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ANALYSIS OF THE ABUNDANCE AND DIVERSITY OF PLANKTON IN THE NEGARA RIVER OF HULU SUNGAI SELATAN DISTRICT, SOUTH KALIMANTAN

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ABSTRACT

Plankton is used as a bioindicator of water conditions because plankton has tolerance limits to certain substances, because the presence of plankton in water can provide information about water conditions. Phytoplankton as a biological indicator can determine water quality either through the approach of species diversity and indicator species. Phytoplankton as a biological indicator not only determines the level of water fertility, but also the phase of pollution that occurs in the waters. The study was conducted for 6 (six) months in the waters of the Negara River, which is located in the South Hulu Sungai Regency, South Kalimantan. Sungai Negara is an ecosystem that is important for the life of living things and the surrounding environment. The presence of plankton in waters can provide information about the Negara of the waters. So the purpose of this research is to obtain data on the composition, and diversity of phytoplankton in the waters of the Sungai Negara. The results of the research on the composition, yield and diversity of phytoplankton in the waters of the Negara River were mostly by the type of Navicula sp. which was found at all stations for each sampling.

KEY WORDS

Plankton, abundance, community structure, Negara River, South Kalimantan.

Plankton is organisms (plants and animals) whose lives float or float in water and their movements are influenced by currents. So, plankton can be in the form of plants which are commonly called “phytoplankton” and animal plankton is called “zooplankton”, and there are far more of them than fish. The large number of plankton cannot be separated from its very important role, where phytoplankton are able to produce energy sources (through the photosynthesis process) which are directly or indirectly needed by all living things through the food chain process in a complex ecosystem (Soedarsono, et al. al., 2002). Meanwhile, zooplankton have an important role in the food chain, namely as primary consumers in aquatic ecosystems.

The river is an aquatic ecosystem that plays an important role in the hydrological cycle and functions as a catchment area for the surrounding area. As an ecosystem, river waters are composed of various biotic and abiotic components that interact and influence each other. Components in the river ecosystem will be integrated with each other to form an energy flow that will support the stability of the ecosystem (Suwondo, et al., 2004).

Negara River is an ecosystem that is important for the life of living things and the surrounding environment. Rivers provide benefits for human life in the vicinity and the life of organisms in the waters. The role of rivers for human activities is related to the life of organisms. The existence of human activities that utilize river waters does not only have an impact on the life of organisms but also on the quality of the river water.

METHODS OF RESEARCH

The research was conducted in Negara River, Hulu Sungai Selatan Regency. Sampling was carried out for 3 times in May – June 2022. Sampling was carried out at two stations, namely upstream and downstream of the Hulu Sungai Selatan in South Kalimantan of Indonesia (Figure 1).

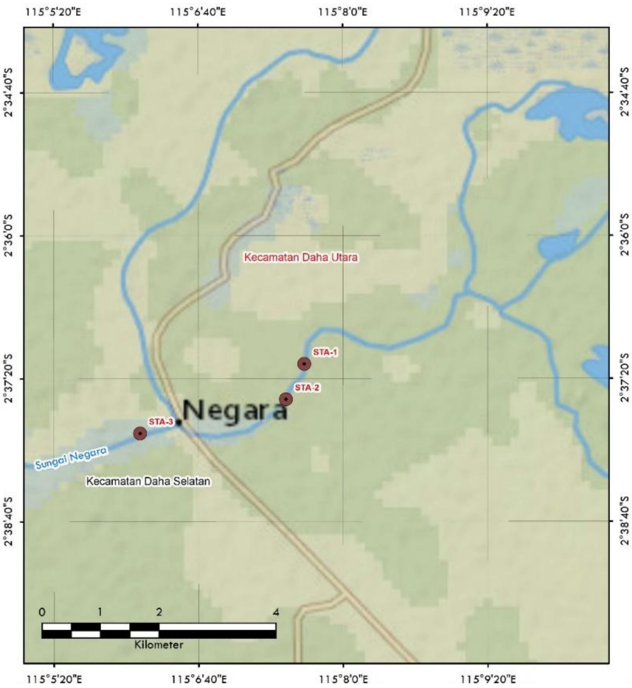

Figure 1 – Research Location Map

Sampling was carried out every two weeks as much as 3 times at each observation station. Sampling of plankton was carried out at each station by taking 25 liters of water and then filtered using plankton net no. 25. The remaining volume is 50 ml then put into a sample bottle. then preserved with 4-6 drops of Lugol's solution in each sample bottle, then each sample bottle is labeled. Then identification of plankton was carried out under a microscope and assisted by identification books from Needham (1962), Edmondson (1963) and Mizuno (1979).

Before the plankton sample was observed, the sample volume was measured using a measuring tube. Volume measurement results obtained are recorded for data analysis purposes. The plankton samples obtained were identified using a microscope. For identification purposes, 1 – 1.5 ml plankton samples were taken using a dropper and then placed in the Sedgwick Rafter Counting Cell (SRCC) which was then observed using a microscope (Rachman et. al. 2018). Plankton samples were identified by the identification table method.

The identification table method is the observation of plankton samples using a microscope to determine the genus and number of plankton found in the sample. Furthermore, the plankton genera found were identified and counted and then entered into the observation table. Meanwhile, plankton samples were identified by referring to the identification books of Shirota (1966), Tomas (1997) and Yamaji (1979).

To determine the amount of plankton contained in waters at each volume, the abundance of plankton was calculated. The abundance of plankton is the number of plankton individuals/cells in waters in a certain unit (cells/L or ind/L). Analysis of the abundance of plankton (N) can be calculated using the formula APHA (1989) (Equation [1]).

$$N = (\frac{Oi}{Op} x \frac{Vr}{Vo} x \frac{1}{Vs} x \frac{n}{p}) \quad (1)$$

Where: N = Number of cells per liter (cells/liter); Oi = Area of the cover glass (mm2); Op = Area of one field of view (mm2); Vr = Volume of filtered water (ml); Vo = Volume of sample under cover glass (ml); Vs = Volume of filtered seawater sample (L); n = Number of phytoplankton cells in the entire field of view (cells); p = Number of fields observed (mm2).

According to Odum (1996), the abundance of phytoplankton can indicate an indicator of the fertility of waters. Water fertility based on the abundance of phytoplankton can be seen in Table 1.

Table 1 – Water fertility based on phytoplankton abundance

Abundance (N)	Category
> 500 cells/L	high water fertility
< 500 cells/L	moderate water fertility

According to Sri Artiningsih (2013) the diversity index is often referred to as diversity index. This analysis is used to determine the diversity of aquatic biota species. To determine the value of diversity can use the Shanon-Wiener diversity index (Odum, 1993) with Equation 2.

$$H' = -\sum_{i=0}^{i} Pi \ln Pi \qquad (2)$$

Where: H' = diversity index; Pi = ni/N; ni = Number of individuals of type I; N = Total number of individuals.

The diversity index value (H') according to the Shannon-Wiener equation is classified in Table 2 (Odum, 1993).

Table 2 – Shannon-Wiener Diversity Index

Diversity (H')	Category
0 < H'< 2.3	belongs to the category of low diversity level
2.3 < H' < 6.9	belongs to the category of moderate level of diversity
H' > 6.9	belongs to the category of high diversity level

RESULTS AND DISCUSSION

Phytoplankton sampling was repeated 3 times at each station with a difference of ± 14 days for each sampling.

The first sampling was carried out on May 9, 2022 at 3 stations, namely station 1 (Hulu, an area without settlements), station 2 (a market and residential area), and station 3 (a blacksmith's home industry area).

Table 3 shows the results of phytoplankton calculations at each station with the highest value being at station 2 reaching 390 cells/liter, while the lowest value at station 3 with a value of 240 cells/liter. Plankton sticky rice in waters is influenced by various things including environmental variables. This also affects the density and distribution of each species so that the composition of the plankton community structure will be different in each waters (Abdul et al., 2016). The highest abundance of plankton at station 2 is in the market and residential areas which are very likely to cause waste that contains a lot of organic waste. Although it has the highest plankton, the nitrate content at Station 2 is not the highest; this is thought to be due to the utilization of water phosphate by plankton in its metabolic process. These results are in line with Permatasari et al., (2013) that the low levels of phosphate in the waters are caused by plankton so that their utilization also increases.

As stated by Rahmawati et al. (2014) that organic matter in waters will be positively correlated to nitrate content, while nitrate content is also positively correlated to plankton. This positive correlation argues that the higher the organic matter in the waters, the higher the nitrate content, which also has an impact on the plankton in the waters, which will increase. However, plankton does not only determine the level of nitrate in a water so that nitrate cannot independently determine the presence of plankton in a waters. The abundance

of plankton in sampling 1 at all stations is included in the low category according to Madinawati (2010). The abundance of plankton is said to be low if it has a value of <1,000 ind/l, the medium category has between 1,000-4,000 ind/l, and the high category reaches >4,000 ind/l.

Table 3 – Observations of the plankton sampling community 1

No	Phyllum	Genera	Sample Code		
			St-1	St-2	St-3
Phytoplankton					
1	Cyanobacteria	*Planktonitrix*	-	120	60
2	Chrysophyta	*Navicula cuspidata*	-	30	50
		Navicula sp	70	-	-
3	Charophyta	*Zygnema*	-	80	30
		Closterium	-	150	-
4	Ocrophyta	*Thallasionema*	-	10	-
		Synedra	-	-	80
		Pinnularia viridis	10	-	-
5	Chloropyta	*Microspora*	90	-	-
		Ulothrix	20	-	-
		Quadrigula	-	-	20
6	Chloropyta	*Netrium*	60	-	-
		Zygnema	20	-	-
Abundance (Cells/liter)			270	390	240
Diversity Index (Shannon-Wiener)			1.5581	1.3464	1.5066
Uniformity Index			0.8696	0.8365	0.9361
Dominance Index			0.2401	0.2913	0.2396
Number of Taxa			6	5	5

The plankton community was also measured based on the diversity index with the highest index value being at station 1 of 1.55 and the index value being located at station 2 of 1.35. The value due to the diversity in the three stations in sampling 1 is classified as diversity with the moderate category in the range 1 <H'<3 as stated by Fachrul (2007). In addition to the diversity index, the Diversity index was also calculated with the result that the uniformity at the three stations in sampling 1 was included in the category of high evenness. The uniformity index is declared to have a high level of uniformity (relatively the same species uniformity) if it has a value ranging from 0.6 to 1 (Hariyanti & Wijaya, T. S, 2009). The next index is the index of dominance of one species on the composition of the ecosystem in waters. The index value at the research site at sampling 1 was at a value of 0.23 – 0.29, which is a low result that the index belongs to the category of dominance, ie there is no particular type of phytoplankton that dominates the other species. This is supported by the statement of Fachrul (2007) that if the value of the dominance index <0.5 or close to zero indicates the absence of certain types of phytoplankton that dominate other species.

Figure 2 shows the presence of several different types of plankton found in each station with the most species found at station 1 with a total of 6 species. Station 1 has the highest number inhabited by Microspora species with a percentage of 33% and Station 2 is inhabited by Closterium species with a percentage of 38%. Microspores are species belonging to the phylum Chlorophyceae which have the ability to adapt to various freshwater habitats under various conditions. Chlorophyceae have a role as producers of organic matter and oxygen in the waters through the process of photosynthesis. Apart from being a producer, this class also functions as a bioindicator of water quality due to its sensitivity to environmental changes (Sagala, 2013).

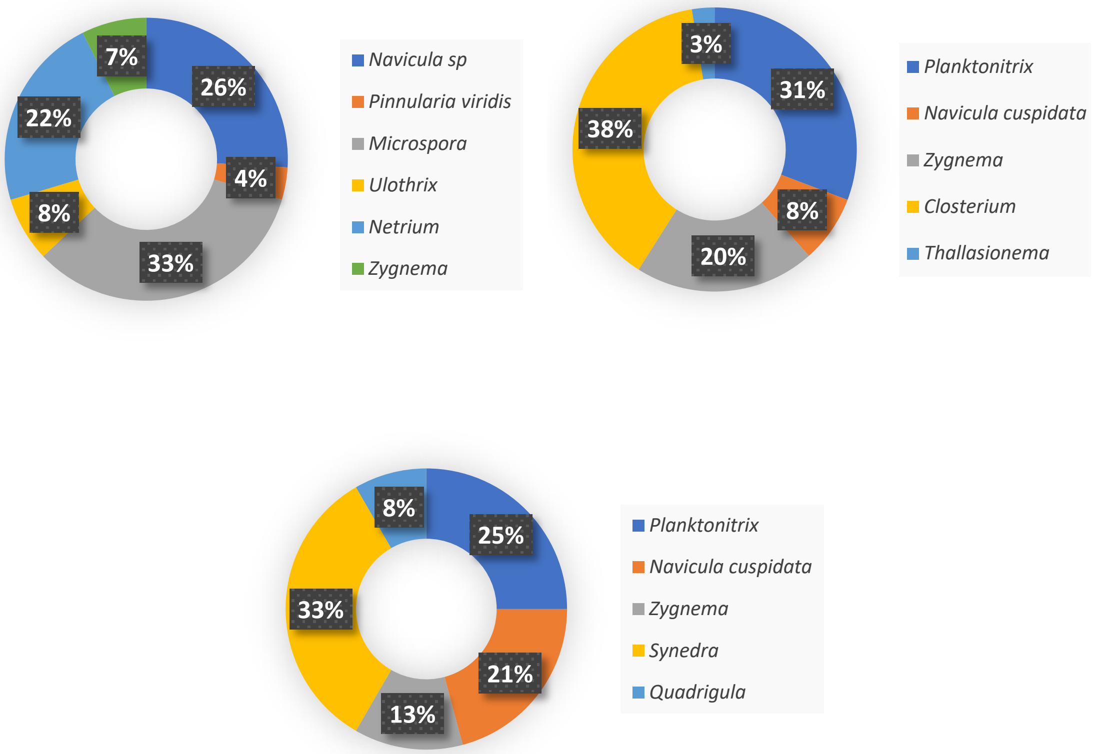

Figure 2 – Composition of plankton on sampling 1

Station 2 is dominated by Closterium plankton species which are included in Charophyta where this plankton indicates contamination in the waters. This result is in accordance with the statement of Hidayat et al. (2021) that one of the plankton that can be used as a bioindicator and indicates contamination in the waters is Closterium sp. One of the contaminants in question is contamination of organic and inorganic compounds that can come from industrial or household waste and other anthropogenic activities. The results at station 3 show that the highest number comes from the Synedra species with a percentage of 33%. Synedra plankton itself is also able to survive in unsuitable environmental conditions such as low nutrients, and this type is plankton with high abundance and can be found in various habitats (Isti'anah et al., 2015).

Sampling 2 or the second data collection was carried out 14 days after sampling 1, namely on May 23, 2022 at the three research stations. The observations of the phytoplankton community in sampling 2 showed that there were several differences compared to sampling 1. The abundance index decreased at all stations ranging from 170 to 240 cells/liter and was included in the low abundance category because it was less than 1000 cells/liter. Despite the decline, station 2 still has the highest abundance index compared to other stations with a value of 240 cells/liter. The decline in the abundance index was not followed by other indices such as the diversity index and the uniformity index which actually increased. The diversity index value in sampling 2 ranges from 1.56 to 1.73 with the highest value located at station 1. Although it has increased, the diversity index in sampling 2 is still included in the category of moderate diversity because it is in the range $1<H'<3$. Station 1 still has the highest diversity value compared to other stations. The measured phytoplankton diversity index value has a value of $1<H'<3$ which means that the community has a moderate level of diversity with the biota community having moderate stability (Fachrul, 2007).

The next index is the uniformity index which also increased with values ranging from 0.95 to 0.97 where station 3 still has the highest value compared to other stations. This result

is similar to sampling 1, namely station 3 has the highest uniformity index value, followed by station 1 and then station 2. The value of the dominance index has decreased with values ranging from 0.18 to 0.21 with the highest value found at station 3. This result is different from the results of sampling observations 1, where the highest dominance index is located at station 2. A dominance index value of less than 0.5 at all stations indicates that there is no dominance of one species over another.

Table 4 – Observations of the plankton sampling community 2

No	Phyllum	Genera	Sample Code		
			St-1	St-2	St-3
Phytoplankton					
1	Cyanobacteria	*Planktonitrix*	30	30	-
		Calotrix	-	20	-
2	Chrysophyta	*Navicula cuspidata*	40	70	-
		Navicula sp	-	-	40
3	Charophyta	*Zygnema*	20	-	-
		Closterium corni	20	-	-
		Closterium parvulum	30	-	-
		Gonatozygon	-	-	30
4	Ocrophyta	*Synedra*	-	40	30
		Synedra ulna	-	-	50
5	Chloropyta	*Microspora*	50	50	-
		Spinoclosterium	-	-	20
		Spirogyra	-	30	-
6	Chloropyta	*Netrium*	-	-	-
		Zygnema	-	-	-
Abundance (Cells/liter)			190	240	170
Diversity Index (Shannon-Wiener)			1.7362	1.7117	1.5644
Uniformity Index			0.9690	0.9553	0.9720
Dominance Index			0.1856	0.1944	0.2180
Number of Taxa			6	6	5

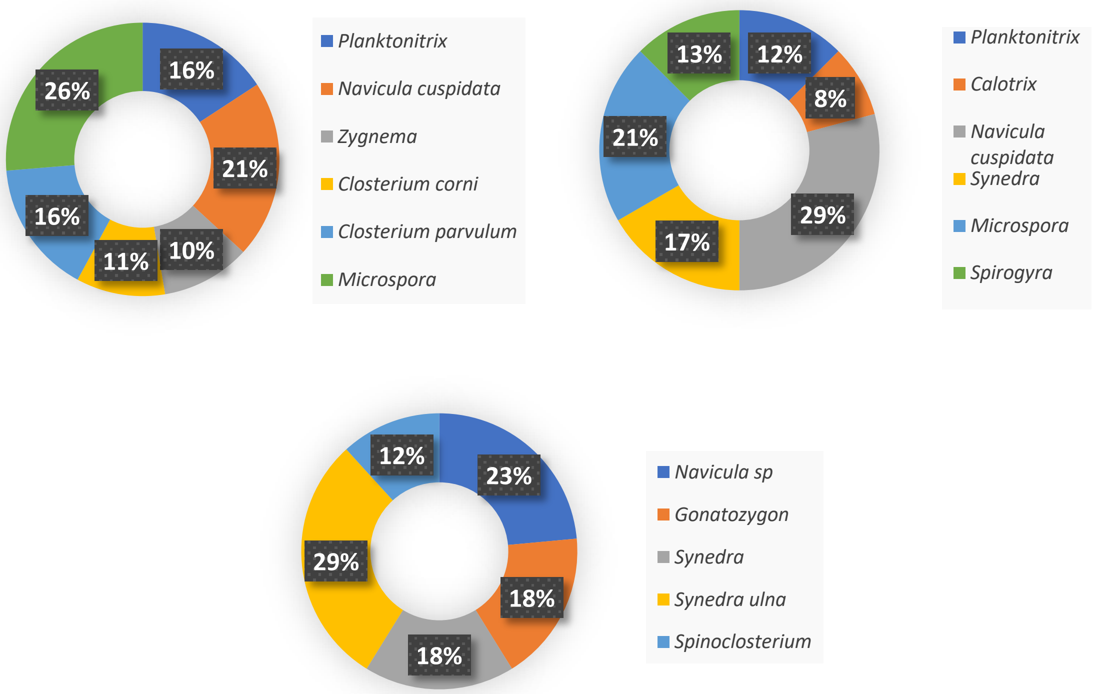

Figure 3 – Composition of plankton sampling 2

Figure 3 shows the presence of several different types of plankton found at each station with the least species found at station 3 amounting to 5 species when compared to the other 2 stations which had 6 species. At station 1, the most species inhabited by plankton type Microspora by 26% which is the phylum Chlorophyceae. Station 2 is dominated by plankton type Navicula cuspidata from the phylum Chrysophyta which can be an indicator of contamination in the waters because it has a high tolerance for environmental changes (Hidayat et al., 2021). Navicula sp. is one type of diatom plankton that has a wide distribution and is almost found in all waters with a high tolerance for changes in the aquatic environment (Abidllah, 2020).

Station 3 is dominated by Synedra plankton with a percentage of up to 47% consisting of Synedra sp and Synedra ulna. This class has a cosmopolitan nature that is able to live in various waters with high adaptability. This type of plankton also has a high tolerance so that it is able to adapt to the surrounding environmental conditions so that it is found in almost all waters (Karina et al., 2016).

The last sample (sampling 3) was taken on 7 June 2022, 15 days after sampling 2 was carried out.

Table 5 – Observations of the plankton sampling community 3

No	Phyllum	Genera	Sample Code		
			St-1	St-2	St-3
Phytoplankton					
1	Cyanobacteria	*Planktonitrix*	-	90	-
2	Chrysophyta	*Navicula cuspidata*	40	40	50
		Navicula sp	160	80	120
3	Charophyta	*Closterium*	-	60	-
		Gonatozygon	-	40	-
4	Ocrophyta	*Synedra*	70	40	30
		Pinnularia viridis	-	-	40
		Melosira	-	-	10
5	Chloropyta	*Quadrigula*	20	-	-
		Geminella	190	-	80
		Spirogyra	20	-	-
Abundance (Cells/liter)			500	350	330
Diversity Index (Shannon-Wiener)			1.4671	1.7326	1.5770
Uniformity Index			0.8188	0.9670	0.8802
Dominance Index			0.2760	0.1869	0.2378
Number of Taxa			6	6	6

Different results were shown in sampling 3 where the highest abundance of plankton was found at station 1, while in the previous 2 observations the highest abundance was at station 2. Although all stations experienced an increase, the abundance measured in sampling 3 was still included in the category of low abundance because it was less than 1,000 cells. /liter. The diversity index also changed where in the previous sampling station 1 had the highest diversity value, while at sampling 3 station 2 had the highest diversity index value. The measured diversity index value at all stations was included in the medium category with a moderate level of stability of the biota community. The uniformity index value is also in the high uniformity category, namely the uniformity between species is relatively the same because it has a value that ranges from 0.6-1 (Hariyanti & Wijaya, T. S, 2009). The dominance index also increased at station 1 with a value of 0.27, higher than the other two stations. However, the three stations are included in the low dominance category because they have an index value of less than 0.5. These results indicate that there is no particular species that dominates the other species.

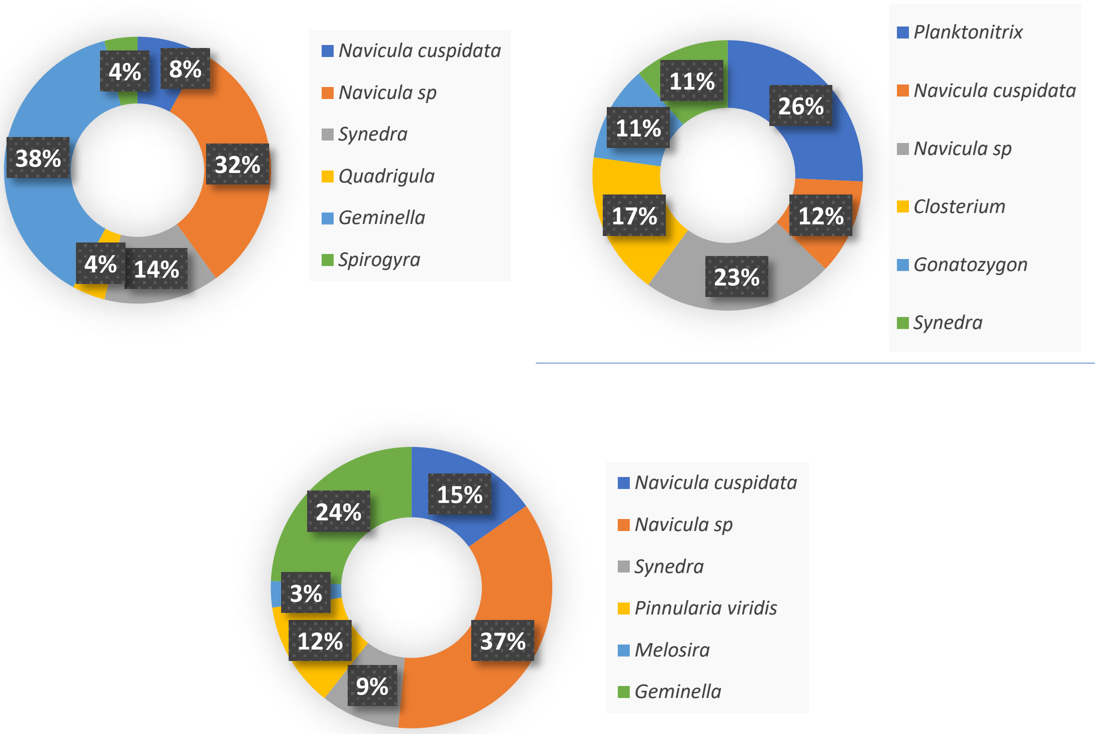

Figure 4 – Composition of plankton sampling 3 at stations 1, 2 and 3

Figure 4 show that the three stations have the same number of types, namely 6 types. As in the previous sampling, the most dominating species was the Crysophyta class as seen at station 1 and station 3. The plankton community at the three stations was dominated by the species Navicula sp. with percentages of 40%, 35%, and 52%, respectively, consisting of Navicula cuspidate and Navicula sp. The abundance of this type of plankton is due to its ability to tolerate various environmental changes so that its distribution is very wide in various waters. The presence of this plankton in the waters is considered important because it is a natural food for fish. However, the presence of species that have a high tolerance for pollutants such as Nitzschia palea, Craticula accomoda, Navicula atomus and Navicula cryptocephala may indicate that these water areas are being polluted. This result is thought to be due to the large number of human activities that cause organic pollution and also affect the type and abundance of epilytic diatoms that are able to adapt to polluted water conditions (Siregar et al., 2013).

In addition to the plankton, there are also species that have a high percentage at station 1 and station 3, namely the Geminella species which are included in the Chlorophyta group. This result is in accordance with Shaykhul et al. (2012) that Geminella belongs to the Chlorophyta group, which is a group that has a high density in various waters, especially pond waters. In addition, the presence of plankton also participates in maintaining the cycle of the food chain in the waters, including the fish around the study site. Similar results were also shown at station 2 which had Plantothrix sp with a percentage of 26%. This result relates to the ability of growth with cell division of the plankton type. Plantothrix sp is a group of Cyanobacteria that grows rapidly and is capable of forming high toxicities that can reduce the presence of other phytoplankton. In addition, this type of plankton is also able to survive in various conditions, even if it is polluted, so that it is widely distributed in various waters (Fatiqin et al., 2021).

CONCLUSION

The results of the analysis of the composition, abundance and diversity of phytoplankton in the waters of the State River are mostly inhabited by Navicula sp species which were found at all stations in each sampling. This can indicate that the water area is being polluted. This result is thought to be due to the large number of human activities that cause organic pollution and also affect the type and abundance of epilytic diatoms that are able to adapt to polluted water conditions.

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