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Distribution and Abundance of Plankton in The Downstream of Jeneberang River

Distribution and Abundance of Plankton in The Downstream of Jeneberang River

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Abstract. This study aimed to investigate the distribution and abundance of plankton in the downstream area of Jeneberang River. A total of three observation stations were chosen through purposive sampling method on a watershed in the downstream area, which lies between Gowa Twin Bridge and Barombong Bridge, Takalar Regency, and Makassar City. At each station, a sample was taken from the northern (N) and southern (S) part of the river. The collected sample of Plankton was observed using a binocular light microscope and Sedgwick Rafter Counting Cell (SRCC), and then subjected to the identification by using plankton identification book. The result of data analysis showed that phytoplankton and zooplankton could be found in all observation stations, but the abundance and distribution of each group differed one another. Phytoplankton group with the highest to the lowest abundance is the member of Class Chlorophyceae, Bacillariophyceae, and Dinophyceae. Meanwhile, the commonly found zooplankton is the member of Protozoa, including Paramecium sp., *Chilomonas* sp. Besides that, the member of Animalia, including annelid larvae and polychaeta larvae were also found with a lower level of abundance.

Keywords: phytoplankton, zooplankton, Jeneberang River, distribution, abundance

1. Introduction

Plankton consists of animals-zooplankton and microscopic plants-phytoplankton. This group of organisms has a limited ability to swim in the pond and inhabit the pelagic part of a pond. Zooplankton consists of holoplankton (plankton throughout its life) and meroplankton (only plankton in certain stages of its life). Phytoplankton consists of various types of microalgae and chlorophyll bacteria (Flagellates and Dinoflagellates) which are biotic components of the primary food sources of zooplankton.

Plankton plays an important role in a variety of aquatic food chain in aquatic ecosystems. However, the presence and abundance of plankton are strongly influenced by the changes in the aquatic environment. Therefore, the presence of plankton can be used as a determinant of aquatic ecosystems quality. Hence, their presence is often used as a bio-indicator of water [1]. Phytoplankton also has economic value. Some blue-green algae can form a sheath of $CaCO_3$, which can form a fairly extensive lime deposit.

Similarly, diatomaceous soil formed by diatom fossils also has a large industrial value [2]. Rivers that are located across residential areas are often very affected by influents from agricultural areas, household, and industrial waste. According to Ama-Abasi et al. [3], that waste that enters the waters can cause ecosystem disturbances, including total damage to ecosystems that can disrupt the balance of the ecosystem, causing changes in ecological processes.

The wastes could cause a lot of changes in the physical environment of the water body, and the highest impact would be found on the downstream of the river. Such an impact also occurs in Jeneberang River South Sulawesi, as the downstream flows across residential and agricultural areas around Gowa, Takalar, and Makassar City. Thus, the plankton community could be strongly influenced by various influent in the water body. Accordingly, this study aims to investigate the plankton distribution and abundance in the downstream area of Jeneberang River.

2. Research Method

The study was conducted in April 2018, located in the downstream area of Jeneberang River. Three observation stations were chosen through purposive sampling method on a watershed in the downstream area which lies between Gowa Twin Bridge and Barombong Bridge, Takalar Regency, and Makassar City. At each station, a sample was taken from the northern (N) and southern (S) part of the river. The detail of the sampling location can be seen in Table 1.

Table 1. Sampling station

Location	Coordinate	Administrative area/Riverbank environs
Station 1. Around Jembatan Kembar	5^{o}12’36.01”S, 119^{o}27’4.59”E	North (N): Gowa/residential area and traditional market especially for chicken and meat
		South (S): Gowa/small-scale agriculture
Station 2. Around Bendungan Karet	5^{o}11’30.77”S, 119^{o}26’22.65”E	N: Makassar/unused land
		S: Gowa/ small-scale agriculture
Station 3. Around Jembatan Barombong/Estuary	5^{o}11’38.47”S, 119^{o}23’36.40”E	N: Makassar/residential area
		S: Takalar/unused land

Plankton sample was taken by filtering 100L river water through a plankton net of 40 µm^2, and the filtered water was then stored in a 200 mL bottle. Furthermore, the filtered water was fixed with lugol and brought to the laboratory to be identified and analyzed. Plankton identification and analysis were carried out in the Biology Laboratory of the Faculty of Mathematics and Natural Sciences of Makassar State University and in the Chemical Oceanography Laboratory of the Department of Marine Sciences, Faculty of Marine and Fisheries, Hasanuddin University. Plankton was observed using a binocular light microscope and *Sedgwick Rafter Counting Cell* (SRCC), and the identification was conducted by using the plankton identification book from [4][5]. Meanwhile, calculation of the number of cells follows the method of Mamun et al. [2] by using the following formula:

$$\text{Abundance Nu. of cell/mm} = \frac{\text{C x 1000 mm}^3}{\text{L x D x W x S}}$$

Description:

C = Number of plankton counted
L = Length of each strip (SRCC cell length) in mm
D = Depth of a strip (whipple grid image width) in mm
S = number of strips counted
W = Width of the strip (whipple grid image width) in mm

The number of cell per mm then multiplied by a factor to adjust the number in Liter. In this study, measurements of abiotic factors were carried out along with the sampling of plankton, which is shown in Table 2.

Table 2. Physico-chemical parameters recorded on observation site

Station	I		II		III	
	A	B	A	B	A	B
Water depth (m)	1.5	3.35	2.15	1.8	2	2
Turbididty (m)	0.5	0.3	0.6	0.5	1.5	1.5
Velocity (m s^{-1})	0.06	0.06	0.04	0.04	0.12	0.12
Salinity (ppt)	0	0	0	0	14	14
Water temp. (ºC)	30	30	30	30	31	31
Dissolved oxygen (DO) (ppm)	4.45	4.45	4.13	4.13	4.08	4.08

3. Results and Discussion

The results showed that phytoplankton and zooplankton could be found in all observation stations, but the abundance and distribution of each group differed as (Table 3 and Figure 1).

Table 3. The Distribution and abundance of plankton during the observation

	Plankton Group	Station 1		Station 2		Station 3	
		North (N)	South (S)	N	S	N	S
Class Bacillariophyceae							
1	*Coscinodiscus* sp.	-	-	+++	+++	-	-
2	*Cyclotella* sp.	+	+++	-	-	-	-
3	*Pleurosigma* sp.	-	-	-	-	++	++
4	*Leptocylindricus* sp.	++++	-	+++	-	++++	-
Class Chlorophyceae							
5	*Chlorella* sp.	*****	*****	++++	++++	-	-
6	*Dunaliella* sp.	-	-	-	-	++	++
7	*Eudorina* sp.	-	+++	-	+++	-	-
Class Dinophyceae							
8	*Prorocentrum* sp.	-	-	-	-	-	+++++
Zooplankton							
9	*Paramaecium* sp.	+++++	*****	-	-	-	-
10	*Chilomonas* sp.	+++	-	++	++	-	-
11	Annelida Larvae	-	+	+++	+++	++	++++
12	Polychaeta Larvae	-	-	-	-	+	++

Note: (-):0 ind./L; (+) 1-10 ind./L; (++) 11-20 ind./L; (+++) 21-30 ind./L; (++++) 31-40 ind./L; (+++++) 41-50 ind./L; (*****)>50

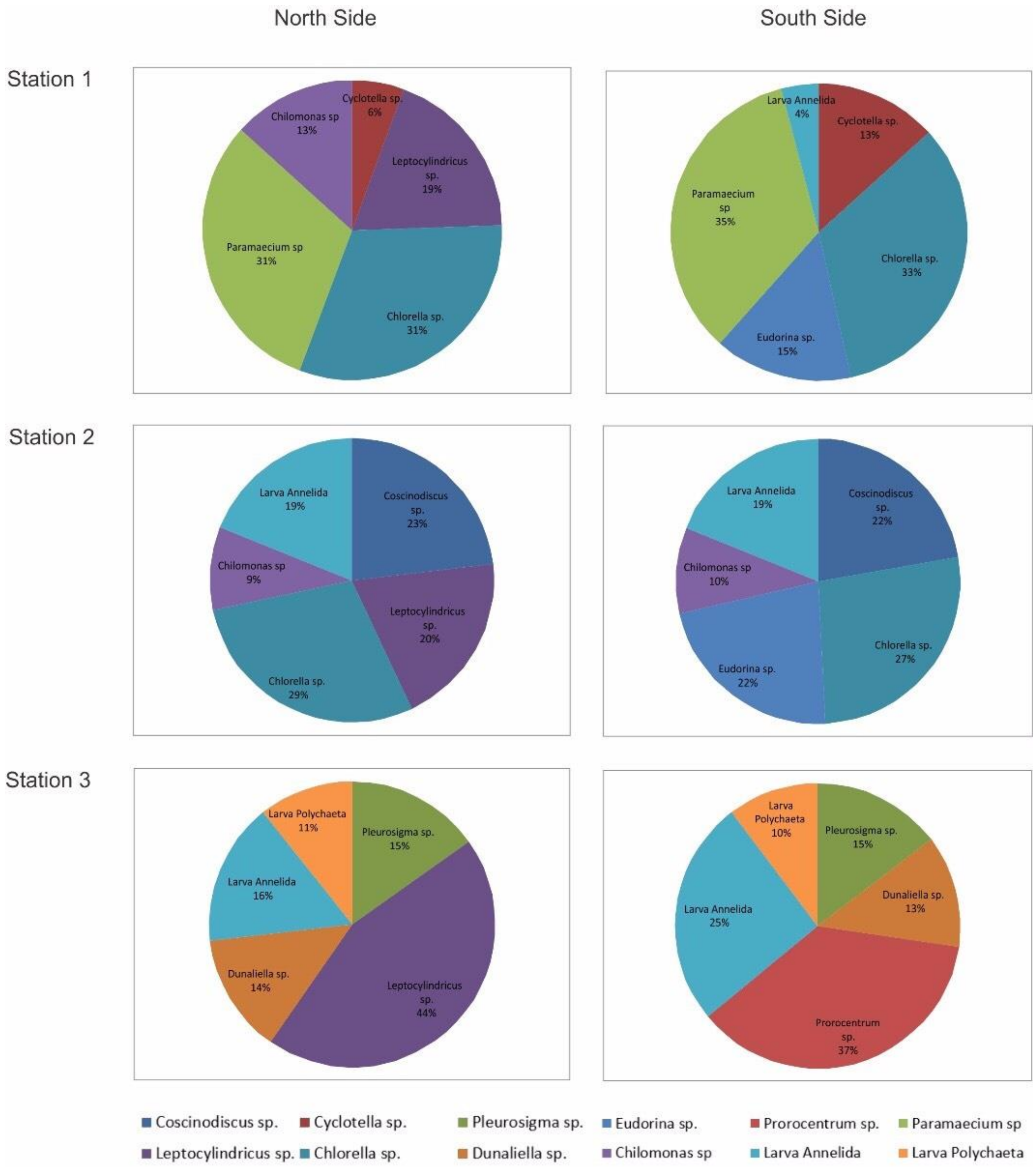

Figure 1. Percentage of abundance group of plankton (%) in every observation site

In general, Phytoplankton group that can be found in the member of class Chlorophyceae, Bacillariophyceae, and Dinophyceae. Meanwhile, the commonly found zooplankton is the member of Protozoa, including *Paramecium* sp., *Chilomonas* sp., and also the member of Animalia, including annelid larvae and polychaeta larvae.

Species abundance of the phytoplankton found in this study from the highest to the lowest is Chlorophyceae, Bacillariophyceae, Dinophyceae, respectively. Dinophyceae is a group of phytoplankton with the lowest abundance of only 47 cells/L, but this number only comes from one species, *Prorocentrum* sp., which is only found on station 3S. The observation location is the Jeneberang River estuary. Hence the water conditions are directly affected by sea water. As shown in Table 1, the water salinity at the location is 14 ppt. Therefore, it can be assumed that *Prorocentrum* sp. is a type of phytoplankton adapted to the brackish water environment. *Prorocentrum* sp. was also found by Jasprica and Car [6] in The Mali Stone Bay. Similarly, Rezende et al. [7] also discovered this type at all times of observation in Guanabara Bay. Different observations were obtained by Essien-Ibok and Ekpo [1] who obtained *Prorocentrum* sp. in a river in Tropical River in Southern Nigeria. There, *Prorocentrum* sp. has a high abundance along with the increase of Biochemical Oxygen Demand (BOD). Efendi et al. [8] also found this type in the Mahakam Delta, although the numbers are very limited and only distributed in areas whose conditions are affected by tidal current from the nearby coast. It seems that this type is not only an adapted to tropical waters since *Prorocentrum* is also found throughout the year in the oceans of Western Subarctic Ocean and its abundance is greatly increased in the summer [9]. Pleurosigma has the highest abundance with an increase of dissolved oxygen [1].

In this study, Chlorophyceae has the highest abundance of 208 cells/L. It seems that these phytoplankton groups can live with a slight increase in aquatic nutrient enrichment. As found by Sipaúba-Tavares et al. [10], the abundance of Chlorophyceae is often associated with high nitrate content in waters. However, not all types of Chlorophyceae can be found in an aquatic ecosystem. The main types of Chlorophyceae found in this study is *Chlorella* sp. which dominates stations 1N, 1S, 2N, and 2S, although the environmental conditions of these two locations are quite different. As shown in Table 1, station 1 and station 2 are located near agricultural and residential areas, except station 1N which is located close to vacant land. Therefore, effluents in the form of domestic waste and chemical fertilizer residues are highly possible to occur. This is consistent with the assertion of Kalita et al. [11] that *Chlorella vulgaris* can be found in an area of water which is affected by industrial effluent, with the water conditions of pH 6.5, temperature 29.8ºC, turbidity 68, conductivity 297 ms, DO 5.9, BOD at 27ºC for day = 8. Other types of Class Chlorophyceae is *Eudorina* sp., which is only found on station 1S and 2S in this study. Nevertheless, as can be seen in Figure 1, the species abundance at station 1 was slightly lower (15%) than station 2 (22%). It seems similar to *Chlorella* sp., as *Eudorin*a sp. also requires a little nutritional enrichment. In this study, nutritional enrichment was obtained from the agricultural areas effluent. As found by Kalita et al. [11], *Eudorina elegans* Ehrb. was found in the paddy field area which has a pH of 6.7; temperature 36.8 oC; Turbidity of 86; conductivity of 432 ms; DO of 1.5; and BOD at 27ºC for a day = 70. Different things are found on *Dunaliella* sp., as this type of Chlorophyceae is only found on 3N and 3S locations, meaning that this type is adapted to the estuary condition. This is supported by the findings of Hammer et al. [12] which stated that *Dunaliella salina*, is a type of microalgae adapted to a broad spectrum of salinity.

The class Bacillariophyceae shows a lower abundance compared to Chlorophyceae, as there were only 1038 individuals per liter of water throughout the observation stations. The different result was found by Arimoro et al. [13], as Bacillariophyceae Class was found as the most abundant group of phytoplankton in Nigeria, especially *Coscinodiscus* sp. whose amount became abundant when it rained. Furthermore, Taucher et al. [14] asserted that *Coscinodiscus* sp. which is large phytoplankton could dominate phytoplankton biomass in waters up to 40-50%. Uttah et al. [15] also found the abundance of *Coscinodiscus* sp. (11.48%) in Nigeria's Calabar River. There are four types of Bacillariophyceae which can be found at the observation locations, each of which is specifically distributed. *Leptocylindricus* sp. is the most abundant type (91 cell/L), and distributed to all observation stations although only on the north side of the river, namely 1N, 2N, and 3N. Meanwhile, *Pleurosigma* sp. was only found in 3N and 3S station. Similarly, *Cyclotella* sp. is only found at station 1. Meanwhile *Coscinodiscus* sp. was only distributed at Station 2N and 2S with an abundance of 132 and 143 cell/L, respectively.

It seems that *Leptocylindricus* sp. has a wide tolerance range for salinity, as it shows the same abundance at station 1 (19%) and station 2 (20%), and it also becomes the most abundant in station 3 since it reaches 44% of the total five types of plankton in the station. The finding is in line with the study of Kiteresi et al. [16] and Zakariya et al. [17] who discovered *Leptocylindricus* sp. in the ocean and the Lower Niger River, respectively. Kiteresi et al. [16] also found it as the dominant type of plankton in Kenyan Cost and asserted that Leptocylindricus has the potential to cause a harmful algal bloom on fish. Another report from Ama-Abasi et al. [3] stated that *Leptocylindricus danicus* was also found in the upstream section, which in this study the area was not traversed by the waste studied.

In this study, the abundance of zooplankton groups reached a total of 271 individuals and cells, which were dispersed throughout the observation stations. The type of zooplankton that can be found is *Paramecium* sp., *Chilomonas* sp., unidentified *Annelida larvae*, and *Polychaeta larvae*. The highest abundance of zooplankton is found at station 1, where there is also the highest abundance of phytoplankton. The most abundant type of zooplankton is *Paramecium* sp. which reaches a total of 105 cells/L. Although the amount is abundant, this Protozoan is only distributed on 1N and 1S stations with an abundance of 31 and 33%, respectively. According to Debastiani et al. [18], ciliate distributions in urban streams, such as *Paramecium caudatum*, depends on dissolved oxygen, conductivity, and the presence of chlorophyll and flagellate organisms. It is in line with the finding of this study, in which Chlorophyceae has the highest abundance at this station.

Another zooplankton group, unidentified polychaeta larvae, has the lowest abundance and is only distributed in station 3. As stated earlier, station 3 is the estuary of the Jeneberang River which directly faces the Makassar Strait. Márquez-Rojas et al. [19] who discovered 11 types of Polychaetes in Atlantic Coast in Venezuela stated that pelagic polychaetes are a distinctive group of Annelids that lives as marine zooplankton. Based on research conducted Lyster [20], it is known that polychaeta larvae generally could live very well on the salinity of 20 ppt, whereas the salinity tolerance limit for Polychaeta larvae is 10-15 ppt. Furthermore, De Marchi et al. [21] stated that a Polychaetes species, Hediste diversicolor, can also be used as an estuarine environmental quality bioindicator.

On the other hand, other annelids larvae which are not classified as of polychaetes are not found throughout the observation stations, except station 1N. In this section, there are residential areas and traditional markets that sell fresh chicken and beef. Thus, the effluent that enters Jeneberang River water bodies is not only in the form of household waste but also in the form of livestock's blood and animal waste. Accordingly, it may increase the concentration of organic matter, nitrogen and phosphate to the water bodies [22]. One of the Annelida Class, Oligocheta, may be used as a biological indicator of stream condition [23].

Different conditions were observed on *Chilomonas* sp.in station 1 N, 2 N, and 2S. When viewed based on the abiotic factors of the two observation stations, station 1S is unique as it has the short turbidity of 0.3 m. Meanwhile, other stations have a turbidity of 0.5 – 0.6 m. The salinity of these two observation stations is less than 1 m. Thus, it can be inferred that *Chilomonas* sp. is adapted to conditions with salinity close to freshwater salinity, with a little tolerance. This is consistent with research conducted by Kumar and Harbhajan [24] which found *Chilomonas* sp. at Harsholav Pond in a very high abundance, reaching a total of 100 individual per liter.

4. Conclusion

The most abundant phytoplankton group found in the downstream of Jeneberang River is the Chlorophyceae Class > Bacillariophyceae > Dinophyceae. Chlorophyceae and Bacillariophyceae classes were distributed in all observation site, but Dinophyceae only distributed at the mouth of the river. The most abundant zooplankton group in the downstream of Jeneberang River are *Paramaecium* sp. > unidentified annelids larvae > *Chilomonas* sp. > unidentified polychaeta larvae. Only Annelid larvae were distributed in all observation site, while *Chilomonas* sp. only distributed at stations 1 and 2. On the other hand, Polychaeta larvae were only distributed at the river mouth, while *Paramaecium* sp. only distribution at station 1.

References

[1] M. A. Essien-Ibok and I. Ekpo, "Assessing Environmental Impact on Phytoplankton Composition and Distribution in a Tropical River in Southern Nigeria," *Int. J. Eng. Sci.*, vol. 5, no. 7, pp. 40–48, 2015.

[2] M. M. Mamun, M. G. Sarower, M. A. Ali, S. M. B. Rahman, and K. A. Huq, "Abundance and Distribution of Plankton in the Sunderbans Mangrove," *Preservation*, vol. 3, no. May, pp. 43–54, 2009.
[3] A.-A. DE, W. G, and A. ER, "Possible Impacts of Wastewater Discharge from the University of Calabar Teaching Hospital on the Biota of Great Kwa River, Nigeria," *Oceanogr. Fish. Open access J.*, vol. 1, no. 5, pp. 1–3, 2017.
[4] G. E. Newell and R. C. Newell, *Marine plankton a practical guide*. London: Hutchinson educational, 1963.
[5] J. L. Sumich and J. F. Morrissey, *Introduction to the biology of marine life*. Boston: Jones and Bartlett Publishers, 2004.
[6] N. Jasprica and A. Car, "Toxic and potentially toxic phytoplankton species in the Mali Ston bay (Eastern Adriatic)," *NAŠE MORE Znan. časopis za more i Pomor.*, vol. 50, no. 1–2, pp. 68–71, 2003.
[7] K. R. V. de Rezende, M. M. F. Hatherly, C. M. M. Pimenta, J. Eduardo, S. de C. Vianna, and N. Mangiavacchi, "Phytoplankton community structure in one sector of Guanabara Bay (RJ, Brazil) during 2011 and 2012," *Brazilian J. Oceanogr.*, vol. 63, no. 3, pp. 239–254, 2015.
[8] H. Effendi, M. Kawaroe, D. F. Lestari, and T. Permadi, "Distribution of phytoplankton diversity and abundance in Mahakam Delta, East Kalimantan," *Procedia Environ. Sci.*, vol. 33, pp. 496–504, 2016.
[9] H. Liu, K. Suzuki, and H. Saito, "Community structure and dynamics of phytoplankton in the western subarctic Pacific Ocean: A synthesis," *J. Oceanogr.*, vol. 60, no. 1, pp. 119–137, 2004.
[10] L. H. Sipaúba-Tavares, A. R. V Donadon, and R. N. Milan, "Water quality and plankton populations in an earthen polyculture pond," *Brazilian J. Biol.*, vol. 71, no. 4, pp. 845–855, 2011.
[11] J. Kalita, S. I. Bhuyan, and R. Das, "An assessment of Green algae (Chlorophyceae) diversity in different habitats of RiBhoi, Meghalaya," *Pharma Innov.*, vol. 4, no. 2, Part B, p. 50, 2015.
[12] U. T. Hammer, J. Shamess, and R. C. Haynes, "The distribution and abundance of algae in saline lakes of Saskatchewan, Canada," *Hydrobiologia*, vol. 105, no. 1, pp. 1–26, 1983.
[13] F. O. Arimoro, N. E. Edema, and R. O. Amaka, "Phytoplankton community responses in a perturbed tropical stream in the Niger Delta, Nigeria," *Trop. Freshw. Biol.*, vol. 17, no. 1, pp. 37–52, 2008.
[14] J. Taucher, M. Haunost, T. Boxhammer, L. T. Bach, M. Algueró-Muñiz, and U. Riebesell, "Influence of ocean acidification on plankton community structure during a winter-to-summer succession: An imaging approach indicates that copepods can benefit from elevated CO2 via indirect food web effects," *PLoS One*, vol. 12, no. 2, p. e0169737, 2017.
[15] E. C. Uttah, C. Uttah, P. A. Akpa, E. M. Ikpeme, J. Ogbeche, L. Usip, and J. Asor, "Bio-survey of plankton as indicators of water quality for recreational activities in Calabar River, Nigeria," *J. Appl. Sci. Environ. Manag.*, vol. 12, no. 2, 2008.
[16] L. Kiteresi, S. Mwangi, and M. Mary, "Potentially Harmful Algae along the Kenyan Coast: A Norm or Threat.," *Harmful Algae*, vol. 3, no. 9, 2013.
[17] A. M. Zakariya, M. A. Adelanwa, and Y. Tanimu, "Physico-chemical characteristics and phytoplankton abundance of the lower Niger River, Kogi State, Nigeria," *IOSR J. Environ. Sci. Toxicol. food Technol.*, vol. 2, no. 4, pp. 31–37, 2013.
[18] C. Debastiani, B. R. Meira, F. M. Lansac-Tôha, L. F. M. Velho, and F. A. Lansac-Tôha, "Protozoa ciliates community structure in urban streams and their environmental use as indicators," *Brazilian J. Biol.*, vol. 76, no. 4, pp. 1043–1053, 2016.
[19] B. Márquez-Rojas, O. Díaz-Díaz, and M. A. Balza, "Holoplanctonic polychaetes (Annelida: Polychaeta) from Venezuela," *Pan-American J. Aquat. Sci.*, vol. 8, pp. 160–165, 2013.
[20] I. H. J. Lyster, "The salinity tolerance of polychaete larvae," *J. Anim. Ecol.*, pp. 517–527, 1965.

[21] L. De Marchi, V. Neto, C. Pretti, E. Figueira, F. Chiellini, A. Morelli, A. M. V. M. Soares, and R. Freitas, “The influence of salinity on the effects of Multi-walled carbon nanotubes on polychaetes,” *Sci. Rep.*, vol. 8, no. 1, p. 8571, 2018.
[22] F. O. Arimoro and A. O. Oganah, “Zooplankton community responses in a perturbed tropical stream in the Niger Delta, Nigeria,” *Open Environ. Biol. Monit. J.*, vol. 3, pp. 1–11, 2010.
[23] R. T. Martins, N. N. C. Stephan, and R. G. Alves, “Tubificidae (Annelida: Oligochaeta) as an indicator of water quality in an urban stream in southeast Brazil,” *Acta Limnol. Bras.*, vol. 20, no. 3, pp. 221–226, 2008.
[24] L. S. Kumar and K. Harbhajan, “Study of Diversity and Population of Zooplankton at Harsholav pond of,” *Int. Res. J. Environ. Sci.*, vol. 4, no. November 2013, pp. 37–42, 2015.