STUDIES ON SOME PHYSICO-CHEMICAL PARAMETERS AND RELATIVE ABUNDANCE OF ZOOPLANKTONS OF ANTAU RIVER, NASARAWA STATE

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J. K. Makpo, S. M. Ameh* and M. A. Olatunde
Department of Zoology, Nasarawa State University PMB 1022, Keffi, Nigeria
*Corresponding author: samuelameh328@yahoo.com

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Abstract: In recent years, there have been increase concern about the rate at which inland waters are polluted through run offs into streams, therefore leading to eutrophication which affect the specific composition of Zooplanktons and variation of physicochemical parameters as well as changing the qualities of these water bodies. The studies on some physicochemical parameters and relative abundance of zooplankton of Antau River, Keffi, Nasarawa State was carried out at Antau River while water samples were transported to the Research Laboratory of Nasarawa State University Keffi for water quality analysis. Water temperature (^oC) and Dissolve Oxygen (DO) (mg/l) of the water were analyzed using JPB-607A portable DO analyzer. Portable turbidity meter SGZ-200BS was used to determine the turbidity of the water. HI 83200 multi-parameter Bench Photometer was used to determine the alkalinity of the water samples. Water pH was measured with Hanna 420 pH meter. Electrical conductivity (EC) was measured using Hanna 420 conductivity meter. Monthly mean value of temperature ranged from 26.30±0.40 – 27.55±0.21^{0}C, water pH ranged from 6.68±0.46-7.79±0.03, and depth from 23.19±4.70 – 53.15±3.05 cm. Electrical conductivity (EC) was between 60.00±20.00 – 314.00±346.0 µs/cm. Dissolve oxygen (DO), Alkalinity and Total dissolved solid (TDS) monthly mean value ranges from 3.45 – 5.40 mg/L, 2.50±2.50 – 70.00±70.00 mg/L and 40.20±13.40 – 210.40±164.80 mg/L, respectively. Analysis of variance revealed that there was no significant difference between monthly values of the physic-chemical parameters of Antau River during the study period (May - August) at P>0.05, except the depth that showed significant difference at P<0.05. Zooplanktons abundance in Antau River during the study period was dominated by Copepods, and Cladocerans, followed by Rotifers and Protozoan's. The Zooplankton abundance varies with month and sites, which may be due to fluctuation of physico-chemical parameters. Correlation matrix showed that there were significant correlations between Zooplankton and Physicochemical parameters.

Keywords: Physicochemical parameters, relative abundance, zooplanktons, Antau River

Introduction

Water is one of the major components of environmental resources that are under threat either from over exploitation or pollution exacerbated by human activities on the earth surface (Efe, 2002). Though life cannot run without water, on earth 97.2% of water is salty and 2.8% is fresh water from which about 20% constitutes ground water (Rajesh *et al.*, 2011). The quality of groundwater depends on various chemical constituents and their concentrations, which are mostly derived from geological data. In many parts of the country, available water is rendered non-portable because of the presence of heavy metals (Amarachi and Ako, 2012). Water pollution affects drinking water, rivers, lakes and oceans all over the world, which consequently harms human health and the natural environment. This includes sewage, waste water, industrial waste, oil spillage, marine dumping, atmospheric deposition, radioactive waste, underground storage leakages, eutrophication, etc. (Gambhir *et al*., 2012). Zooplankton consists of macro and microscopic animals, comprising representatives of almost all major taxa particularly the invertebrates (Gosswami, 2004). Zooplankton can also be categorized as herbivorous and carnivorous based on their nature of feeding, and in turn makes up an important food item to other aquatic animals in the higher trophic levels (Haven, 2002). The water quality parameters and zooplankton diversity of a river tell much about its quality and suitability for both human use and survival of the living biota within it. The objective of this study is to determined physicochemical parameters and relative abundance of Zooplanktons in Antau River.

Materials and Methods

Study area

This study was carried out at Antau River located in Keffi Metropolis, the headquarters of Keffi Local Government Area of Nasarawa State, Nigeria. Keffi is about 58 Km from Abuja (the Federal Capital Territory) and 128 Km from Lafia, the Nasarawa State Capital. The town is situated on latitude 80 5" North and longitude 70 50" East and about 850 meters above the sea level (www.wikipedia) (Fig. 1). Keffi has population of 92,664 (NPC, 2006), making it the second populated city in Nasarawa State.

Source: www.wikipedia.com
Fig. 1: Location and accessibility map of the study area

Sample collection and analysis

Two sampling stations were selected based on the stratified method of sampling of Antau River. Site 1 was located at the Angwan Dadin Kowa known as Gada Manu where human activities, like bathing and washing takes place. Site II was located along Federal Government College Keffi popularly known as Antau Bridge where mechanical activities take place. The distance between stations is 1 km. The procedural plan of this study was monthly sampling of water and zooplanktons from May 2019 - August 2019. The water were sampled dipping 1 liter sampling bottle at 15 cm into the water and the bottles were covered with cap under the water to avoid destruction of the water parameters. The water samples were then transported to the Research Laboratory of Nasarawa State University Keffi for analysis.

Water temperature and dissolve oxygen (DO)

Water temperature (°C) and Dissolve Oxygen (DO) (mg/l) of the water were taken monthly by dipping JPB-607A portable DO Analyzer into the water from each station for about 3 – 5 min and allowed to stabilized before taking the reading.

Turbidity

Portable turbidity meter SGZ-200BS was used to determine the turbidity of the water collected from the sampling sites. The Portable Turbidity Meter SGZ-200BS was calibrated with zero degree turbidity water and Formazine of 400 NTU. 50 ml water sample was poured into the turbidity tube and allowed to settle before taking the readings.

Alkalinity

HI 83200 multi-parameter Bench Photometer was used to determine the alkalinity of the water samples collected from each sampling sites. Hi937755.0 alkalinity indicator reagent was used to calculate the test. The alkalinity method was selected. The corvette was filled with 10 ml of unreacted sample and cap replaced. The corvette was placed into the holder while the lid was closed. The HI 83200 multi-parameter Bench Photometer was calibrated to zero by pressing zero buttons. The corvette was filled with sample and exactly 1 ml of Hi937755.0 liquid alkalinity reagent was added using the supplied syringe. The cap of the corvette was replaced and was invert 5 times. The corvette was reinserted into the instrument and the lid was closed. The reading started after pressing the start button and the readings were recorded.

Water PH

Water pH was determined using Hanna 420 pH meter. It was calibrated according to instructional manual provided by the manufacturer. The electrode of the pH meter was dipped into the water sample for 3 – 5 min and allowed to stabilize before taking the readings.

Electrical conductivity (EC)

This was determined by Hanna 420 conductivity meter. It was calibrated according to instructional manual provided by the manufacturer. The electrode of the conductivity meter was lowered into the water sample for 3 – 5 min and allowed to stabilize before taking the readings.

Depth

The depths of water at each sampling station were measured using calibrated tape in meter and weighed with heavy metal at the bottom. The tape was lowered from the boat into the water until it reached the bottom of the River, the point at which it reached the bottom was marked and then removed; the value was then recorded as the depth of water in meters (m) as Sani *et al*. (2019).

Zooplanktons

Zooplankton samples were collected with silk plankton net of 25 cm diameter of 70 microns/cm attached with a collection bottle of 50 ml capacity at the base. The net was sunk just below the surface and towed through a distance of 5 m. The content of the collected vial was poured into plastic bottles of 70 ml capacity and preserved in 4% formalin. Counting was done by shaking the preserved sample and pupetting 1 ml of it into a Sedgwick Rafter Counting Cell and then mounted on a microscope. Identification was done using standard textbook such as Lynne (2004).

Data analysis

Descriptive statistics was used to calculate Mean, Mean ± Standard Error (SE), Standard deviation, Minimum and Maximum values. Percentage was used for zooplankton abundance and the results obtained was subjected to analysis of variance to test the level significance at $P<0.05$; between the water quality parameters and seasonal variation. Least significant difference (LSD) was used to separate mean. Pearson's correlation coefficient was used to test the relationship between physic-chemical parameters and zooplankton using SPSS version 20.

Result and Discussion

Physico-chemical parameters of Antau River

The Physico-chemical parameters of Antau River showed monthly mean variation (Table 1). The water temperature variation indicated mean ± SE value of 23.08 ± 0.8^0C ranged from 25.90 – 27.70^0C. Water temperature is an important factor that influences primary production in lakes and it depends on the climate, sun light and depth (Lewis, 2000; Abolude, 2007). Water temperatures were relatively lower in the month of May and increased progressively in August. The water temperature of the River fluctuated with months, which was between 25.90 and 27.70°C in both sampling sites. The water temperature indicated positive correlation with other parameters and zooplankton in the case study. This result agreed with previous reports that temperatures in tropics varies between 21 and 32°C (Atobatele and Ugwumba, 2008). Ayoade *et al*. (2006) recommended temperature range of 20 – 30^0C for optimum fish growth. This implies that the temperature range in Antau River is suitable for fish growth. Temperature influences the oxygen content of water, quantity and quality of autotrophs while affecting heterotrophy and photosynthesis. Temperature plays a vital role in the distribution of Zooplankton and Phytoplankton species (Tanimu *et al.*, 2011).

The Water turbidity of the River was least in the month August and Higher in the month of June with mean ± SE value of 157.95 ± 34.28 NTU.

Water pH values ranged between 6.22 –v7.81 with mean ± SE value of 7.13 ± 0.22. The water pH values observed during the study period were 6.22-7.81 within the month in both sites, and it was within the range for inland waters (pH 6.5 – 8.5) as reported by Mahar (2003). This was similar with the results of Ibrahim *et al.* (2009) which reported that hydrogen ion concentration (pH) was nearly neutral throughout both seasons, and it was within the range for inland water pH 6.5 – 8.5 in Kontagora reservoir, Niger state, Nigeria; which makes it suitable for optimal biological activity. Federal Environmental Protection Agency FEPA (1991) recommended pH 6.5 – 8.0 for drinking and 6.0-9.0 for aquatic life.

The Electrical Conductivity (EC) ranged from 40.00 to 560.00 µS/cm with mean ± SE of 128.88 ± 61.79 µS/cm. Electrical conductivity (EC) had its highest mean value (314.00±246.0 uS/cm) during the month of August and lowest (60.00±20.00 uS/cm) during the month of June. The accepted range is 30-5,000 µS/cm (Stone and Thomforde, 2015). The higher values may be due to chemical fertilizers from irrigated farmlands around the river coupled with high rate of evaporation that reduces the level of the water; thus conductivity of water depends upon the concentration of ions and its nutrients status.

The Dissolved Oxygen (DO) values in Antau River during the months of study ranged from 1.10 to 5.80 mg/L; with the mean value of ± SE 4.39 ± 0.55 mg/L. The least dissolve oxygen was recorded in the month of June with value of 1.10 mg/L in site I and the highest was recorded in the month of August in site II. The negative correlation of dissolved oxygen with turbidity and depth could be due to flooding of solid and breakdown of organic matter. Similar report was made by (Araoye, 2008) flooding of the lake came with suspended solids and dissolved salts, which also resulted in the negative correlation of DO concentration with turbidity, total dissolved solids (TDS), and conductivity. Oniye *et al*. (2002) reported that mean oxygen concentration of 0.17 mg/L in Zaria Dam, while the following values were reported at various reservoirs 4.8 – 8.2 mg/L in Oyun Reservoir Kwara (Mustapha, 2008), 4.7 – 9.8 mg/L in Sabke Reservoir (Bala and Bolorunduro, 2011), 2.24 – 3.46 mg/l in Ona River Apata, Ibadan and 0.7 – 1.8 mg/l in Awba Reservoir (Anago *et al*., 2013).

Total Dissolved Solids (TDS) in the Antau River had peaked value of 375.00 mg/L which was recorded in the month of August while the least mean value of 26.80 mg/L was recorded in the month of June; the mean ± SE was 86.53 ± 41.38 mg/L. The mean ± SE value of depth was 39.46±4.7 cm. The Total Dissolved Solid (TDS) which usually consist of organic and inorganic substances dissolved and washed into the lake by runoffs (Bala and Bolorunduro, 2011) are essential in the life of aquatic bio-community. There was no significant difference between monthly values of Total dissolve solid in Antau River at P > 0.05. The least total dissolved solid (TDS) was recorded in the month of June with value of 26.8 mg/L in site II and the highest was recorded in the month of August in site I with value 375.2. Dissolved solids determination are important in water quality studies, though no serious health effect has been associated with dissolved solids ingestion in water but some regulatory agencies (NAFDAC, 2001) recommended a maximum dissolved solids value of 500 mg/l in drinking water supplies.

Alkalinity is the measure of the capacity of water to neutralize or buffer acids using carbonate, bicarbonate ions, and in rare cases by hydroxide, thus protecting the organisms from major fluctuations in pH. The alkalinity values recorded in this study were within the recommended values between 0 – 500 mg/l (Lawson, 1995). In this study high level of alkalinity were observed in the month of August which is similar to value observe by (Sani *et al*., 2019) in Bodna River.

The water depths of the Antau River fluctuated with months. The mean value of depth was higher in the month of June with the value of 53.15±3.05 but lower in the month of May with the mean value of 23.19±4.70. The decrease in water depth especially May was caused by high evapo-transpiration during the onset of rain. Ibrahim *et al*. (2009) made similar observation of water depth fluctuation with season in Kontagora reservoir Niger State. As the depth of the reservoir increases dissolved oxygen decrease and this may affects zooplankton abundance and distribution. Araoye (2008) reported the depth of the reservoir decreases light intensity. There was no significant difference between turbidity values in the month of study at P <0.05. The turbidity showed negative correlation with temperature, PH, dissolve oxygen, electrical conductivity, alkalinity and Copepoda while positive with dept, Clodocera and Protozoa. Turbidity was lesser in the month August in site I with the recorded mean value of 6.6 (NTU) and higher in the month of June in site I with the recorded value of 140 (NTU). The high values of turbidity in the month of August also coincide with low count of plankton abundance in the month. This supported the observation of Mustapha (2008) who reported that turbidity of water is affected by the amount of the suspended solids in it, and it reduces the light penetrating depth, and hence, reduces the growth of the plants. (Essien-Ibok *et al.*, 2010) observed that decreasing turbidity downstream, in Mbo River may be attributed to increased tributary input of suspended materials and increased surface run-off from the drainage basin and it could probably be attributed to increased plankton abundance downstream.

Table 1: Mean values, ±SE, standard deviation, minimum and maximum physico-chemical parameters of River Antau during the months of May - August, 2019

Month	Temp. (^{0}C)	Turbidity (NTU)	Water Quality Parameters				Alkalinity (mg/L)	TDS (mg/L)
			pH (cm)	Depth (µS/cm)	E.C (mg/L)	D.O		
May	26.30±0.40^a	175.40±77.80^a	6.91±0.61^a	23.19±4.70^a	71.00±14.00^a	4.85^a	9.00±3.00^a	48.25±10.05^a
June	27.29±0.40^{ab}	267.50±32.50^a	7.15±0.35^a	53.15±3.05^b	60.00±20.00^a	3.45^a	10.00±0.00^a	40.20±13.40^a
July	27.50±0.00^b	114.20±1.10^a	7.79±0.03^a	48.85±3.25^b	70.00±3.50^a	3.85^a	2.50±2.50^a	47.25±2.35^a
August	27.55±0.21^b	74.70±68.10^a	6.68±0.46^a	32.75±3.55^a	314.00±246.0^a	5.40^a	70.00±70.00^a	210.40±164.80^a
Mean± SE	27.14±0.22	157.95±34.28	7.13±0.22	39.46±4.79	128.88±61.79	4.39±0.55	22.88±16.81	86.53±41.38
SD	0.62	96.95	0.63	13.55	174.76	1.55	47.54	117.04
Min	25.90	6.60	6.22	18.40	40.00	1.10	0.00	26.80
Max	27.70	300.00	7.81	56.20	560.00	5.80	140.00	375.00

Columns with same superscript are not significantly different; Temperature (Temp.), Nephelometric Turbidity Unit (NTU), Dissolved Oxygen (DO), Electrical conductivity (EC), Total Dissolve Solid, Standard Deviation (SD), Standard Error (SE), Minimum (min), Maximum (max)

Table 2: Monthly zooplanktons abundance and percentage in Antau River

Month	Rotifer (No. of Organism)	Copepods (No. of Organism)	Cladocera (No. of Organism)	Protozoa (No. of Organism)
May	12	08	03	15
June	10	09	08	12
July	20	18	13	16
August	05	15	07	06
Total	**47**	**50**	**31**	**49**
Percentage (%)	26.71	28.41	17.05	27.84

Table 3: Correlation matrix showing relationship between zooplankton and some physico-chemical parameters

Parameter	PH	D.O	E.C	TDS	Alkalinity	Turbidity	Depth	Clodocera	Protozoa	Copepod	Rotifer
Temp	1										
pH	0.47	1									
D.O	0.165	0.015	1								
E.C	0.158	-0.032	0.110	1							
TDS	0.157	-0.035	0.110	1.000*	1						
Alkalinity	0.131	-0.013	0.136	0.993*	0.993*	1					
Turbidity	0.141	-0.388	-0.470	-0.614	-0.613	-0.057	1				
Depth	0.393	0.549	-0.527	-0.112	-0.115	-0.102	0.185	1			
Clodocera	0.010	0.134	0.269	-0.488	-0.488	-0.502	0.131	0.218	1		
Protozoa	0.550	0.194	0.194	-0.680	-0.680	-0.674	0.259	0.029	0.391	1	
Copepod	0.289	0.062	0.449	-0.508	-0.508	-0.528	0.008	-0.040	0.946*	0.363	1
Rotifer	O.289	0.442	0.330	-0.570	-0.569	-0.557	0.064	0.059	0.796*	0.590	0.794

*= significant; Temperature (Temp.), Dissolved Oxygen (DO), Electrical conductivity (EC), Total Dissolve Solid

Zooplankton

Zooplanktons abundance in Antau River during the study period was dominated by Copepods 50 (28.41%), and then, Protozoan's 49(27.84%) followed by Rotifers 47(26.71%) and Cladocerans 31(17.05%). The zooplankton abundance varies with months and sites, which may be due to fluctuation of physico-chemical parameters (Table 2). Mahar (2003) reported factors such as light intensity; food availability, dissolved oxygen, and predation affects the population of zooplanktons. River Antau had higher zooplankton abundance in the month of July with Rotifer 20, Copepod 18, Cladocerans 13, Protozoan 16. This observation coincides with that of Edward and Ugwumba (2010) in which they reported the increased number of zooplankton during the rainy season which could be linked to the influx of nutrients.

The positive correlation of rotifers with dissolved oxygen and biochemical oxygen demand was an indication the reservoir was unpolluted; Balogun *et al*. (2005) in Makwaye Zaria (Ahmadu Bello University Farm) made similar observation. Analysis of variance showed that there is no significant difference in Rotifers in relation to the months.

The Copepods exhibited monthly variation in abundance, 08 in May, June 09, July 18, August 15, respectively and positive correlation with dissolved oxygen and turbidity of Antau River (Table 2). The positive correlation with dissolve oxygen was an indication the reservoir was unpolluted and productive. The individual growth rate of copepods may depend on temperature alone in a global viewpoint; food condition is still considered an important factor affecting growth and reproduction of copepods in nature, especially in closed environment such as reservoirs and lakes (Mahar, 2003).

Cladocerans in River Antau during the month of study, also indicates no monthly variation in abundance that may be due to no variations of water quality parameters. Cladocera indicated positive relation with temperature, turbidity, dissolved and oxygen. The result was similar with that of Syuhei (1994) in which it was reported that Cladocerans positive correlation with dissolved oxygen and temperature. Analysis of variance showed that there is no significant difference in Cladocera in relation to the month.

Protozoa showed higher abundance in the month of July with 16 and lower abundance in the month of August with 06. Analysis of variance showed that there is no significant difference in Protozoa in relation to the month. Protozoa showed positive relationship with temperature, PH, dissolve oxygen and turbidity.

Conflict of Interest

Authors declare that there is no conflict of interest reported in this work.

Conclusion

Water quality parameters and zooplankton diversity of a river tell much about its quality and suitability for both human use and survival of the living biota within it. This investigation gave the overall picture of water quality parameters of Antau River which was conducive for aquatic organisms within the study period. However, the Alkalinity value in August raised concern as accumulation of alkaline can pose a threat of pollution to the River. Zooplankton abundance in Antau River during the study period was dominated by Copepods, and Protozoan which were followed by Rotifers and Cladocera. The Zooplanktons abundance varied with months and season, which can be due to fluctuation in the water quality parameters. Overall, the result gave a positive picture of the objectives of this investigation.

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