Global Scientific and Academic Research Journal of Multidisciplinary Studies
ISSN: 2583-4088 (Online)
Frequency: Monthly
Published By GSAR Publishers
Journal Homepage Link- https://gsarpublishers.com/journals-gsarjms-home/

Physiochemical parameters and plankton diversity in River Idye within Makurdi, Benue State.

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Article History

Received: 04/03/2024
Accepted: 25/03/2024
Published: 28/03/2024

Vol – 3 Issue –3

PP: - 46-51

Abstract

This study determined the physiochemical parameters and plankton diversity in River Idye within Makurdi, Benue State. A total of five Phytoplankton and four Zooplankton species with a total abundance of 64 were observed. The results indicated that the most abundant plankton species was the Ulothrix spp. with abundance of 19 representing 29.69%, Clostrium spp. 17 (26.56%), and the Glaucocysis spp, 10 (15.63%). The least observed species were the Euglena spp, Strongloides stercolaris, and Paramecium spp. representing 1.56% of the total abundance observed. It was further observed in this study that four Zooplankton species with a total abundance of 64 were examined across the sampling sites. Physiochemical properties of River Idye was also considered, physico-chemical parameters were recorded on site: temperature (T) in $^{\circ}$C, conductivity and pH using a pocket tester field conductivity meter, model pH/TDS/salts. Other physicochemical parameters were analysed at the Department of Chemistry, Benue State University, Makurdi. The temperature observed was within the range of 28.3 – 29.8^{o}c with a mean value of 29.02 $\pm$ 0.54^{o}c. The mean dissolved oxygen was 3.8 $\pm$ 0.49mg/l, pH was 7.34+0.61, Electrical conductivity was observed to be 803.80+268.12 (us/cm), on the other hand, the total dissolved solid was 400.60+132.87, turbidity (26.41$\pm$9.86NTU) and Air temperature was 35.26$\pm$0.42^{o}c with a range of 35.0 – 36.0^{o}c respectively. The results revealed that the parameters are within safety boundaries for animal habitation and productivity.

Keywords: Phytoplankton, Zooplankton, plankton, Physiochemical properties and water

INTRODUCTION

There are enormous investigation and documentation on the impact of phytoplankton and zooplankton in various ponds management in the research community, some researchers also proceeded to evaluate the impacts of some physicochemical parameters on the community structure of rivers.

The occurrence and growth of various species of plankton living in the water body are controlled by factors such as abiotic, morphometric factors of water body, sewage discharges, and anthropogenic factors capable of altering the habitation, productivity, and community influence. Phytoplankton is the autotrophic (self-feeding) components of the plankton community and a key part of ocean and freshwater ecosystems. The name comes from the Greek words (phyton), meaning 'plant', and (planktos), meaning 'wanderer' or 'drifter (Karlusich *et al*., 2020).

The development and spread of phytoplankton biomass relatively depends on certain factors such as nutrient availability and concentrations, light conditions, flow velocity (residence time), and the “grazing and development" effect of zooplankton and benthic filter-feeding animals within the ecosystem (Karlusich *et al*., 2020).

Phytoplankton receives their energy through photosynthesis, as do trees and other plants on land. This means phytoplankton must have light from the sun, so they live in the well-lit surface layers (euphotic zone) of oceans and lakes. In comparison with terrestrial plants are evenly distributed along a larger area of coverage, are exposed to minimal seasonal difference, and have markedly faster turnover rates than trees (days versus decades). On this account, phytoplankton responds swiftly on a larger scale to climate variations as it were.

Phytoplankton forms the base of marine and freshwater food webs and are vital key players in the global carbon cycle. They account for about half of global photosynthetic activity

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and not less than half of the oxygen production, despite amounting to only about 1% of the global plant biomass. Phytoplankton is largely diverse, ranging from bacteria to plant-like algae to armour-plated coccolithophores and others. Important classes of phytoplankton are the diatoms, cyanobacteria, and dinoflagellates, although a whole lot of other classes are represented (Adebisi, 2021). Most phytoplankton are too small to be singly seen without the aid of a microscope. However, while viewed in a larger number, some varieties may be noticeable as colored patches on the water because of the presence of chlorophyll within their cells and accessory pigments (such as phycobiliproteins or xanthophylls) in some species (Adebisi, 2021). In parallel to plants on land, phytoplankton are agents for primary production in water. They create organic compounds from carbon dioxide dissolved in the water, a process that sustains the aquatic food network, Phytoplankton relay the river food network and are crucial players in the Earth's carbon cycle (Ozigbo *et al*., 2014). Research shows about 5,000 known species of marine phytoplankton in a favorable ecosystem (Hallegraeff, 2003). However, such diversity evolved despite scarce resources (restricting niche differentiation) is unclear. Zooplankton and other smaller marine animals feed on phytoplankton and in turn become relevant in the feed chain, especially for fish, crustaceans, and other larger species. Phytoplankton plays vital role in what is known as bioindicator and water quality check while zooplankton functions in the food chain, being in the second trophic level as primary consumer and also as contributors to the next trophic level (Southern Regional Aquaculture Center (SRAC), 2013). Phytoplankton is known the foundation of the aquatic food network, the most active producers, feeding everything from microscopic, animal-looking zooplankton to multi-ton whales in the population. Small fish and invertebrates also feed on the plant-like organisms, and then those smaller animals are fed by larger creatures (SRAC, 2013).

Biological indicator theory explains a situation whereby organisms gives information about their habitats in one form or the other. A biological indicator (or bio-indicator) is a taxon/taxa selection based on its delicate nature to a particular characteristic and then assessed to make inferences about that attribute (Echoke, *et al.*, 2018). The plankton community comprises of the phytoplankton and zooplankton. Phytoplankton is important organisms which act as producers of the primary food supply in any aquatic ecosystem (Battish, 2019). They are the initial biological components from which energy is transferred to higher organisms through the food chain (Chukwu and Afolabi, 2017). Environmental factors in aquatic habitats include various physical properties of water such as solubility of gases and solids, penetration of light, temperature, and density. Chemical factors such as salinity, pH, hardness, phosphates, and nitrates are also very important for growth and density of phytoplankton on which zooplankton depend (Roy, 2014). Phytoplankton species are used as indicators of water quality on account of their sensitivity can be a dynamic response to changes in the surrounding environment (Chukwu and Afolabi, 2017). Phytoplankton plays a Significant role serving as bioindicator of water quality while zooplankton also plays a critical role in the food chain, being in the second trophic level as primary consumer and also as contributors to the next trophic level.

This study will help to identify the different species of phytoplankton and zooplankton in River and highlight their economic significance role.

METHODOLOGY

Study area

The study was conducted at 5 different selected sites in River Idye, Makurdi Benue State. Makurdi local government is a capital of Benue. Located in central Nigeria, it can be found along the Benue River, on latitude $07^0$43'N and Longitude $08^0$35'E, and holds the base for the Nigerian Air Force. Benue is a tropical State with two distinct seasons, the wet season that begins from April to October with an average annual rainfall range of 800 – 1500mm (Temi and Tor, 2006). The dry season starts from November and ends in March. Temperature fluctuate between 21 – 37^{o}C in the year. Also, the temperature in Makurdi ranges from 40^0C and a maximum of 22.5^0C daily.

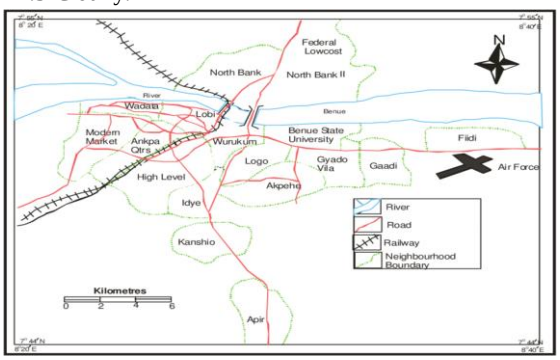

Figure 1: Map of Makurdi (Source: Benue State Ministry of Lands, Survey and Solid Minerals, 2011).

Sample collection

Samples were collected from five (5) selected sites in River Idye: (Site 1, Site 2 … Site 5) respectively. Samples were collected during morning hours of 7:00 am - 8:00 am for a period of 2 weeks for chemical and biological analysis. Plankton sampling was carried out by using plankton net of mesh size 55 µm by hauling horizontally at a distance of five meters for 3 minutes at constant speed according to the method described by Hassan *et al*., (2019). Filtered water samples were stored in sample sterile bottle labeled with identification code of each sampling unit and preserved with 4 % formalin which serves as a fixative and Lugol solution of 10%. Samples were immediately transported to Microbiology laboratory of Benue State University, Makurdi for further analysis.

Physico-chemicals analysis

The following physicochemical parameters were recorded on site: temperature (T) in $^{\circ}$C, conductivity, and pH using a pocket tester field conductivity meter, model pH/TDS/salts. Other physicochemical parameters were analysed at the Department of Chemistry, Benue State University, Makurdi.

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Turbidity

Turbidity was measured using Sper® Scientific Turbidity meter Model L87652. This was determined in the laboratory by taking 10 ml of water sample into the glass vial using adjustable Micropipette. The sample was inserted into the well of the equipment after been cleaned and the lid closed. The test button was press and results displayed on the Liquid Crystal Display (LCD).

Dissolved oxygen (DO)

Dissolved oxygen was determined using HANNA® dissolved oxygen (DO) meter Model HI 93246. This was done insitu by immersing the probe of the meter into the water and the reading on the LCD taken when it stabilized.

Hydrogen ion concentration (pH)

Hydrogen ion concentration (pH) determined using HANNA® multiparameter water tester model HI 98129. This was done by inserting the probe of the meter into the water sample and setting the mode to read pH using the MODE keypad.

Electrical conductivity (EC)

Electrical Conductivity was determined using HANNA® multiparameter water tester model HI 98129. The probe was immersed in water sample and the mode to read EC using the MODE keypad. The reading was taken after it was left to stabilize for about five (5) minutes.

Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) was determined using HANNA® multiparameter water tester model HI 98129. The probe was immersed in water sample and the mode to read TDS using the MODE keypad. The reading will be taken after left to stabilize for about five (5) minutes.

Air and water temperature

Water temperature was determined using HANNA® multiparameter water tester model HI 98129. This was done by inserting the probe of the meter into the water sample and setting the mode to read temperature using the MODE keypad. While the air temperature was determined using the Alcohol in Glass thermometer with result read between seven (7) to ten (10) minutes.

Sample identification

Fixed samples were given a rest to settle in the Laboratory for 24 hours and the supernatant was carefully discarded. Sediment was dropped on a microscope slide using a pipette and covered with a microscope cover slip and examined microscopically using Olympus microscope Identification of the zooplankton species was according to the identification method described by (Upper Benue River Basin Development Authority 2012) and (Xiong *et al*., 2020). Phytoplankton species were identified on the basis of their morphological characteristics with the aid of standard identification keys of Huynh and Serediak, (2006); Li and Wikfors (2010), and EABA, (2019).

Statistical analysis

Shannon Wiener diversity index was used to determine the plankton species composition and their diversity across the different ponds sampled. Physicochemical parameters and plankton parameters were analyzed using one-way ANOVA and Post-hoc comparisons using Duncan test (P>0.05) while Pearson's Correlation coefficient was used to determine the association between abundance and physicochemical parameters.

RESULTS

Some Physiochemical properties and plankton diversity and abundance from River Idye were evaluated in this study. Five phytoplankton and four zooplankton species with a total abundance of 64 were observed in this study. Table 1 Shows most abundant plankton species was the *Ulothrix spp.* with abundance of 19 representing 29.69%, *Clostrium spp*. 17 (26.56%), and the *Glaucocysis spp*, 10 (15.63%). The least observed species were the *Euglena spp*, *Strongloides stercolaris*, and *Paramecium spp.* which occurred only once, each representing 1.56% of the total abundance observed. The result further showed the Shannon-Weiner diversity index (H) of 1.785 with an Evenness of 0.812 was observed. The abundance of the planktons was observed to be significantly associated with the plankton species observed at sampling sites (X^2 = 81.882; df = 8 P= 0.000).

Table 2. Shows the physiochemical properties of River Idye. The temperature observed was within the range of 28.3 – 29.8^{o}c with a mean value of 29.02 $\pm$ 0.54^{o}c. The mean dissolved oxygen was 3.8 $\pm$ 0.49mg/l, pH was 7.34+0.61, Electrical conductivity was observed to be 803.80+268.12 (us/cm), while the total dissolved solid was 400.60+132.87, turbidity (26.41$\pm$9.86NTU) and Air temperature was 35.26$\pm$0.42^{o}c with a range of 35.0 – 36.0^{o}c respectively.

The Plankton abundance in relation to the Physiochemical properties of River Idye was investigated in this study using the Pearson's correlation coefficient (r). A very strong significant negative relationship was observed between plankton abundance and Electrical conductivity (r = - 0.938; P = 0.018), total dissolved solid (r= - 0.949; P = 0.014), Turbidity (r = - 0.0899; P = 0.038) (see figures 5, 6 and 7). The Plankton abundance in relation to the pH was also negative but non-significant (Fig 3). However, it was positive and non-significant in relation to dissolved oxygen(r=0.408; P=0.592). (Fig 3.) while no significant relationship was observed in relation to the temperature (r= 0.016;) – 0.016; P = 0.979) see (Fig 2).

Table 1. The abundance and diversity of planktons observed in River Idye.

Plankton	Abundance	Relative abundance (%)
Phytoplankton species		
Ulothrix sp.	19	29.69
Scenedesmus incrassatulus Bohlin	6	9.38

Glaucocystis sp.	10	15.63
Euglena sp	1	1.56
Closterium sp.	17	26.56
Zooplankton		
Strongeriodes stercolaris	1	1.56
Centropyxis sp.	6	9.38
Bosmina sp.	3	4.69
Paramecium sp.	1	1.56
Total	64	100
Shannon-Wienner Index (H)	1.785	
Evenness (E)	0.812	

$\chi^2 = 81.882$; df = 8l; P = 0.000.

Table 2. The Physiochemical properties of River Idye.

Physiochemical parameter	**Mean Value**	**Range**
Temperature (^{O}C)	29.02 ± 0.54	28.3 - 29.8
Dissolved oxygen (mg/l)	3.80 ± 0.49	3.10 – 4.40
pH	7.34 ± 0.61	6.80 – 8.40
Electrical conductivity (us/cm)	803.80 ± 268.12	502 – 1119
Total Dissolved solid (mg/l)	400.60 ± 132.87	261 – 559
Turbidity (NTU)	26.41 ± 9.86	19.11 – 41.19
Air temperature (^{O}C)	35.26 ±0.42	35.0 – 36.0

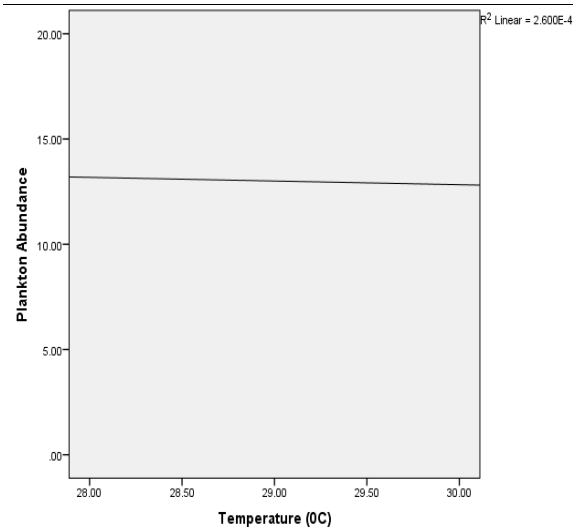

Figure 2. Effect of temperature on the abundance of planktons in River Idye using the Pearson's correlation.

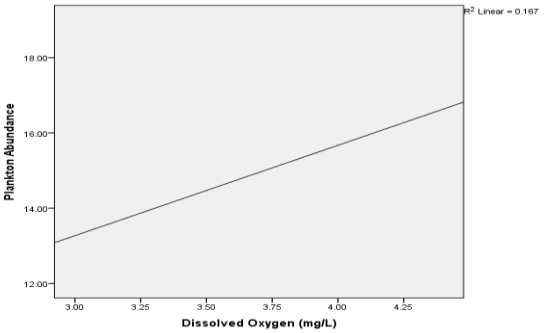

Figure 3. Effect of dissolved oxygen on the abundance of planktons in River Idye using the Pearson's correlation.

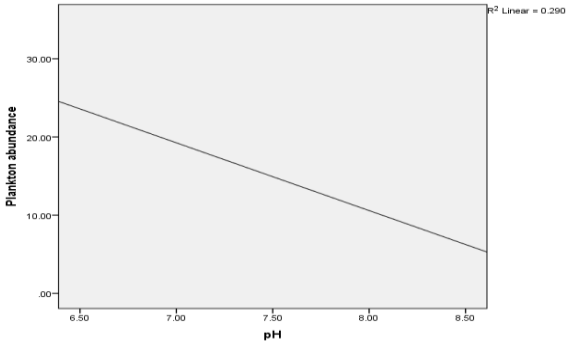

Figure 4. Effect of pH on the abundance of planktons in River Idye using the Pearson's correlation.

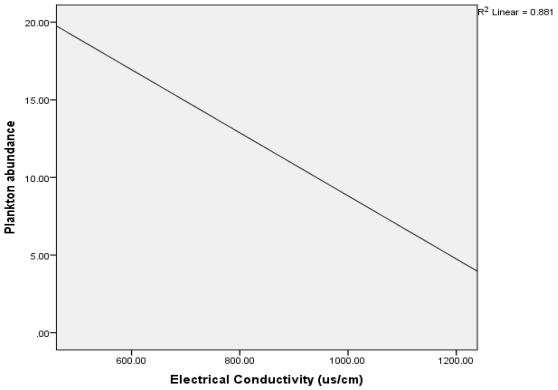

Figure 5. Effect of electrical conductivity on the abundance of planktons in River Idye using the Pearson's correlation.

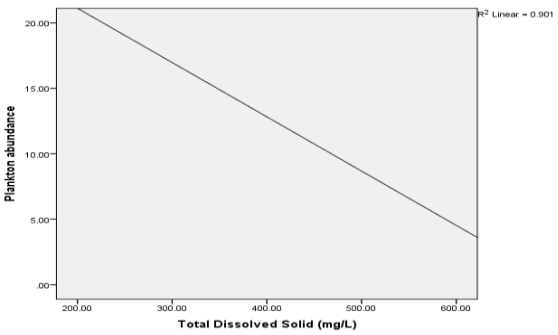

Figure 6. Effect of total dissolved solid on the abundance of planktons in River Idye using the Pearson's correlation.

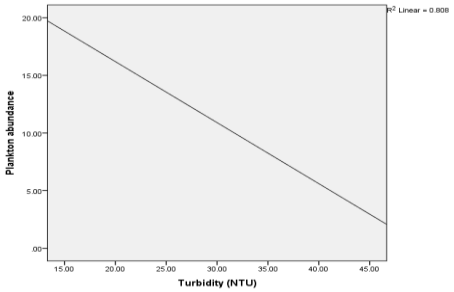

Figure 7. Effect of turbidity on the abundance of planktons in River Idye using the Pearson's correlation.

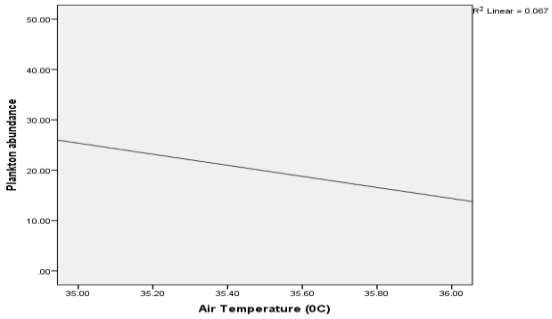

Figure 8. Effect of air temperature on the abundance of planktons in River Idye using the Pearson's correlation

DISCUSSION

A total of Five Phytoplankton and four Zooplankton species with a total abundance of 64 were observed in this study. The results revealed that the most abundant plankton species was the *Ulothrix spp.* with abundance of 19 representing 29.69%, *Clostrium spp*. 17 (26.56%), and the *Glaucocysis spp*, 10 (15.63%). The least observed species were the *Euglena spp, Strongloides stercolaris,* and *Paramecium spp.* representing 1.56% of the total abundance observed. This agree with the findings of Chukwu and Afolabi, (2017) who also carried out a research to investigate phytoplankton abundance and distribution in various ponds management to determine the impact of some physicochemical parameters on the community structure of three on research fish earthen ponds of Nigerian Institute for Oceanography and Marine Research, Badore, Lagos and reported *Ulothrix spp.* and *Clostrium sp*. to be more abundant in ponds.

It was further observed in this study that four Zooplankton species with a total abundance of 64 were examined across the sampling sites. Physiochemical properties of River Idye was also considered in this study, temperature observed was within the range of 28.3 – 29.8^{o}c with a mean value of 29.02 $\pm$ 0.54^{o}c. The mean dissolved oxygen was 3.8 $\pm$ 0.49mg/l, pH was 7.34+0.61, Electrical conductivity was observed to be 803.80+268.12 (us/cm), while the total dissolved solid was 400.60+132.87, turbidity (26.41$\pm$9.86NTU) and Air temperature was 35.26$\pm$0.42^{o}c with a range of 35.0 – 36.0^{o}c respectively. The similar range of temperature, Dissolved oxygen, and pH revealed in this research agree with the study documented by (Hossain *et al*., 2013) who determined the relationship between physico-chemical elements with the measured cell density of phytoplankton in nursery, growout, and broodstock ponds of fish. It is imperative to know certain information about different physicochemical parameters like color, temperature, acidity, hardness, pH, sulphate, chloride, dissolved oxygen, and alkalinity for the purpose of testing of water quality since they indicate the integrity of water in the ecosystem (Karmakar, *et al*., 2022). The corresponding influence of these parameters and plankton diversity determine the population density of the dependent animals in this habitation.

Conclusion

This study recorded different species of phytoplankton and zooplankton within the pond sites examined. Physiochemical such temperature, dissolved oxygen, water pH, Turbidity, seasonal variations, water characteristics, and nutrient enrichment relationship may be related to variable changes in the phytoplankton and zooplankton distribution and their abundance in ponds' water.

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