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THE RELATIONSHIP BETWEEN THE STRUCTURE COMMUNITY PLANKTON AND THE QUALITY OF THE BEROK MUARA RIVER, CENTRAL BANGKA

Hubungan Struktur Komunitas Plankton Dan Kualitas Perairan Muara Sungai Berok Bangka Tengah

Nurliana Isroq Dly*, Eva Utami, Aditya Pamungkas

Marine Science, Bangka Belitung University

Balunijuk Village, Merawang District, Bangka 33172 Indonesia

*Corresponding Author: isroq2001@gmail.com

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ABSTRACT

Plankton are the smallest biota that drift and inhabit marine and fresh waters. Plankton have a variety of responses and are susceptible to changes in water quality. The purpose of this research is to find out and analyze the structure of the plankton community and also the quality of the waters and their relationship using spearman correlation analysis. The time and place of the research was carried out of October 2022 in the waters of the Berok Estuary, Central Bangka, as many as 6 station points using the plankton net tool with the vertical method. Plankton samples were identified under a binocular microscope with three repetitions. The results showed that 67 species from 39 genus. Lowest plankton abundance at station 1, namely 82 cells/l and the highest at stations 5 and 6, namely 1,310 cells/l and 1,327 cells/l. The results of the analysis of the lowest plankton diversity index were at station 1, namely 1.945 and the highest at station 5, namely 3.265. The lowest uniformity index at station 1 is 0.620 and the highest at station 2 is 0.877. The lowest dominance index at station 5 is 0.055 and the highest at station 1 is 0.183. several water parameters have been tested according to quality standards, except brightness, nitrate and orthophosphate, will the appropriate parameters have been optimal for marine biota. The relationship of water quality including orthophosphate and current velocity a significant relationship to the plankton community structure in the waters of the Berok Estuary, Central Bangka.

Keywords: Relationship, The River, Structure Community Plankton, Biota, Parameter

ABSTRAK

Plankton termasuk biota terkecil yang hanyut dan mendiami perairan laut maupun tawar. Plankton mempunyai variasi respon dan rentan terhadap perubahan kualitas perairan. Tujuan penelitian ini ialah mengetahui dan menganalisis struktur komunitas plankton dan kualitas perairan serta hubungannya menggunakan analisis korelasi spearman. Waktu dan tempat penelitian dilaksanakan pada bulan Oktober 2022 di Perairan Muara Sungai Berok Bangka

Tengah sebanyak 6 titik stasiun menggunakan alat plankton net dengan metode vertikal. Sampel plankton diidentifikasi di bawah mikroskop binokular sebanyak tiga kali ulangan. Hasil penelitian menunjukkan identifikasi plankton yang ditemukan sebanyak 67 spesies dari 39 genus. Kelimpahan plankton terendah pada stasiun 1 yaitu 82 sel/liter dan tetinggi di stasiun 5 dan 6 yaitu 1.310 sel/liter dan 1.327 sel/liter. Hasil analisis indeks keanekaragaman plankton terendah pada stasiun 1 yaitu 1,945 dan tertinggi pada stasiun 5 yaitu 3,265. Indeks keseragaman terendah pada stasiun 1 yaitu 0,620 dan tertinggi stasiun 2 yaitu 0,877. Indeks dominansi terendah pada stasiun 5 yaitu 0,055 dan tertinggi stasiun 1 yaitu 0,183. Beberapa parameter air yang telah diuji sesuai baku mutu kecuali parameter kecerahan, nitrat, dan ortofosfat dan parameter yang sesuai telah optimum untuk biota laut. Hasil analisis kualitas perairan meliputi ortofosfat dan kecepatan arus menunjukkan hubungan kuat terhadap struktur komunitas plankton di Perairan Muara Sungai Berok Bangka Tengah.

Kata Kunci: Hubungan, Muara Sungai, Struktur Komunitas Plankton, Biota, Parameter

INTRODUCTION

The Berok River Estuary is located in Berok Village, Central Bangka Regency, Bangka Belitung Islands Province. The Berok River Estuary is used by local residents as a route for fishing boats to and from the river. Estuary areas generally accumulate river and sea water, as water flowing from upstream is held back by seawater before finally merging with the seawater. This process impacts waste storage at the river estuary, causing all waste received to impact water quality in the estuary (Warman 2015). The Berok River Estuary is home to a number of anthropogenic activities, including agriculture, mining, settlements, and fishing. Mining, agricultural, and household waste activities can contribute to pollution and high sedimentation levels originating from the river basin (Ayyub *et al.,* 2018).

Activities around river estuaries generally significantly impact the natural ecosystems within them. Organic matter carried by currents can lead to nutrient enrichment, impacting aquatic organisms, particularly plankton. Hamuna (2018) stated that phosphate, a nutrient essential for plankton and other organisms, is essential for growth and metabolism. Therefore, plankton are the first organisms to respond to changes in water quality. Plankton is one of the many dominant communities found in waters, characterized by its sensitivity and varied responses to changes in water quality (Rizqina *et a*l., 2018). This characteristic can be an advantage for plankton, as it can serve as an indicator of aquatic environmental quality (Thakur *et al*., 2013). A decline in plankton numbers will impact other organisms living in the waters and can degrade water quality.

Water quality in the Berok River Estuary, Central Bangka, is suspected to have been affected by community activities, such as mining activities in the upstream part of the river (Kurniawan et al., 2021). Based on physical observations, the water in the Berok River appears cloudy brown due to suspected mixing of water with mud caused by the flow of mud dumped by small-scale tin miners. Assessing the environmental quality of the waters in the Berok River Estuary is crucial to determine the extent of water quality degradation due to various wastes from anthropogenic activities, particularly mining activities. This monitoring is expected to lead to further management of the ecosystem in the Berok River Estuary. Assessment of the environmental quality of the waters can be carried out by identifying aquatic biological indices such as plankton community structure, diversity, uniformity, and plankton dominance. Therefore, this study aims to determine the abundance of plankton and other water quality parameters in the Berok River Estuary to determine the extent of water quality degradation in this environment and to implement further management appropriate to the conditions in the Berok River Estuary.

RESEARCH METHODS

Place and Time of Research

The location of this research was carried out at the Berok River Estuary, Central Bangka at six stations with a distance of 750 meters and started in October 2022. The station points were determined using a purposive sampling method, which means that data sampling was carried out with certain considerations that represent the area (Sugiyono, 2016).

Station one is the river's headwaters, where community activity is prevalent. Station two features several mangrove plantations, residential areas, and fishing boat moorings. Station three is an open estuary receiving seawater inflow. Stations four, five, and six are 750 meters north, west, and east of the river mouth.

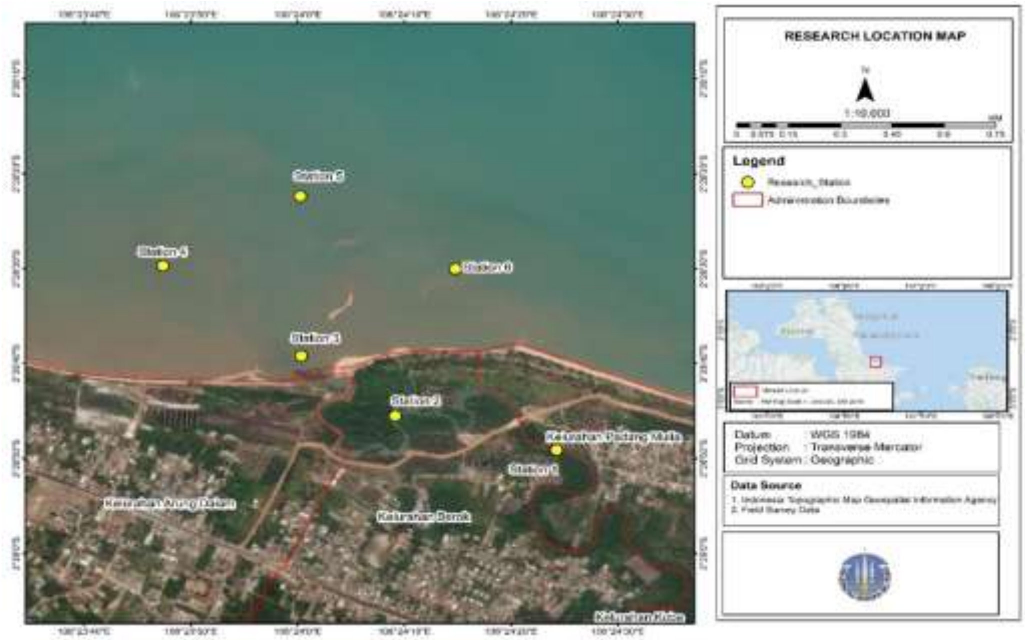

Figure 1. Observation Station

Tools and materials

The use of materials and tools in the research process in the form of 4% formalin solution, plankton samples, concentrated sulfuric acid (H2SO4), plankton net, sample bottles, cool box, sedgwick rafter, DO meter, refractometer, secchi disk, pH, current kite, water sampler, binocular microscope, identification book, dropper pipette, polyethylene bottle.

Plankton Sampling Process

Plankton sampling was carried out using a plankton net placed in a 100 mL sample bottle using a vertical method, referring to Novrilianty's research (2022). The plankton net was lowered to a depth of 3 m, then slowly pulled up so that the filtered sample entered the collection bottle. The sample was then transferred to a sample bottle that had been given 4% formalin. The purpose of plankton preservation is to maintain the obtained sample intact, then placed in a cool box. Then, identification was carried out using a Sedgewick Rafter and a binocular microscope at 40x magnification using the book by Isamu Yamaji (1979) at the Aquatic Resources Management Laboratory of the University of Bangka Belitung.

Data Analysis

Plankton Abundance

Plankton abundance aims to determine the amount of plankton obtained in each volume, the value can be determined using the following formula (Choirun *et al*., 2015):

$$N = ni \text{ X } \frac{1}{Vd} \text{ X } \frac{Vt}{Vs}$$

N is the total number of cells per liter (Cells/liter), ni is the total observed plankton species (Cells), Vd is the volume of filtered water = (π.r2) x Length of rope at depth (L), Vt is the volume of sample water in the sample bottle, namely 100ml and Vs is the volume of water sample under the cover glass, namely 1ml.

Diversity Index

The diversity index aims to determine the diversity of biota found in waters. Plankton diversity values can be obtained based on the following Shannon–Wiener equation (Puspita, 2017):

$$H' = -\sum_{i=0}^{s} Pi \ \ In\ (Pi) \text{ Where } Pi = \frac{ni}{N}$$

H’ is a symbol that indicates the species diversity index, ni is the number of species individuals and N is the total number of plankton individuals.

Uniformity Index

The uniformity value is obtained by comparing the value obtained from the diversity index with its maximum value. This index can determine the distribution of plankton in an aquatic community. The following is the equation for the plankton uniformity index (Yuliana, 2014).

$$E = \frac{H'}{Hmaks}$$

E shows the uniformity index while H’ shows the diversity index value and Hmaks is In S, with S being the number of species.

Dominance Index

Nilai This calculation aims to determine whether or not dominant species are present in the research area. Dominance values are determined using the Sympson dominance index based on the following equation (Rahmatullah *et al*., 2016).

$$D = \sum \left[\frac{ni}{N}\right]^2$$

D is the dominance index, ni is the number of individuals, N is the total number of individuals.

Water Clarity

The water clarity measurements that have been measured at the research location are then calculated using the following equation (Tison *et al*., 2016).

$$c = 0{,}5\ \frac{m + n}{z}\ x\ 100$$

c is the water clarity value (%), z is the water depth (m) and m is the depth at which the Secchi disk begins to be visible (m) and n is the depth at which the Secchi disk begins to be visible (m)

Current Speed

The value of the directional speed measurement that has been carried out can be determined using the following equation (Azis *et al*., 2020).

$$V = \frac{s}{t}$$

V is the speed of the water current (m/second), s is the length of the current kite pull (m) and t is the length of time used (seconds).

Spearman Correlation Analysis

Statistical analysis is used to determine whether or not there is a relationship between two or more variables using SPSS software version 22. The results of the correlation analysis are +1 or -1 which can be calculated using the following equation.

$$rho = 1 - \frac{6 \sum d^2}{n(\ n^2 - 1\ )}$$

rho rho is the Spearman correlation coefficient, d^2 is the squared rank variable; and n is the number of data samples.

RESULTS

Plankton Community Structure in the Estuary of the Berok River, Central Bangka

The results of the identification of plankton species in the Berok River Estuary, Central Bangka, consist of 3 classes of phytoplankton types, namely Bacillariophyceae with 17 genera, Dinophyceae 5 genera, and Cyanophyceae consisting of 3 genera. The total number of genera of phytoplankton types is 25. The type of zooplankton consists of 5 classes including Maxillopoda with 5 genera, Copepoda 4 genera, Ciliatea 3 genera, and Appendicularia 1 genus, and Gastropoda consisting of 1 genus. The total number of genera in the zooplankton type is 14 genera, according to the following table:

Table 1. Plankton Genus at Each Research Station

Class	Genus	Total genus of each station					
FITOPLANKTON		**I**	**II**	**III**	**IV**	**V**	**VI**
	Rhizosolenia	10	55	30	24	124	143
	Biddulphia	0	12	13	1	24	29
	Leptocylindrus	0	8	2	8	30	66
	Nitzschia	10	6	0	2	94	8
	Coscinodiscus	0	5	3	0	7	11
	Hemiaulus	0	2	3	0	6	7

Bacillariophyceae	Guinardia	0	2	1	2	9	11
	Thallasionema	0	0	0	2	5	1
	Thalasionthrix	0	2	0	0	0	4
	Pleurosigma	0	5	0	0	0	1
	Bacillaria	0	4	0	0	0	0
	Eucampia	0	0	0	0	7	6
	Gyrosigma	0	1	0	0	1	1
	Lithodesmium	0	1	0	0	1	0
	Triceratium	0	1	0	0	0	1
	Ditylum	0	1	0	0	0	0
	Chaetoceros	0	0	2	0	12	9
Dinophyceae	Peridinium	0	0	0	0	1	0
	Pyrocystis	0	0	0	0	4	1
	Gonyaulax	0	0	0	0	1	0
	Isthmia	0	0	0	1	0	0
	Ceratium	0	19	1	7	46	31
Cyanophyceae	Pelagothrix	1	1	0	0	11	1
	Tricodesmium	1	12	2	0	8	2
	Rhicelia	0	0	0	0	1	0
ZOOPLANKTON		**I**	**II**	**III**	**IV**	**V**	**VI**
Maxillopoda	Oncaea	0	0	1	0	0	0
	Calanus	0	0	0	0	8	4
Maxillopoda	Eurytemora	1	3	0	0	3	10
	Microsetela	0	2	0	0	0	2
	Tigriopus	0	0	0	0	5	0
Copepoda	Oithona	0	1	2	0	15	14
	Paracalanus	0	0	0	0	1	0
	Euterpina	0	0	0	0	0	1
	Acartia	0	1	0	0	3	9
Ciliatea	Tintinnopsis	0	1	0	0	16	2
	Parafavella	0	0	1	0	0	0
	Helicostomela	0	0	1	0	0	0
Apendicularia	Oikopleura	0	0	0	0	1	0
Gastropoda	Limacina	0	1	0	0	0	0

Abundance of plankton

The lowest plankton abundance value was at station 1, namely 82 cells/liter, and the highest at stations 6, namely 1,327 cells/liter and 5, namely 1,310 cells/liter. The plankton abundance values found at each research station are shown in the following bar chart.

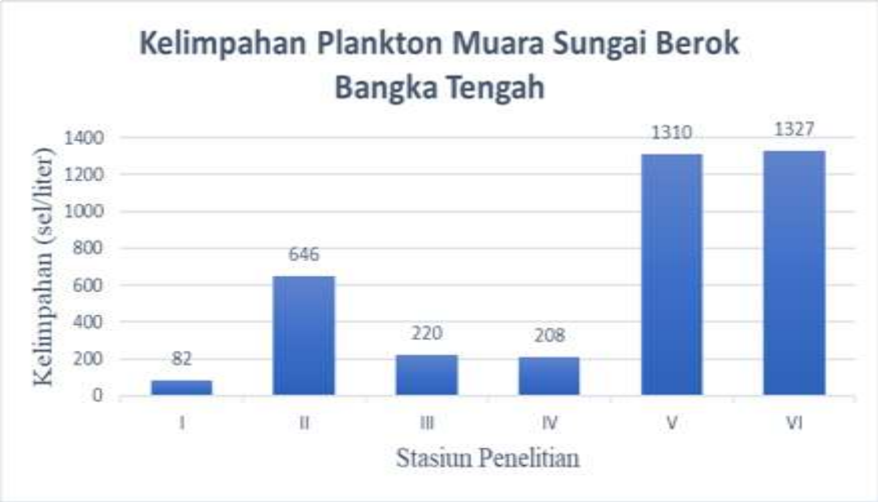

Figure 2. Plankton abundance

Diversity Index

The diversity index at stations 2, 5, and 6 is classified as strong, while stations 2, 3, and 4 are classified as moderate.

Table 2. Diversity Index Values in the Estuary Waters of the Berok River

	Station	Diversity (H')	Category
The waters of the Berok River Estuary, Central Bangka	I	1,945	Currently
	II	3,091	High
	III	2,597	Currently
	IV	2,208	Currently
	V	3,265	High
	VI	3,012	High

Plankton Species Uniformity Index

The research uniformity index at this research location is classified as moderate to high as shown in the following table.

Table 3. Uniformity Index Value of Berok River Estuary Waters

	Station	Uniformity (E)	Category
The waters of the Berok River Estuary, Central Bangka	I	0,620	Currently
	II	0,877	High
	III	0,853	High
	IV	0,861	High
	V	0,848	High
	VI	0,801	High

Plankton Species Dominance Index

The dominance index value at station 1 was categorized as the highest, namely 0.184, while the dominance value at station 5 was the lowest, namely 0.056.

Table 4. Dominance Index Value in the Estuary Waters of the Berok River

	Station	Dominance (D)	Category
The waters of the Berok River Estuary, Central Bangka	I	0,183	There is no dominant type of plankton.
	II	0,058	
	III	0,105	
	IV	0,141	
	V	0,055	
	VI	0,077	

Water Quality (Physico-Chemical Parameters) of the Berok River Estuary

The following table shows the varying water quality values at the research locations.

Table 5. Results of Measurement of Physical-Chemical Parameters of Water

Physical and Chemical Parameters								
Station	**Temperature**	**pH**	**Brightness**	**Salinity**	**DO**	**Current**	**Nitrat**	**Ortofosfat**
I	28,3	7,6	3	25	6,9	0,10	0,210	0,222
II	28,5	7,5	2,5	25	7,1	0,25	0,160	0,188
III	29	7,9	6	31	7	0,29	0,190	0,066
IV	30,9	8	18,75	33	6,5	0,28	0.008	0,033
V	30,2	8	48	34	7	0,33	0,008	0,022
VI	30,4	8	17	33	7,2	0,29	0,008	0,025

Analysis of the Relationship between Plankton Community Structure and Water Quality

The Spearman correlation level of the results of water quality data measurements based on the physical-chemical parameters of the water and the structure of the plankton community in the Berok River Estuary, Central Bangka, was taken from a strong relationship.

Table 6. Correlation of Plankton Community Structure with Water Quality

Correlation Variables		Spearman Correlation Analysis SPSS		
Plankton Community Structure	**Water Quality**	**Correlation**	***P-Value***	**Information**
Plankton Abundance	Ortofosfat	-0,714	0,111	Strong
	Current Speed	0,696	0,125	Strong
	Nitrat	-0,638	0,173	Strong
Plankton Diversity	Brightness	0,657	0,156	Strong
	Current Speed	0,638	0,173	Strong
	Ortofosfat	-0,600	0,208	Strong
Plankton Dominance	Brightness	-0,657	0,156	Strong
	Current Speed	-0,638	0,173	Strong
	Ortofosfat	0,600	0,208	Strong

DISCUSSION

The results of the identification of plankton species in the Berok River Estuary, Central Bangka, consist of three classes of phytoplankton with 25 genera and five classes of zooplankton with 14 genera. The dominant class obtained at all stations was phytoplankton from the Bacillariophyceae class with 17 genera.

At stations 1 and 5, the number of observed individuals was 23 and 444, respectively, with *Nitzschia seriata* being the dominant species. This species is generally cosmopolitan and can be found in both freshwater and marine waters (Putri *et al*., 2014). Station 1 is located upstream with a salinity of 25 °C and high nitrate and orthophosphate levels, while station 5 is located offshore with a salinity of 34 °C and decreasing nitrate and orthophosphate levels.

Plankton obtained at stations 2 and 4 amounted to 146 and 47 individuals with the species *Rhizosolenia alata, Rhizosolenia imbricata* and *Rhizosolenia* hebetate were found in abundance. These species are thought to be abundant because they are strong in surviving and have broad adaptations in absorbing nutrients in waters from both low and high concentrations. A total of 62 plankton individuals were identified at station 3, which is the location where river water merges with sea water, while the dominant species is *Biddulphia sinensis*. This species is abundant because it is able to adapt to the research location with fluctuating waters. Based on research by Dirani *et al*., (2022), *Biddulphia sp.* was dominantly found because it has the ability to adapt to dynamic changes in water quality.

At Station 6, 375 plankton individuals were observed, with the dominant species being Leptocylindrus danicus. Its cells are elongated and contain numerous small chloroplasts, enabling photosynthesis to produce abundant chlorophyll, supporting the rapid growth of this species, which is abundant in the research waters. This phytoplankton species is found in tropical and subtropical regions, such as marine waters and estuaries (Rahmi *et al*., 2021).

Nilai The lowest plankton abundance value was at station 1, namely 82 cells/liter. This is because the level of clarity is influenced by suspended particles originating from residential waste, so that the waters tend to be cloudy and can be an obstacle in the process of photosynthesis. The content of orthophosphate and nitrate values at this station is high compared to other stations, namely 0.222 mg/l and 0.210 mg/l. Research by Rahmawati *et al*., (2014) in the Sayung River Estuary showed that high phosphate levels actually resulted in low plankton abundance. At station 6, namely 1,327 cells/liter and 5, namely 1,30,271 cells/liter are classified as high abundance, it is suspected that the level of clarity at both stations is quite high compared to other stations, because phytoplankton contain chlorophyll pigments for photosynthesis as reproduction (Zainuri *et al*., 2023).

The diversity index at stations 2, 5, and 6 is classified as strong, indicating a balanced environmental carrying capacity. Conversely, stations 2, 3, and 4 are classified as moderate, indicating disturbances or pressures are present (Shabrina *et al*., 2020). A comparison of research by Sari *et al*. (2017) at the Kurau River Estuary indicates moderate diversity, due to the influence of physicochemical parameters, nutrient availability, and the ability of individuals to adapt to their environment.

The uniformity index of this study is classified as high, which means that the distribution of individuals of each type tends to be more even and each biota in the waters has the opportunity to utilize the available nutrients simultaneously, even though the nutrient content is limited (Djunaidah *et al*., 2017).

The overall station dominance index indicates the absence of any particular dominant species. Station 1 had the highest dominance index value, at 0.184, due to the low number of plankton species identified (Mahmudin and Sakaria, 2022). Station 5 had the lowest dominance value, at 0.056, due to the increasing number of plankton species found in the waters, which in turn lowers their dominance value.

The dissolved oxygen levels in this study ranged from 6.5 to 7.2 mg/L. The factors influencing the differences in dissolved oxygen levels in the Berok River Estuary are the activities of local residents and fishermen, which facilitate oxygen diffusion from the air into the water. The lowest value was at station 4 due to its proximity to the coast, making this location appear more turbid due to particles carried by the water from the beach sand (Sidabutar *et al*., 2019). This parameter is appropriate for marine biota, namely >5 mg/L, as stipulated in Government Regulation (PP No. 22 of 2021). The highest temperature value in this study was at station 4, namely 30.9°C, and the lowest was at station 1, namely 28.3°C. Temperature variations in the waters are strongly influenced by the intensity of light entering the water column, the time of day, and the presence of vegetation cover from surrounding trees (Leidonald *et al*., 2022). The temperature range in this study is still optimal and suitable for plankton growth, at 28–32°C.

The waters of the Berok River Estuary in Central Bangka have a current velocity of 0.1 m/s at station 1 and increasing to 0.483 m/s at station 5, which leads offshore. Research (Sidabutar *et al*., 2019) states that current velocities <0.5 m/s are categorized as low to moderate. This value allows plankton activity to run more efficiently in the waters. Offshore locations generally have a more alkaline pH of around 8 ppm, with the lowest value at station 2, at 7.5 ppm. Waters with very acidic and very alkaline conditions are not good for biota because they can be dangerous and cause metabolic and respiratory disorders (Hamuna *et al*., 2018). A pH value that shows a range of 7-8.5 ppm is suitable for marine biota life, this is stated in Government Regulation (PP No. 22 of 2021).

The salinity of stations 1 and 2, which are upstream, is categorized as low at 25, and increases towards offshore waters. The effect of the increase in salinity is due to the distance of the observation station to the downstream of the river. Government Regulation (PP No. 22 of 2021) indicates the suitability of the salinity parameters for marine biota, namely 33-34. The lowest clarity value at station 2, namely 2.5%, is the location where ships dock and residential areas. Based on research (Mainassy 2015), turbid waters with low clarity indicate a large number of suspended particles from waste from community and domestic activities in the area, as well as the minimal role of mangrove plants. Station 5 has a clarity value of 48%. This difference is due to its location in the offshore area and far from land influence. The water clarity at these six stations does not comply with the predetermined category, namely >3 meters, as stated in Government Regulation (PP No. 22 of 2021).

Nitrate levels in the Berok River Estuary in Central Bangka were found to be 0.008–0.210 mg/L, with station 1 showing the highest nitrate concentration. This is due to the large amount of wastewater entering the water body due to its location in a populated area. Research (Fatma *et al*., 2022) suggests that the low nitrate concentration is due to the low nitrate nutrient input and the study's distance from residential areas. Discussing nitrate is closely related to orthophosphate, which has a value between 0.022–0.222 mg/L. Stations 3, 4, 5, and 6 had low orthophosphate values, presumably because the sampling locations were located offshore. Rahmawati *et al*. (2014) stated that orthophosphate was low due to its location far from land influence. Meanwhile, the highest orthophosphate value was at station 1, due to this location being in the upstream area of the river that receives waste input. Government Regulation (PP No. 22 of 2021) states that the suitability of nitrate and orthophosphate values for marine biota exceeds the established quality standard limits.

The correlation between plankton and water quality is categorized as strong with current velocity and orthophosphate, which in terms of correlation values are (r = +0.696) and (r = -0.714). The difference between the two is clearly visible in the direction of the resulting correlation, namely in the same direction (+) and in the opposite direction (-). High current velocity values in the Berok River Estuary Waters will be followed by high plankton values in those waters, while low orthophosphate values in those waters are followed by high plankton values in those waters.

Plankton utilizes slow currents to carry and distribute these species throughout the waters, as they lack swimming abilities. Research by Azzam *et al*. (2018) found that currents of less than 0.5 m/s are classified as low to moderate. Such current speeds allow for adequate plankton activity, but excessively strong currents can result in high turbidity, which can impact brightness and suboptimal photosynthesis. Faster currents mean fewer plankton are captured.

Plankton negatively correlates with orthophosphate in waters. Low levels of orthophosphate in these waters indicate that plankton utilize nutrients for growth and development. Phytoplankton significantly utilize orthophosphate levels in the waters for growth and photosynthesis (Azis *et al*., 2020). Orthophosphate and nitrate levels at research stations facing offshore waters are generally lower because they are far from land influences, and plankton at these stations are more abundant.

CONCLUSION

1. Plankton species found in the Berok River Estuary waters of Central Bangka totaled 67 species from 39 genera. The plankton community structure is classified as moderate to high, with almost no individuals dominating the area.
2. The water quality of the Berok River Estuary in Central Bangka meets the quality standards and is optimal for marine biota, except that the parameters of clarity, nitrate, and orthophosphate do not meet the quality standards based on PP RI No. 22 of 2021.
3. The strong relationship between water quality and plankton community structure includes current speed with a unidirectional correlation and orthophosphate with an inverse correlation to plankton. The P-*Value* of both correlations is >0.05, meaning there is no significant relationship.

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