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COMPARATIVE PLANKTON SURVEY AND PHYSICO-CHEMICAL ASSESSMENT OF TWO PONDS IN KANO METROPOLIS, NIGERIA

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ABSTRACT:*Monthly charges in plankton periodicity levels, temperature, pH, turbidity and heavy metals were studied in two ponds in Kano metropolis for a period of 12 months. Physico-chemical parameter studied has shown that temperature, pH and turbidity ranged between 14.2-33.5°C, 6.5-8.6 and 2.3-143 NTU respectively. Dissolved oxygen, biochemical oxygen demand, nitrate and phosphate concentration were within the ranges of 3.3-7.9 mg/1, 1.1-6.4 mg/1, 1.26-12.2 and 1.11-9.60 mg/1 respectively. Plankton periodicity in the ponds shown two phases separated by shift in nutrient concentration and temperature regimes. Significant difference occurred between the wet and dry seasons values of temperature, pH, turbidity, nitrate, phosphate, phytoplankton and zooplankton (p<0.01). However, no significant different was found between the seasons in terms of BOD5 at p>0.05. Phytoplankton and zooplankton densities were found to correlate positively with pH, BOD5 nitrate, phosphate and the heavy metals (p<0.01). Ten (10) phytoplankton species were identified in the ponds dominated by Green algae (site A 50.00% and site B 71.43%)and (7.14%) each for blue green algae, diatom and flagellate, while Eight zooplankton species were identified dominated by rotifera 3 (29.47%) followed by protozoa 2 (18.03%), copepoda 1 (18.18%), and flagellates 1 (15.58%). While 22.35% was recorded for nematoda. Double maxima occurred in terms of the total monthly density of phytoplankton recorded from site B which were 8,653 and 7,126 orgs/l in April and February respectively.*

INTRODUCTION

Fresh water has become recognized as an increasingly important resource, with the quality of the water a great concern. Studies on the ecological aspects of a given water body helps to provide clear understanding on its quality as well as the physical and biological factors that interact to influence productivity of the water bodies. The quality of a given water body is governed by its physical, chemical and biological factors all of which interact with one another and greatly influence its productivity (Balarabe, 1989). It is necessary to study the influence with a view to controlling and maintaining them within the optimum range. Monitoring of biological and physico-chemical characteristics of water body is important for both short and long term (Stent, 1981). Nigeria's vast freshwater resources are among those most affected by environmental stress imposed by human population growth, urbanization and agricultural practice (Adeyemo, 2003). Environmental factors comprising physical and chemical component have been reported in several studies to have a great influence on the well-being of aquatic species, plankton inclusive (Ovie, 1997; Kawo, 2005; Okogwu and Ugwunba, 2006). In an aquatic ecosystem, plankton play important role in aquatic food chain and their density has been reported to vary depending on the availability of nutrients and the stability of the water (Redmond, 2008). Equally, results of several studies have shown that physical and chemical condition of aquatic ecosystems determine the occurrence, diversity and density of both flora and fauna in any given habitat, which may change with season of the year (Aoyagui and Bonecker, 2004; Ayodele and Adeniji, 2006).

Inland water resources and their high productivity have a very important place in human civilization and therefore an adequate knowledge of their environments is indispensable. Freshwater represents only 2.5% of Earth's water of which only about 1.2% is accessible liquid surface water (Perlman, 2018). Lakes and rivers are important water resources. Reservoirs made by constructing dams across the rivers serve a variety of purposes viz. drinking, irrigation,

industrial processes, recreation and generation of hydroelectricity, hence Lakes plays an important role in the development programmes of country (Shrivastava, 2018). It is obvious that water is a poor thermal conductor and slight variation in temperature results in rapid change in its density. The surface tension and viscosity of water surface play a significant impact in shaping the characteristics of concerned planktonic communities and other micro-organisms (Shrivastava, 2018). Reservoirs in semiarid climates are exposed to drastic variations in water volume due to human demand during drought seasons, which accelerates eutrophication processes particularly in tropical regions (Salusso & Moraña, 2017). The major factors responsible for the quality of water composition are natural weathering of geological soil components, entrainment of suspended solids through surface runoff from agricultural areas, and anthropogenic actions (Salusso, Moraña, &Araoz, 2004). Phytoplankton mainly represented by algae form a vital part in almost all the fresh water ecosystems and plays an important role through primary productions in the food chain and is also a useful tool for the assessment of water quality. These organisms are very reactive element of the lake ecosystem because of changes in the environment. These changes concern both quantitative and qualitative phytoplankton structure (Kozak, Gołdyn & Dondajewska, 2015). Algae play a significant ecological role and are being used extensively as indicators of water pollution (Bhatnagar & Bhardwaj, 2013).

METHODOLOGY

Study Area

This study was carried out in two local government areas (Gwale and Municipal) within Kano metropolis, with a pond selected from each of the local government areas.

Site A. This is located at Dukawiya, Gwali Local Government Area of Kano opposite Bayero University, Kano Old Campus main (11°50′ 14.20″ N, 08° 28′ 53.66″ E) (Cartongraphy Laboratory, 2011). It receives domestic wastes from household around and a waste dumping site.

Site B. This pond is known as Dan' Agundi pond beside Kofar Dan' Agundi city gate (11° 59′ 53.7″N, 08° 31′ 24.4″E) in Kano municipal. It serves the purpose of fishing and drainage.

Sample Collection

Samples were collected between 7 – 9 am on fortnight basis at each site for a period of 12 months (March 2011-February 2012).

Determination ofPhysico-chemical Parameters

Determination of physico-chemical parameters including temperature, pH, turbidity, DO, BOD_5, nitrate (NO_3^-N) and phosphate (PO_4^-P) concentrations were carried out according to the manufacturer's instructions (Janway and Hanna Instruments). The heavy metals determined were lead, iron, magnesium and zinc. This was done spectrometrically with thermo electron atomic absorption spectrophotometer (AAS), evolution 600 S-series (APHA, 2010).

Biological Analyses

Phytoplankton Sampling

Phytoplankton examination was done using a planktonnet with conical bag (Net mesh size of 0.01 mm) 25 cm long, attached to 25 ml bottle and with an opening of 20 cm diameter. At each station, the net was sunk just beneath the water surface and towed for one meter. The samples were transferred to a plastic bottle of 50 ml and preserved in lugol's iodine. The samples from each site were taken to the laboratory for identification (APHA, 2005).

Zooplankton Sampling

The zooplankton sampling was carried out using silk plankton net of 20 cm diameter and 70 meshes attached with 25 ml capacity bottle at the base. At each site, collection was done by sinking the net which was lowered through 1metre. The samples were then poured into plastic bottle of 70 ml capacity and preserved in 4% formalin and taken to the laboratory for identification (APHA, 2005).

Laboratory Analyses

From the 25 ml collected samples, 1ml was drawn for phytoplankton and zooplankton each into a counting cell and the number of organisms was expressed per litre with the aid of a light microscope (Olympus Japan). Identification was done by using various identification guides such as Palmer (1980), Anand (1998) and APHA (2005).

Statistical Analysis

The Pearson correlation coefficient was used to examine the relationships among the different environmental variables including phytoplankton and zooplankton densities. The linear regression model was performed using SPSS version 17. The community structure was analyzed using the Shannon-Wiener Index of Diversity (H/), Evenness Index (J) and Berger-Parker Index of Dominance (DBP) and Odum's Index (Magurran, 2004).

RESULTS AND DISCUSSION

The mean monthly temperature values at the sites were within the FEPA (1991) emission standard of 30°C except in March – May 2011 were temperatures of above 30°C were recorded for all the sites (Table 1). This could be due to increased solar radiation during the period (Ezra, 1999). Negative significant correlation occurred between temperature and phytoplankton values of wet and dry season ($p < 0.01$).

The mean pH recorded at all the sites were within the acceptable limit of 6.5 – 8.5 recommended for inland and drinking water quality (Antonie and Al saadi, 1982; WHO, 1996) except at site A in September (8.6) (Table 1), which could be attributed to unusual effluent discharges into the pond from the surrounding households. The relatively stable pH recorded during this study seems to corroborate with the reports of Toman (1996) and Ibrahim (2003). The results of pH obtained throughout the study were optimum for fish culture, as reported by Bennett (1974) that pH of 5.5 – 10 is recommended for tropical fish culture. Monthly variation of pH with phytoplankton and zooplankton densities was observed to be in inverse proportionate. Significant positive correlation was observed between pH, BOD_5 and iron. While a negative significant correlation occurred between pH and phytoplankton values of wet and dry season ($p < 0.01$).

Variations in phytoplankton and zooplankton densities with changes in turbidity, DO and BOD_5 during this study are presented in Table 2. The turbidity appeared to be high during the wet season (June - September) which might be largely responsible for low plankton densities as reported by Dejen*et al,* (2004) that silt held in suspension in turbid water interferes with light penetration into the water for photosynthetic activities by phytoplankton and also interferes with filter feeding mechanisms of zooplankton which eventually affects their reproduction success (Dissmeyer, 1976). This was because of heavy rainfall experienced and due to increase in suspended solids from surface run off from house wastes into the ponds. This observation is in line with the findings of Ezra (1999). Low transparency in rainy months tends to indicate the presence of high suspended matter which offers little light penetration into the water. However, high suspended matter may serve as adaptive feature enabling the free-floating biota and fish eggs to become attached to suspended solids. It may also aid in reduction of solar heat radiation to bottom dwellers and so help in eliminating or reducing predatory organisms (Boyd, 1989). Dissolved oxygen in water is an important factor determining the occurrence and abundance of aquatic organisms, because for all the aquatic aerobes, oxygen is pre-requisite for life, thus the more the oxygen available the more the organisms are found (APHA, 2005). The result of DO at the sampling sites was not a bio- limiting factor in the ponds as their means were all above the minimum of 5.00mg/l required for the survival of aquatic organisms (FEPA, 1991) except for site A in June (3.30 mg/l) which was due to high organic load received by the pond been the on- set of wet season. The high DO values recorded in the dry season could partly be due to effect of harmattan wind that facilities mixing of the surface water with atmospheric oxygen in the pond (Ibrahim, 2009).

Indeed, the results of this study showed thatBOD_5 at the sampling sites was generally low throughout the study period with the lowest and highest value 6.36mg/l recorded from site A in August. This may be because of mixing of the water and hence, increase in dissolved oxygen, which also raises the activities of organisms in the water and consequently raise the BOD_5 values. Coute, (1990) reported that the greater the BOD_5 the greater the degree of pollution. The mean monthly BOD_5 values of site A were all above the MOEF, (1994) standard of 3 mg/l for bathing water which makes it not safe for baffling. Hence, contamination level decreases (pond A > pond B). The above findings corroborate with the work of Abdullahi *et al*. (2004) in a study on limnological parameters and phytoplankton dynamics in some borrow pit ponds in kano metropolitan area. Significant difference occurred between values of turbidity, DO, and phytoplankton ($p < 0.001$).

For the anions (nitrate and phosphate) high concentration with ranges of 1.80 – 13.70 mg/l nitrate and 1.11 – 9.60 mg/l phosphate were recorded in site B (June), site A (June) and site A (October), site B (June) respectively (Table 3). During dry season (November – May) their concentrations increases due to dumping of organic materials into the water and then drops during wet season because of dilution effect of rainwater. These fluctuations were probably because of influx through rain runoff followed by a decline as they are taken up by phytoplankton. This agrees with report of Palmer (1980) who stressed the relationship between reduced initial turnover of phosphate and changes in phytoplankton composition and biomass in the restored lake Trumaren Sweden. Significant difference occurred between values of nitrate, phosphate and plankton ($p < 0.001$). The decline in the nitrate and phosphate as they are taken up by phytoplankton indicate a positive change in plankton composition and biomass. The results of heavy metals analysis showed that of all the metals determine, iron and magnesium were only identified at the sites in both seasons (Table 4). Concentration ranges of 0.09 to 4.71mg/l and 0.15 to 6.12 mg/l were recorded for iron and Magnesium respectively. But the mean values of all the metals studied in all the sites falls within the standards of USEPA (1979); 1S (1993); MOEF (1994) and WHO (1996). No significant difference ($p > 0.05$).

The phytoplankton occurrence relates directly with changes in nutrient concentration of the surface waters which is in turn affected by temperature at different times of the year. Thus, causing phytoplankton periodically as reported by Khan (1984). Double maxima occurred in terms of the total monthly density of phytoplankton recorded from site B which were 8,653 and 7,126 orgs/l in April and February respectively as shown in Table 1. The above observation corresponds with the report of Ovie (1997); Okogwu and Ugwumba (2006) and Ibrahim (2009) that plankton maxima may occur at any time of the year in the tropics depending on the conditions of the ecosystem. The periods of maximum phytoplankton growth in site A and site B coincided with periods of increased nitrate concentration in the ponds (Table 4) as reported by Kant (1978). The phytoplankton populations of the ponds were dominated by Green algae (site A 50.00% and site B 71.43%) (Table 5). This differs from situation in Kainji and Tiga lake as reported by Adebisi (1981) and river Tigris where blue – green algae make up to 95% of the phytoplankton population (Sa'ad and Antanie, 1978); the result agrees with the report of Adikwu (2004). Increase in phytoplankton population was observed during the dry season (November - April) due to abundant in nutrients because of harmattan wind which causes mixing of the water. On the other hand, a drop was noticed from May to October which might probably due to increase in predation by the zooplankton. Highly significant positive correlation occurred between nitrate and phosphate ($p<0.01$). Eight zooplankton species were identified dominated by rotifera 3 (29.47%) followed by protozoa 2 (18.03%), copepoda 1 (18.18%), and flagellates 1 (15.58%). While 22.35% was recorded for nematoda (Table 6).

Frequency of occurrence per site (%) of plankton shows that site A has the values of 50% and 71.45% for phytoplankton and zooplankton respectively, site B has 36.36% phytoplankton and zooplankton respectively. The low frequency of occurrence in site B may be due to the unfavorable nature of the pond in terms of temperature, turbidity and DO which are the basic physico-chemical parameters that determines productivity in water (APHA, 2004)

A study in a shallow lake in the south of Brazil showed transparency and water temperature as the important environmental variables in the variation of composition (Avila *et al*., 2004). This study revealed that factors that governed the growth of phytoplankton are temperature and turbidity.

The physico-chemical and biological data generated were analyzed statistically (SPSS, 1999) using analysis of variance (ANOVA) for significant differences or otherwise between the wet season (June- October) and the dry season (November- May).Significant difference occurred between the wet and dry season values oftemperature, pH, turbidity, nitrate, phosphate, phytoplankton and zooplankton ($p < 0.01$). However, no significant difference was found between the seasons in terms of BOD_5 at $p > 0.05$. Pearson correlation analysis was also carried out to determine the relationship between the physic-chemical parameters and plankton determined (SPSS, 1999). Phytoplankton and zooplankton densities were found to correlate positively with pH, BOD_5, nitrate, phosphate and the heavy metals ($p < 0.01$). Negative significant correlation occurred between temperature and phytoplankton values of wet and dry season ($p < 0.01$). Significant difference occurred between values of turbidity, DO, and phytoplankton ($p < 0.01$).

Analyses of community structure were carried out for the determination of plankton diversity, abundance, richness and dominance. Shannon-wiener diversity index was used to calculate the diversity of phytoplankton and zooplankton. This formula assumes an infinite sample, but if sample size is large, the bias is likely to be small if $\frac{n_i}{N}$ is used to approximate p_i. The higher the value if H, the greater is the diversity. The maximum value of H can be more than I. The decline in the value of H is taken as an evidence of pollution. According to APHA, (2004) a value of this index above 3 will indicate clean water, whereas values fewer than this would indicate pollution. Although, mild pollution conditions as the systems undergo transition from one season to another was observed as reported by APHA (2004). Evenness is referring to the absolute distribution of relative abundance of species at a site. The higher the pollution stresses the lesser the Evenness Index. Margalef Index of Species Richness is a simple ratio between total species (S) and total numbers of individuals (N). It was used to compare one community with another. The Odum's Index is extremely useful for comparison of various sites. The values decrease with rise in the level of pollution. Community dominance index (CDI) was used to determine the percentage of abundance, which is contributed by the two most abundant species within the community. Species abundance is determined as a bio-mass, productivity or density.

Table 1: Mean Monthly Values of Temperature, pH, Phytoplankton and Zooplankton Density obtained from some ponds in Kano metropolis (March 2011 - February 2012)

	Temperature(°C)		pH		**Phytoplankton** (org/l)		**Zooplankton** (org/l)	
Month	Site A	Site B	Site A	SiteB	Site A	Site B	Site A	Site B
March	32.6	32.7	7.6	7.2	7,635	5,344	9.37	26.42
April	33.5	33.4	6.5	7.8	7,126	8,653	13.07	10.60
May	32.6	33.7	7.8	7.7	3,817	3,054	5.30	174.0
June	29.6	29.8	6.8	8.0	1,527	5,853	4.89	19.55
July	29.0	28.0	8.0	8.1	7,63	5,090	17.11	25.66
August	26.0	26.0	7.2	8.3	1,018	3,308	16.70	43.22
September	26.3	26.0	8.6	8.1	1,527	4,326	9.89	33.81
October	27.4	27.1	7.0	7.9	4,072	5,090	9.37	23.63
November	24.0	23.0	8.2	7.1	6,689	6,362	15.48	37.68
December	16.0	14.2	6.5	7.2	5,689	6,871	16.70	49.90
January	20.0	19.4	6.9	7.0	8,653	6,,871	19.15	28.45
February	26.0	24.0	7.3	7.1	7,635	7,126	6.25	30.16
Mean	26.9	26.4	7.4	7.6	4,459	5,595	11.94	28.23
±SD	9.89	9.67	4,26	4.79	3,589	1,597	4.96	10.1

Table 2: Mean Monthly Values of Turbidity, D0, BOD5, Phytoplankton and Zooplankton Density obtained from some ponds in Kano metropolis (March 2011- February 2012)

	Turbidity		DO		BOD_5		Phytoplankton**(mg/l)**		Zooplankton**(mg/l)**	
Month	Site A	Site B	Site A	Site B	Site A	Site B	Site A	Site B	Site A	Site B
	20.1	2.6	5.8	5.2	4.7	1.1	7,635	5,344	9.37	26.42

March										
April	23.5	2.3	6.9	5.0	3.1	1.1	7,126	8,653	13.10	10.60
May	30.1	2.3	5.1	5.5	3.1	2.4	3,817	3,054	5.30	174.0
June	70.4	5.2	3.3	5.8	5.1	2.2	1,527	5,853	4.89	19.55
July	143.0	70.0	6.6	7.2	5.6	3.1	763	5,090	17.10	25.66
August	93.5	63.0	6.7	7.1	6.4	2.1	1,018	3,308	16.70	43.22
September	45.5	25.4	5.4	7.4	4.3	4.2	1,527	4,326	9.89	33.81
October	32.6	9.2	6.9	7.9	4.0	3.2	4,072	5,090	9.37	23.63
November	30.0	18.0	6.9	7.9	4.9	3.3	6,689	6,362	15.50	37.68
December	31.6	12.0	6.3	7.2	3.9	3.0	5,689	6,871	16.70	49.90
January	28.5	9.4	6.8	6.5	4.6	2.7	8,653	6,.871	19.20	28.45
February	25.6	3.0	6.2	5.5	4.1	1.2	7,635	7,126	6.25	30.16
Mean	47.9	18.4	6.1	6.1	4.5	2.5	4,459	5,595	11.90	28.23

Table 3: Mean Monthly Values of Alkalinity, Phosphate, Nitrate, Phytoplankton and Zooplankton Density obtained from some ponds in Kano metropolis (March 2011 - February 2012)

	Nitrate (mg/l)		Phosphate(mg/l)		Phytoplankton(mg/l)		Zooplankton(mg/l)	
Month	Site A	Site B	Site A	Site B	Site A	Site B	Site A	Site B
March	12.2	9.40	5.13	8.80	7,635	5,344	9.37	26.42
April	12.2	12.0	5.71	8.30	7,126	8,653	13.07	10.60
May	9.16	14.1	7.23	9.60	3,817	3,054	5.30	174.0
June	13.7	1.80	6.00	5.10	1,527	5,853	4.89	19.55
July	2.33	4.27	3.33	3.20	763	5,090	17.11	25.66
August	2.00	6.17	2.68	2.39	1,018	3,308	16.70	43.22
September	1.26	3.37	2.40	2.00	1,527	4,326	9.89	33.81
October	3.71	6.27	1.11	2.50	4,072	5,090	9.37	23.63
November	6.33	6.00	9.74	1.27	6,689	6,362	15.48	37.68
December	8.42	5.10	10.0	1.67	5,689	6,871	16.70	49.90
January	8.23	5.00	7.30	3.00	8,653	6,.871	19.15	28.45
February	9.20	7.65	5.13	6.24	7,635	7,126	6.25	30.16
Mean	7.38	6.76	5.48	4.51	4,459	5,595	11.94	28.23
±SD	4.26	3.55	2.81	3.01	3,589	1,597	4.96	10.17

Table 4: Mean Monthly Value of Iron, Lead, Magnesium, Zinc, Phytoplankton and Zooplankton Density obtained from some ponds in Kano metropolis (Mach 2011 - Feb 2012)

	Iron (mg/l)		Lead (mg/l)		Magnesium (mg/l)		Zinc (mg/l)		Phytoplankton (mg/l)		Zooplankton (mg/l)	
Month	SiteA	SiteB	SiteA	SiteB	SiteA	SiteB	SiteA	SiteB	SiteA	SiteB	SiteA	SiteB
March	4.71	4.13	BTL:	0.003	1.37	6.12	BTL	BTL	7,635	5,344	9.37	26.42
April	1.77	1.33	BTL	BTL	0.50	1.35	BTL	BTL	7,126	8,653	13.07	10.60
May	3.15	2.45	0.001	0.001	0.87	2.41	BTL	BTL	3,817	3,054	5.30	174.0
June	0.79	0.58	0.001	BTL	0.48	0.27	BTL	BTL	1,527	5,853	4.89	19.55
July	0.70	1.23	BTL	0.003	0.20	1.12	BTL	BTL	763	5,090	17.11	25.66
August	0.62	0.42	BTL	0.001	0.60	0.89	BTL	BTL	1,018	3,308	16.70	43.22
September	0.32	0.26	BTL	0.001	0.15	0.73	BTL	BTL	1,527	4,326	9.89	33.81

October	0.10	0.18	BTL	0.002	0.19	0.33	BTL	BTL	4,072	5,090	9.37	23.63
November	0.16	0.09	0.002	0.001	0.26	0.30	BTL	BTL	6,689	6,362	15.48	37.68
December	1.02	0.06	0.002	BTL	0.67	0.16	0 .01	BTL	5,689	6,871	16.70	49.90
January	1.50	1.12	0.001	BTL	1.03	2.50	0 .01	BTL	8,653	6,.871	19.15	28.45
February	2.40	1.50	0.001	BTL	1.11	2.30	BTL	BTL	7,635	7,126	6.25	30.16
Mean	1.44	1.11	0.001	0.002	0.62	1.54	0 .01	BTL	4,459	5,595	11.94	28.23
±SD	1.39	1.19	0.001	0.001	0.40	1.68	0.00	0.00	3,589	1,597	4.96	10.17

Table 5: Checklist for the Occurrence, Distribution and Abundance of Phytoplankton Density Obtained from some Ponds in Kano Metropolis (March 2011 - February 2012)

	Site			
Taxon	**A**	**B**	**Total (org/l)**	**Frequency (%)**
Diatom				
***1**. Stephandiscus spp.*	20,360	20,360	40,720	1.45
Flagellate				
***2**. Mallomonas spp.*	-	52,800	52,800	1.88
Green Algae				
***3**.Ankistrodesmus fecutus*	539,480	427,560	967,040	34.43
***4**.Actinastrum gracillimum*	183,240	91,600	274,840	9.79
***5**.Polyedriopsis spinulosa*	203,600	122,160	325,760	11.60
***6**.Scendesmus dimophus*	-	142,520	142,520	5.08
***7**.Sirogyra communis*	132,320	122,160	254,480	9.09
***8**.Spirulina subblissima*	-	48,000	48,000	1.71
***9**.Tetraspora gelatnosa*	427,560	213,760	641,320	22.83
***10**.Ulothrix zonata*	30,520	30,520	61,040	2.17
Total (org/l)	1,537,080	1,271,440	2,808,520	100
Frequency/site (%)	7 (50.00)	10(71.43)	10(100)	

Table 6: Checklist for the Occurrence, Distribution and Abundance of Zooplankton Density Obtained from some Ponds in Kano Metropolis (March 2011 - February 2012)

S/N0	Taxon	Site A	Site B	Total(org /l)	Frequency (%)
	Protozoa				
1	*Arcella*spp.	-	40.94	40.94	12.14
2	*Orkomonas*spp.	-	-	20.32	5.93
	Copepoda				
3	*Tigriopus*spp.	78.62	27.09	111.0	32.91
	Rotifera				
4	*Brachoinus*spp.	-	32.99	37.88	11.23
5	*Kerateli*aspp.	-	36.66	36.66	10.87
6	*Palvarthra*spp.	4.89	19.96	24.85	7.37
	Flagellates				
7	*Cytomonas*spp	-	52.55	-	15.58
	Nematoda				
8	*Plectus*spp.	31.78	43.59	75.37	22.35
	Total(org/l)	83.51	253.78	337.29	
Frequency/site (%)		3(36.36	7(63.64)	7(100.0)	8(100)

Table 7: Diversity Indices of phytoplankton sampling obtained from some ponds in Kano metropolis During March 2011 to February 2012

Diversity Indices	Site *A*	Site B
Shannon-Wiener Diversity Index (HI)	1.32	2.00
Evenness Index (JI)	0.00	0.01
Berger-Parker Index of Dominance (DBP)	0.63	0.52

Margalef Index of Species Richness (D)	0.57	0.83
Odum's Index	0.02	0.02

Table 8: Diversity Indices of zooplankton sampling obtained from some ponds in Kano metropolis during March 2011 to February 2012

Diversity Indices	SiteA	Site B
Shannon-Wiener Diversity Index (HI)	0.75	1.90
Evenness Index (JI)	0.002	0.005
Berger-Parker Index of Dominance (DBP)	0.96	0.38
Margalef Index of Species Richness (D)	0.42	0.37
Odum's Index	2.60	2.76

Parameters February	**Phyt**	**Temp**	**pH**	**Turbidity**	**DO**	**BOD_5**	**Alkalinity**	**Nitrate**	**Phosphate**	**Iron**	**Lead**	**Magnesium**	**Zinc**	**Zoop**
Phyt	1	-0.724	0.841	-0.932	0.881	-0.861	-0.239	0.220	0.221	-0.826	0.949	0.447	-1.000**	0.446
Temp		1	-0.924	0.924	-0.312	0.974	0.843	0.514	0.513	0.987	-0.470	-0.941	1.000**	-0.996
pH			1	-0.980	0.486	-0.999*	-0.726	-0.343	-0.342	-1.000*	0.629	0.860	-1.000**	0.960
Turbidity				1	-0.651	0.987	0.574	0.147	0.147	0.974	-0.772	-0.74	1.000**	-0.884
DO					1	-0.519	0.248	0.655	0.655	-0.463	0.985	-0.029	1.000**	0.222
BOD_5						1	0.700	0.307	0.306	0.998*	-0.658	-0.840	1.000**	-0.949
Alkalinity							1	0.895	0.894	0.744	0.078	-0.975	1.000**	-0.890
Nitrate								1	1.000**	0.367	0.515	-0.774	1.000**	-0.592
Phosphate									1	0.367	0.516	-0.774	1.000**	-0.592
Iron										1	-0.608	-0.873	1.000**	-0.967
Lead											1	0.143	-1.000**	0.385
Magnesium												1	-1.000**	0.968
Zinc													1	-0.280
Zoop														1

** = Correlation is significant at $p<0.01$ level, '-' indicate negative correlation; * = Correlation is significant at $p<0.015$level, DO= Dissolved Oxygen, BOD= Biochemical Oxygen Demand, phyt = phytoplankton, zoop = zooplankton

CONCLUSION

From the result of this study, it was concluded that limnological parameters play a significant role in determining water quality and productivity. Plankton richness and abundance decreases from site A to site B and to site C. This was due to the increase in frequency of occurrence of phytoplankton and zooplankton per site (50.00, 71.43 and 36.36) and (36.36, 63.64 and 63.64) for site A, B and C respectively.

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