i>Philodina</i> sp.	3	0	7	10
<i>Nauplius</i> sp.	1	0	1	2
<i>Diaptomus</i> sp.	1	0	1	2
TOTAL	5	0	9	14

The data in Table 2 are composite values per station (without replication); therefore, all between-station comparisons described in this section are descriptive and exploratory. The differences in the number of individuals between stations discussed below describe tendencies in distribution patterns based on the data obtained, not differences that have been statistically tested for significance or that are necessarily ecologically meaningful.

This study found 15 plankton species, consisting of 12 phytoplankton species and 3 zooplankton species. The phytoplankton species found included *Maugetia scalaris*, *Synedra* sp., *Nitzschia* sp., *Oocystis* sp., *Rhizosolenia longiseta*, *Peridinium* sp., *Synedra ulna*, *Bacillaria*, *Microcystis* sp., *Mougeotia* sp., *Cyclotella* sp., *Merismopedia tenuissima*, and the zooplankton species found included *Philodina* sp., *Nauplius* sp. (cyclops), *Diaptomus* sp.

Based on these composite data, the group of species from the class Bacillariophyceae, namely *Synedra* sp., *Synedra ulna*, and *Rhizosolenia longiseta*, cumulatively recorded the highest number of individuals at the downstream station (a total of 146 individuals). The species from the class Zygnematomyceae, namely *Maugetia scalaris*, was also recorded as having the highest number of individuals at the downstream station (104 individuals). In general, the phytoplankton found during the observations were dominated by the classes Zygnematomyceae and Bacillariophyceae at all three stations.

The relatively similar proportions of individuals from the classes Zygnematomyceae and Bacillariophyceae in these composite data may descriptively indicate a relatively balanced aquatic ecosystem. Nevertheless, conclusions regarding the health or stability of water quality require the support of physicochemical water data and further study, and cannot yet be stated with certainty based solely on these species composition data. The zooplankton found belonged to the phyla Rotifera (*Philodina* sp.) and Arthropoda (*Nauplius* sp. and *Diaptomus* sp.), which act as primary consumers in the food chain of the river ecosystem.

Based on the composite data obtained, the number of plankton individuals at the downstream station tended to be higher than at the upstream and middle stations. This pattern is presumably related to the water current velocity at the downstream station, which tends to be slower than at the upstream or middle stations. Plankton are passive organisms that are almost unable to swim against water currents, so their movement is strongly influenced by current velocity and patterns (Nazar *et al.*, 2024). Thus, the slower current presumably causes plankton carried from upstream to be retained in the downstream section, so that more individuals were found at that station (Azhara, 2022).

In addition, the accumulation of nutrients carried from upstream to downstream is presumed to contribute to increased water fertility at the downstream station, which may support plankton growth. The longer water retention time resulting from the slower current downstream is also presumed to give plankton a greater opportunity to reproduce. The presence of waste from activities around the river is also presumed to be an additional source of nutrients that supports plankton growth at that station. However, because this study did not include statistical testing of between-station differences or correlation analysis between physicochemical parameters and plankton abundance, the above explanations are conjectures (hypotheses) supported by descriptive data and related literature, not cause-and-effect relationships that have been statistically proven in this study.

Diversity, Dominance, Evenness, and Abundance Indices

Table 3.

Diversity (H'), dominance (C), evenness (E), and abundance indices of plankton at each observation station in the Bah Bolon River, Simalungun.

Station	INDEX			
	H'	C	E	Abundance
Upstream	1.95 (Moderate)	0.17 (Low)	0.73 (High)	1330 (Moderate)
Middle	1.85 (Moderate)	0.19 (Low)	0.68 (High)	803 (Low)
Downstream	2.11 (Moderate)	0.15 (Low)	0.78 (High)	1607 (Moderate)

The diversity index indicates that the plankton diversity index in the Bah Bolon River, Simalungun, varied at each station. The mean diversity index values were 1.97 upstream, 1.85 at the middle station, and 2.11 downstream. The diversity index values in the Bah Bolon River, Simalungun, fall into the moderate category because $1 < H' < 3$ (Eha *et al.*, 2016).

The dominance index values were low: 0.17 upstream, 0.19 at the middle station, and 0.15 downstream. These values indicate that no plankton dominated at any station. The low dominance of plankton occurs because of several environmental factors and water conditions that affect the plankton community structure. Accordingly, the waters of the Bah Bolon River, Simalungun, can be described as optimal and not extreme, because no single plankton species is superior to the others. This results in the absence of dominance by any

particular species, so the plankton community structure becomes more balanced. In addition, nutrient availability is evenly distributed and thus sufficient to support the growth of various plankton species without any particular species becoming excessive (Mariyati *et al.*, 2020).

The plankton evenness index values obtained in the Bah Bolon River were high at every station: 0.73 upstream, 0.68 at the middle station, and 0.78 downstream. According to (Mariyati *et al.*, 2020), evenness index values of $E > 0.6$, such as those in the Bah Bolon River, Simalungun, are categorized as high. Accordingly, the plankton species found at each research station in the Bah Bolon River, Simalungun, were relatively uniform, and their individuals were evenly distributed.

The differences in plankton abundance among the 3 stations may be caused by different environmental factors at each station, such as nutrient availability, sunlight, and the physicochemical properties of the water. Stations with moderate abundance values have conditions that are more supportive of plankton growth than stations with low abundance (Tamama & Asadi, 2024). In this study, plankton abundance was higher at the downstream station of the river than in the middle and upstream sections.

Among the influencing factors, the downstream section usually serves as a site of accumulation of organic matter and nutrients from upstream and along the river. These nutrients are essential for plankton to grow and develop, so plankton abundance downstream is higher. Stable environmental conditions downstream, with stable temperature and pH, support optimal plankton growth. Regarding the influence of human activities, downstream areas are often sites of human activities such as industry and settlements, which contribute to increased nutrients through waste, although this can also cause pollution. However, these extra nutrients can sometimes increase plankton productivity up to the eutrophic level.

Relative Abundance of Plankton

The highest relative abundance of plankton in the Bah Bolon River, Simalungun, was found in the species *Maugeotia scalaris*, *Synedra* sp., *Nitzschia* sp. 18%, and *cyclotella* sp. The relative abundance of plankton in the Bah Bolon River, Simalungun, is shown in Figure 1.

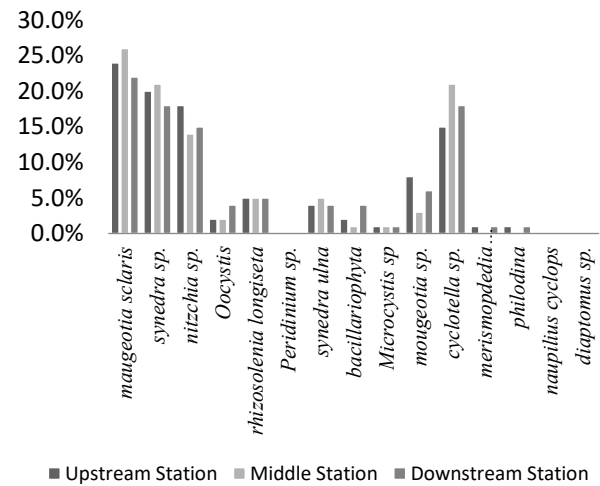


Figure 2. Relative Abundance of Plankton

The highest relative abundance of plankton in the Bah Bolon River, Simalungun, at the upstream station was found in *Maugeotia scalaris* 24%, *Synedra* sp. 20%, *Nitzschia* sp. 18%, and *cyclotella* sp. 15%. For these species, the habitat is considered suitable and appropriate for development because their RA values are $>10\%$. The lowest RA values were found in *Microcystis* sp., *Merismopdedia tenuissima*, *Philodina*, *Peridinium* sp., *Naupilius cyclops*, *Diaptomus* sp., with RA values of 1% and 0%, respectively. These species are not well suited to the environment because their RA values did not exceed 10%.

The relative abundance at the middle station was highest in *Maugeotia scalaris* 26%, *Synedra* sp. 21%, *Nitzschia* sp. 14%, and *cyclotella* sp. 21%. For these species, the habitat is considered suitable and appropriate for development because their RA values are $>10\%$. The lowest RA values were found in *Merismopdedia tenuissima*, *Philodina*, *Peridinium* sp., *Naupilius cyclops*, *Diaptomus* sp., each with an RA value of 0%. These species are not well suited to the environment because their RA values did not exceed 10%.

The relative abundance at the downstream station was highest in *Maugeotia scalaris* 22%, *Synedra* sp. 18%, *Nitzschia* sp. 15%, and *cyclotella* sp. 18%. For these species, the habitat is considered suitable and appropriate for development because their RA values are $>10\%$. The lowest RA values were found in *Peridinium* sp., *Naupilius cyclops*, *Diaptomus* sp., each with an RA value of 0%. These species are not well suited to the environment because their RA values did not exceed 10%.

PHYSICOCHEMICAL WATER PARAMETERS

Results of the water quality measurements in the Bah Bolon River, Simalungun (Table 4).

Table 4.
Measurement of Water Parameters

Parameter	Upstream		Middle		Downstream	
	Initial	Final	Initial	Final	Initial	Final
pH	6.88	6.96	6.94	6.86	7.01	7.02
Temperature (°C)	21.0	24.4	22.4	24.5	22.7	23.3
Transparency (cm)	44.5	41	36	36	41	44.5
Depth (m)	1.5	1.5	1.6	1.6	1.9	1.9
Current (m/s)	1.30	0.99	0.78	0.78	0.99	1.34
DO (mg/l)	-	6.19	-	6.98	-	6.28

*DO was measured only once (final measurement) at each station.

The results of the physicochemical water parameter measurements showed that pH values ranged from 6.88 to 7.02. The highest pH value was found at the downstream station at 7.02 mg/l, whereas the lowest was found at the middle station at 6.86 mg/l. The optimum pH for plankton abundance ranges from 6.5 to 8 Samawi *et al.*, 2020.

Temperature values ranged from 21.0°C to 24.5°C. The highest temperature was found at the middle station, at 24.5°C, and the lowest at the upstream station, at 21.0°C. According to Samawi *et al.*, (2020), the optimal temperature for supporting plankton growth is 20°C – 30°C.

Transparency is a physical parameter related to photosynthesis in an aquatic ecosystem. Transparency reflects the intensity of sunlight penetrating a body of water, so it is strongly influenced by turbidity. Transparency ranged from 36 cm to 44.5 cm. The highest transparency was found at the middle station, at 36 cm, whereas the lowest was found in the initial upstream and final downstream measurements, at 44.5 cm. Sufficiently high water transparency is important so that light can penetrate and support phytoplankton photosynthesis. Low to moderate transparency is considered optimal.

Water depth in this study ranged from 1.5 m to 1.9 m. The greatest depth was found downstream at 1.9 m, whereas the shallowest depth was at the downstream station at 1.5 m. According to Syahrul *et al.*, (2021), a good and normal depth for fish life is between 1.5 and 2 m. It can be concluded that the depths at the three research stations can support the life of aquatic organisms in the Bah Bolon River.

Dissolved oxygen (DO) was measured only once at each station. DO values ranged from 6.19 mg/L to 6.98 mg/L. The highest DO value was found at the Middle station at 6.98 mg/L, whereas the lowest was at the Upstream station at 6.19 mg/L. According to Syahrul *et al.*, (2021), the optimal dissolved oxygen concentration for freshwater plankton ranges from 4 to 6 mg/L. Based on this range, the DO values at the Upstream (6.19 mg/L) and Downstream (6.28 mg/L) stations were slightly above the upper limit of the cited optimal range, whereas the Middle station (6.98 mg/L) was further above that range. Nevertheless, high dissolved oxygen levels generally do not act as a limiting factor for aquatic organisms in the way that excessively low levels do; thus, the DO conditions at all three stations can generally still be considered supportive of the life of plankton and other aquatic organisms.

4. Conclusion

Based on the results of the study, it can be concluded that 15 plankton species (12 phytoplankton and 3 zooplankton) were identified in the Bah Bolon River, Simalungun. The phytoplankton found were *Maugeotia scalaris*, *Synedra* sp., *Nitzschia* sp., *Oocystis*, *Rhizosolenia longiseta*, *Peridinium* sp., *Synedra ulna*, *Bacillariophyta*, *Microcystis* sp., *Mougeotia* sp., *Cyclotella* sp., *Merismopodia tenuissima*, and the zooplankton species consisted of *Philodina*, *Naupilius cyclops*, and *Diaptomus* sp.

The plankton abundance index values in the Bah Bolon River, Simalungun, show that the upstream and downstream stations fall into the moderate category, while the middle station falls into the low category. The plankton diversity index values in the Bah Bolon River, Simalungun, show that all stations fall into the moderate category. The dominance index values in the Bah Bolon River, Simalungun, show that all stations fall into the low category. Meanwhile, the evenness index values in the Bah Bolon River, Simalungun, fall into the high category.

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