ABUNDANCE OF ZOOPLANKTON AND ITS RELATIONSHIP WITH SOME PHYSICO- CHEMICAL PARAMETERS OF RIVER RIMA IN KWALKWALWA PORTION OF SOKOTO STATE, NIGERIA

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ABSTRACT
This study was conducted in Kwalkwalwa area of River Rima Sokoto, Sokoto state, Nigeria. It aimed at assessing abundance of zooplankton and its relationships with some physico-chemical parameters. Three sampling stations were selected as station A (shoreline site), B (Fishing activities. area) and C (Farming and irrigation site). Four seasons were observed. Eight physico-chemical parameters including, temperature, dissolved oxygen, turbidity, pH, electrical conductivity, phosphate and nitrate were measured monthly using portable instruments concurrently with collection of zooplankton samples at each sampling point at depths between 0.1m and 0.5m. All physico-chemical parameters were significantly (P<0.05) different between the four seasons. Nine species of zooplankton were discovered belonging to three groups namely; rotifers, cladoceran and copepods Off these, 2 species were contributed by Rotifera, 2 Cladocera and 5 Copepoda. However, the copepods had the largest contribution in terms of abundance in all the four seasons. The calculated season-wise diversity indices values, for each group of zooplankton showed no considerable degree of differences as all the species were recorded in all the four seasons. Generally, with the exception of turbidity and pH, there was no significant (P>0.05) correlation between zooplankton abundance and physico-chemical parameters. The results showed that there was positive and significant (P<0.05) relationship between turbidity and zooplankton during early wet season. Agroforestry practices should be promoted in the river`s catchment area in order to reduce sedimentation in the lake and on land deforestation.
Keywords: Ecosystems, Detritus, Pollutants, Composition, Harvest net.

INTRODUCTION

Zooplankton includes many kinds of protozoans, micro-crustaceans and other micro invertebrates that are planktonic in water bodies (Farshad and Venkataramana, 2012). Freshwater zooplankton plays an important food chain role in ponds, lakes and reservoirs ecosystems (Manickam *et al.,* 2015). Due to seasonal distribution of rainfall, River Rima experiences seasonal flooding which introduces a lot of detritus and pollutants from the land. The River presently serves as a major drainage channel receiving domestic wastes as well as industrial effluents from industries in the area. River Rima plays an important role in the lives of the surrounding inhabitants. Fishing, bathing, washing/laundry, car washing, refuse disposal, industrial wastes disposal and other human activities are constantly going on within and around this river. These interferes couples with the seasonal fluctuation in surface water level and have the tendency to influence the status of these parameters which may produce significant changes in the quality of the river water and the trophic state of an ecosystem (Yakubu *et al.,* 2000). Owing to these identified problems, the tendency of zooplankton to respond to slight changes in the physical and chemical compositions of aquatic environment has made it a veritable tool in evaluating the relationship of some water quality parameters and the trophic state of zooplankton abundance (Zhao *et al.,* 2019).The specific objective of the study was to determine the influence of physico-chewmical properties on the diversity, composition and abundance of zooplankton of River Rima in Kwalkwalwa area.

MATERIALS AND METHODS

The study was carried out in three stations of Kwalkwalwa area of River Rima in Wamakko Local Government Area of Sokoto state, Nigeria. Sokoto lies between longitudes 408'E and 605'E, and latitudes 120N and 13058'N (Umar and Ismaila, 2017). The climate of Sokoto is tropical continental, with much of the rains between June and September, while the long dry season is from October and May (Shinkafi, 2013 River Rima flows in a South-western direction over 100km and joins the major River Sokoto to form the Sokoto-Rima river system (Shinkafi and Ipinjolu, 2010). The River is seasonal, usually over flooding its banks during the rainy season in August and September, and up to October at times (Shinkafi *et al*., 2013).

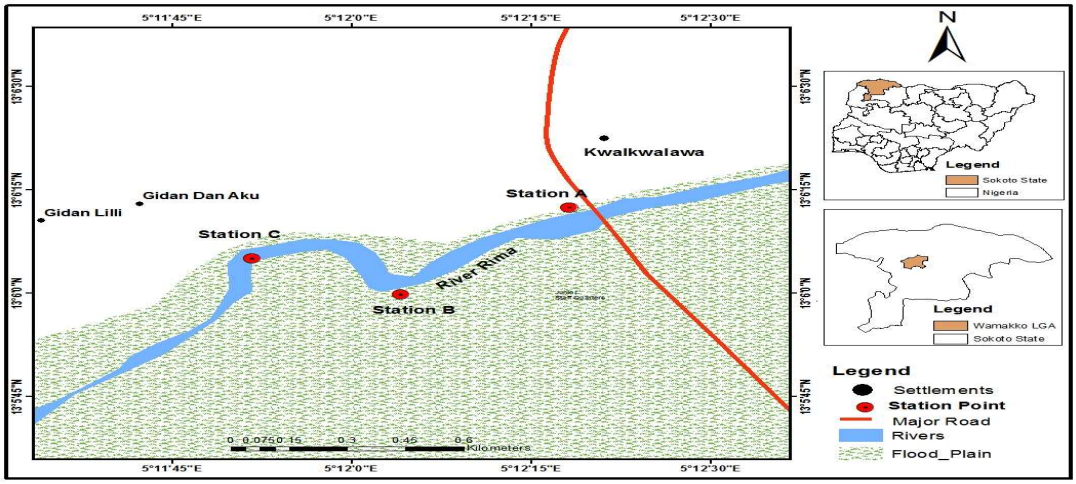

Figure 1: Map of the study area.
Source: OSGOF Drawn by GIS Lab. Department of Geography, UDUS (2019)

Samples and water sample collection
Sampling at the selected stations was carried out monthly, for a year. Water and zooplankton were collected from these sampling stations for the period of the study. Water samples were collected in one litre capacity plastic bottles, between 6 to 7 am, from all the sampling locations, for a period of 12 months. The bottle was immersed into the river to collect water at the hypolimnion layer early in the morning. Temperature, pH and turbidity of the water were measured immediately at the field. Water sample collected was taken to Agrichemical Laboratory, Usmanu Danfodiyo University, Sokoto, for the determination of dissolved oxygen (DO), Conductivity, presence of Total Dissolved Solids (TDS), Nitrate – Nitrogen ($NO3^{-N}$) and Phosphate – Phosphorus (PO_4^{-P}) (Maishanu *et al*., 2011). The plankton and water samples were collected from the selected stations in the river for 12 months. Samples were collected once every month in the morning hours (6.00 A.M. to7.00 A.M.).

Zooplankton collection and identification
Standard plankton net was used. It's conical in shape. A nylon material was attached to it (which is the filtering area of the net). The harvest net was towed vertically over the river water to collect the sample. The content was then transferred into 100ml plastic bottles and was fixed using 5% of formalin (10 ml), the aqueous solution of formaldehyde to preserve the zooplankton. The bottles were kept in cooler boxes and transported to the Biological Science Laboratory, Usmanu Danfodiyo University, Sokoto, for identification. The average values were taken of each month for one year, (i.e., during 2019-2020). Total number of plankton present in 1 litre of water sample was calculated (Santhanam *et al.,* 1989) using the following formula: $N = n \times v / V$ Where,
N = Total number of plankton per liter of water filtered, n = Average number of plankton in 1 ml of plankton sample
v = Volume of plankton concentrated (ml) and, V = Volume of total water filtered (liter)

Statistical Analysis
Season-wise data were subjected to statistical analysis through one-way ANOVA in each of the stations and subsequent post hoc multiple comparisons with Duncan's Multiple Range Test (DMRT) using SPSS (v20.0). The different diversity indices such as Shannon's diversity index (H'), species evenness and species richness were calculated using PAST (Paleontological Statistics) software package (PAST, v2.02). Pearson's correlation (r) analysis was used to investigate whether there was a relationship between physico-chemical parameters to zooplankton abundance. A multiple regression analysis was used to investigate the cause and effect between the zooplankton abundance physico-chemical parameters.

RESULTS AND DISCUSSION
Table 1 showed the mean variations in water quality parameters in River Rima, Kwalkwalwa area during the study period. One-way ANOVA (posthoc test) of physicochemical parameters showed significant differences ($P< 0.05$) with respect to the physicochemical parameters.
Table 2 shows the relationships between the zooplankton and physico-chemical parameters. Temperature, Nitrate *and* pH showed negative relationship with zooplankton abundance. Generally, with the exception of turbidity and pH, there was no significant ($P>0.05$) correlation between zooplankton abundance and physico-

chemical parameters. In this study, the calculated seasonal-wise diversity indices values, for each group of zooplankton showed no considerable degree of differences as all the species were recorded in all the four seasons (Table 5).

Table 1: Physico-chemical characteristics of River Rima, Kwalkwalwa area during the study period

Parameters	Early Wet Season (Apr' 2019-Jun' 2019)	Late Wet Season (Jul' 2019-Sep' 2019)	Early Dry Season (Oct' 2019-Dec' 2019)	Late Dry Season (Jan'2020 Mar' 2020	Overall average
WT (°C)	30.2±0.23[a]	25.5±1.22[b]	22.8±0.57[c]	29.63±0.59[ab]	27.03±0.65
pH	6.66±0.36[ab]	7.05±0.22[a]	7.08±0.08[a]	6.54±0.49[ab]	6.83±0.28
DO (mg/l)	5.01±0.26[a]	5.25±0.33[a]	3.93±0.46[ab]	3.45±0.40[bc]	4.41±0.36
EC(µScm-1)	136.9±23.3[ab]	94.5±2.91[b]	115.83±3.35[b]	161±26.92[a]	127.05±14.12
Turb (cm)	20.33±0.11[a]	20±0.75[a]	18.66±0.6[ab]	19.33±0.98[ab]	19.58±0.61
TDS (mg/l)	6.66±0.02[a]	5.23±0.71[b]	5.89±0.94[ab]	6.22±1.17[ab]	6.0±0.71
Nitrite (mg/l)	1.05±0.49[a]	0.89±0.37[ab]	1.05±0.08[a]	1.08±0.41[a]	1.01±0.33
Phosphate (mg/l)	0.18±0.02[a]	0.19±0.01[a]	0.20±0.01[a]	0.20±0.01[a]	0.19±0.01

Each season-wise value is overall average of mean ± SD (3 stations × 3 months)

Table 2: The Pearson coefficient of correlation of total zooplankton and physico-chemical parameters in River Rima, Kwalkwalwa area during the study period

Parameters	Correlation coefficient, r	P value	Remarks
Temperature	-0.035	0.72	NS
pH	-0.318	0.000	S
DO	0.162	0.114	NS
EC	0.582	0.303	NS
Turb	0.360	0.000	S
Total Dissolve Solid	0.112	0.858	NS
Nitrate	-0.149	0.121	NS
Phosphate	0.151	0.115	NS

NS = Not Significant, S = Significant

Table 5: Diversity indices of zooplankton in River Rima, Kwalkwalwa area during the study period

Plankton group	Diversity indices	Early Wet Season (Apr' 2018-Jun' 2018)	Late Wet Season (Jul' 2018-Sep' 2018)	Early Dry Season (Oct' 2018-Dec' 2018)	Late Dry Season (Jan' 2019-Mar' 2019)	Overall average
Cladocera (2 species)	Shannon (H)	1.356±0.043[ab]	1.337±0.042[ab]	1.322±0.041[a]	1.299±0.035[b]	1.3285±0.024
	Evenness_e^H/S	0.565±0.035[a]	0.512±0.036[a]	0.547±0.032[a]	0.533±0.037[a]	0.539±0.022
	Margalef (R1)	0.297±0.062[b]	0.256±0.054[ab]	0.223±0.066[a]	0.274±0.057[ab]	0.288±0.029
Copepoda (5 species)	Shannon (H)	1.554±0.046[a]	1.562±0.048[a]	1.552±0.045[a]	1.541±0.043[a]	1.552±0.009
	Evenness_e^H/S	0.946±0.035[a]	0.953±0.037[a]	0.953±0.037[a]	0.944±0.034[a]	0.949±0.005
	Margalef (R1)	0.653±0.051[a]	0.623±0.056[a]	0.615±0.053[a]	0.595±0.052[a]	0.622±0.024
Rotifer (2 species)	Shannon (H)	1.261±0.045[a]	1.254±0.032[a]	1.253±0.029[a]	1.245±0.036[a]	1.252±0.007
	Evenness_e^H/S	0.582±0.031[a]	0.588±0.037[a]	0.575±0.032[a]	0.581±0.035[a]	0.582±0.005
	Margalef (R1)	0.208±0.052[ab]	0.322±0.054[b]	0.266±0.058[a]	0.239±0.056[ab]	0.259±0.025

Each season-wise value is overall average of mean ± SD (3 stations × 3 months).

Physico-chemical parameters and quantity of nutrients in water play a significant role in the distribution patterns and species composition of plankton (Jose *et al*., 2015). In the present study, an opposite relationship was observed between zooplankton and pH. This suggests that high pH contributes to the lower densities of zooplankton. However, contrary to the present findings, Beenamma and Sadanand (2011) in India, reported positive relationship between zooplankton and pH. In addition, Tenner *et al.* (2005) in Dhembare (2011) reported that pH values ranging from 6 to 8.5 are associated with medium productivity. Similar to that of the present study, the distribution of various zooplankton species (Rotifers, Cladocerans and Copepods) has been reported in a number of freshwater bodies (Dhanasekaran *et al*., 2017). In this study, the calculated season-wise diversity indices for each group of zooplankton showed no considerable degree of differences as all the species were recorded in all the four seasons. However, some degree of differences was seen in the respective index value between different zooplankton groups in each season, because the number of species in each group varied., For example, the Shannon (H) diversity index for Rotifers, Cladocerans and Copepods during summer were 1.261, 1.356 and 1.554, respectively. Similarly, this kind of difference between different groups was recorded in each and every season in all types of diversity indices studied.

CONCLUSION AND RECOMMENDATION

All the physico-chemical parameters were significantly different between the four seasons. In this study, the calculated seasonal-wise diversity indices for each group of zooplankton showed no considerable degree of differences as all the species was recorded in all the four seasons. Overall, this river was organically polluted since no significant fluctuation in species composition was recorded and all the species appeared in all the four seasons. Turbidity and pH were significantly positively and negatively correlated with zooplankton abundance respectively. Specific practices like contour farming on the catchment slopes will lead to reduction in runoffs into the river, reducing siltation in the river. The present study lasted for one year; a follow up study is hereby recommended.

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