

The Plankton as Indicators of Water Quality in Kusalla Reservoir: A Shallow Man Made Lake

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Abstract: The composition, abundance and distribution of the plankton of Kusalla reservoir was studied between June 2006 and May 2007. With the aim of assessing the responses of the plankton to seasonal and spatial changes. Plankton samples were collected monthly from six sampling stations using standard methods. Eighteen species of phytoplankton belonging to four taxa were recorded. Twenty species of zooplankton from four taxa were observed. There was significant seasonal and spatial variation ($p=0.05$) in the distribution of the phytoplankton and zooplankton. There was significant positive correlation ($r = 0.7689$) between the distribution and abundance of phytoplankton and zooplankton in Kusalla reservoir. Shannon-Weiner index of 5.17, 4.24 and 5.24 for stations 1, 2 and 6 respectively indicate that these stations have a relatively high species diversity and therefore are not polluted. The distribution of the plankton shows that they are sensitive to changes in levels of nutrients and other interactions with one another and with other factors. As such the plankton can be good indicators of water quality.

Key Words: Composition, Distribution, Kusalla, Plankton

I. Introduction

The word plankton originates from the Greek word meaning "wandering" According to Hosetti and Kumar (2002), Plankton is a collective term used to describe all those organisms whose power of movement are insufficient to prevent them from being moved by water currents. The Plankton can be classified in different ways, this include whether they are true or false plankton, their nutritional requirements (Phytoplankton and zooplankton), their size, their environments, and their life history. Kusuma *et al.*, (1988) state that there is great diversity in the composition of plankton not only in different seasons and at different depths, but also at different hours, and probably even in different years in the same place and depth.

The plankton constitute the main producers in any given water body. According to Biddanda and Benner (1997) one of the main sources of carbohydrates in many aquatic systems is phytoplankton, where biomass is typically made up of from 15 to 35% carbohydrate. The production of dissolved compounds from phytoplankton is caused by direct exudation, predation and viral lysis. Direct exudation of dissolved organic carbon from phytoplankton is variable but most often varies within 5 to 20% of the primary production, so when phytoplankton are growing, carbohydrates are actively released in large amounts, and can contribute up to 70% of the Dissolved Organic Carbon (DOC) (Sondergaard *et al.*, 2000).

Both phytoplankton and zooplankton are used in various ways as indicators of water quality. The quality of water, especially of eutrophic waters is essentially determined by the quantity of algae. Drinking water supply, recreational activities and fisheries can be impaired by high phytoplankton biomass. Therefore, water quality management has to monitor the phytoplankton content in order, for instance to come up with preventive measures such as aeration to prevent fish kills during the decay of the planktonic biomass (Imhof and Alberrecht, 1975). According to Khatri (1987) based on the distribution pattern of the plankton the quality of the environment can be assessed. Abubakar (1998) Observed that the seasonal and spatial distribution of phytoplankton in Salanta River can be used as an index to describe the level of pollution in the river. Zooplankton is mainly applied as species-indicators of saprobity or atrophic state of the system. For a long time, the use of zooplankton community characteristics as a tool in bioindication has been considered of rather low information value. However, zooplankton indices based on e.g. taxonomic composition, size distribution, trophic levels, spatial patterns, and functional characteristics and quantitative data may be of high informative potential and should not be overlooked in monitoring studies (Andronikova, 1996).

Lovik and Kjellberg (2003) observed that trophic changes in lake environments could be highlighted through the study of the structure and composition of the planktonic communities, and the observation of the principal physical and chemical parameters of the waters. Such changes allow us to draw useful pictures about the state of water quality in the lake and on its trophic state. The objective of the present study is to assess the

composition of the plankton, determine their responses to seasonal and spatial variations and to assess their diversity indices in the reservoir.

II. Materials And Methods

Study Area

Kusalla reservoir is located at Kusalla village on latitude 10⁰02`N-11⁰00`N and longitude 11⁰42`E-12⁰42`E. It is in the Sudan savanna zone of Nigeria, with two distinct seasons (wet and dry). The rainy season period lasts from May to October and dry season from November to April. Kusalla reservoir is approximately 90km southwest of Kano city. The dam was impounded in 1969 and commissioned in 1970. It has two major tributaries, river Kunkun and river Makugara. It covers about 200heactres with about 17.3 million cubic meters water capacity. About 1million people depend on the dam for their water supply, irrigation, livestock farming and fishing.

Sampling Stations

Six sampling stations were chosen for the study. Station 1 at the dammed site where human activities like washing, bathing, are taking place. Station 2 at the tower point where there are less human activities. Station 3 at the deepest part of the reservoir and station 4 near the middle of the Dam. 5th station at the entrance point of river Makugara and 6th station at the entrance point of river Kunkun both of which are rivers supplying water to Kusalla reservoir (Figure 1.)

Collection of Plankton

Sample of plankton were collected using plankton net of mesh size 70um (microns). The net was tied to a metal rod, and immersed into the water, towed for a fixed distance, and hauled out of the water. The water (containing plankton) that was collected in the plastic bottle at the end of the net was emptied into sample bottles and preserved with 4% formalin, for zooplankton and Lugol's solution, for phytoplankton (Vollenweder, 1974, Wetzel and Likens, 1979). The volume of water that passed through the net was then estimated by using the following formula:

$$V = \pi r^2 d$$

Where V = volume of water filtered by the net, r = radius of the mouth of the net and d = length of the haul (Downing and Rigler, 1982).

Plankton Enumeration

On coming to the laboratory, the phytoplankton samples were condensed by centrifuging 100ml of the sample to10ml. The concentrated sample was taken for enumeration with Sedgwick-Rafter counting chamber. Identification was done to species level, using keys in Palmer (1980) for phytoplankton and Jeje and Fernando (1986) for zooplankton. Data collected were subjected to analysis of variance (ANOVA), Pearson's product moment correlation coefficient and Duncan's multiple range tests.

III. Results

Results of the seasonal and spatial distribution of phytoplankton in Kusalla reservoir is presented in table 1. The phytoplankton was generally more numerous during the rainy season (June-October).

Table 1: monthly values of phytoplankton per station (ind/l)

Station	1	2	3	4	5	6
Month						
June 2006	230	223	154	124	72	255
July 2006	241	223	167	141	84	271
August 2006	262	234	180	154	95	276
September 2006	222	201	142	125	87	224
October 2006	163	157	121	100	71	187
November 2006	123	139	110	80	53	169
December 2006	102	112	80	64	43	127
January 2007	80	93	64	51	34	106
February 2007	72	71	56	44	30	97
March 2007	61	72	76	49	35	89
April 2007	95	95	91	72	43	114
May 2007	168	146	105	87	59	152

The phytoplankton biomass was higher in stations 6 and 1. And it was lower in stations4and 5. Stations 1,2 and 6 had the highest biomass of phytoplankton in the reservoir. The phytoplankton is made up of 18 species from 4 taxa. The chlorophyta dominates the taxa with 36.25%, this is followed by the Cyanophyta (30.06%), Bacillariophyta (27.66%) and Dinophyta (7.03%). The phytoplankton showed significant variation (p=0.01) in distribution both seasonally and spatially.

The zooplankton of Kusalla reservoir consists of four classes, with twenty species of zooplankton. The zooplankton is dominated by the Cladocera both in terms of number of individuals and number of species. The Cladocera makes up 37.95% of the zooplankton with 8 species. This is followed by the Copepoda with 4 species making up 26.60%, the Rotifera with 5 species makes up 19.69% and the Protozoa makes up 15.76% with 3 species. There was significant seasonal and spatial variation ($p=0.05$) in the distribution of the zooplankton. There was significant positive correlation ($r = 0.7689$) between the distribution and abundance of phytoplankton and zooplankton in Kusalla reservoir.

Shannon-Weiner index of 5.17, 4.24 and 5.24 for stations 1,2 and 6 respectively indicate that these stations have a relatively high species diversity and therefore are not polluted. But stations 3 and 4 with indexes of 2.11 and 1.81 respectively have relatively lower species diversity suggesting possible pollution.

Table 2: mean distribution of zooplankton in Kusalla reservoir and the diversity indices of the stations

Station	1	2	3	4	5	6	Total
Protozoa							
<i>Euglena Spp</i>	17	12	7	2	8	15	61
<i>Paramecium Spp</i>	13	9	6	3	11	14	56
<i>Chlamydomonas Spp</i>	19	17	11	5	18	21	91
Cladocera							
<i>Daphnia Spp</i>	25	16	9	5	12	18	85
<i>Simocephalus Spp</i>	11	3	5	4	13	14	50
<i>Ceriodaphnia Spp</i>	22	19	17	2	11	15	86
<i>Bosmina Spp</i>	18	17	9	7	15	15	81
<i>Macrothria Spp</i>	12	19	10	4	24	18	87
<i>Polyphemis Spp</i>	10	7	2	2	9	12	42
<i>Eurycerus Spp</i>	7	5	0	0	3	5	21
Copepoda							
<i>Diaptomus Spp</i>	12	19	5	3	12	10	61
<i>Cyclops Spp</i>	25	17	12	5	19	21	99
<i>Namplii Spp</i>	24	19	15	7	18	22	105
<i>Eubranchipus Spp</i>	11	10	8	3	12	8	52
Rotifera							
<i>Kellicottia Spp</i>	17	12	11	8	21	26	95
<i>Keratella Spp</i>	21	11	9	4	18	16	79
<i>Brachionus Spp</i>	15	12	3	0	5	7	42
<i>Chromogaster Spp</i>	19	2	5	0	7	9	44
<i>Rotaria Spp</i>	18	16	7	4	9	5	59
Mean No of Ind. (N)	298	276	88	43	212	315	784
No. of Species (S)	19	19	18	15	19	19	
Shannon-Weiner Index (D)	5.17	4.24	2.11	1.81	3.98	5.24	
Euenness Index (E)	0.975	0.866	0.621	0.311	0.921	0.986	

IV. Discussion

The composition of plankton in Kusalla reservoir agrees with the findings of several workers in Nigerian waters. Abdullahi and Indabawa (2005) show that the phytoplankton of River Hadejia consists of Chlorophyta (40%), Cyanophyta (30%) Bacillariophyta (24%), Euglenophyta (35), Dinophyta 1%) and Chrysophyta (0.6%). Lamai and Kolo (2003) studied the zooplankton of Dan-Zaria dam and observed about 40 taxa dominated by the Rotifers (35.38%), Protozoa (27.03%) Cladocerans (25.54%) and the Copepoda (12.05%).

The quality of any given water body is influenced by physical and chemical factors. These physico-chemical parameters interact with one another and with more than one parameter at a time to greatly influence the water quality characteristic. Many workers have carried out studies on the effect of different physico-chemical parameters on aquatic organisms. Lovik and Kjellberg (2003) observed that trophic changes in lake environments could be highlighted through the study of the structure and composition of the planktonic communities, and the observation of the principal physical and chemical parameters of the waters. Such changes allow us to draw useful pictures about the state of water quality in the lake and on its trophic state. Studies by Boyd *et al.*, (2000) have shown that the mineral element iron can cause increased blooms of many kinds of phytoplankton. The composition and abundance of phytoplankton and zooplankton in a water body clearly indicates the health status of the water body. The plankton show different responses to different environmental conditions. According to Pannard *et al.*, (2007) depending on the season the phytoplankton responses differed with respect to nutrient and light conditions, and to the intensity of stratification and mixing. The high abundance of phytoplankton in stations 1,2 and since, coincided with entry points of nutrients into the reservoir. According to several workers, nutritive substances chiefly determine the abundance of plankton of any place. According to Walker *et al.*, (2001) the input of nutrients, is the most significant factor affecting phytoplankton biomass and distribution in the Nyara estuary. They showed that when not receiving pulses of nutrients through freshwater inflow the estuary is a predominantly low nutrient, low phytoplankton biomass,

stratified system, dominated by microbial food web. However, this state is altered rapidly by flood events. Barlow *et al.*, (2006) are of the opinion that because of upwelling, phytoplankton biomass and composition, in Namibian waters are highly variable.

The conditions that lead to maxima and minima, as well as to minor fluctuations or abundance of any particular plankton are complex, in their physical, chemical and biological aspects. According to Hosetti and Kumar (2002), Plankton communities are always in the process of change. At any spot changes may occur in the kind of phytoplankton and zooplankton that are present and in the relative and absolute number of the several species. Investigation in Namibian waters revealed that during spring, diatoms dominated Phytoplankton communities while the flagellates were dominant in summer, and Dinoflagellates and prokaryotes were present throughout.

Zooplankton densities in pelagic zones of water bodies are low, but considerably higher in shallow littoral zones. Isumbiso *et al.*, (2006) observed that each year, the total crustacean zooplankton of Lake Kivu increased to a distinct seasonal maximum following a rise of phytoplankton production associated with a deep epilimnetic mixing in the dry season. This dependence on phytoplankton suggests that zooplankton in Lake Kivu is mainly bottom-up controlled. This opinion is in conformity with the findings of the present study which shows positive correlation between the distribution of phytoplankton and zooplankton.

V. Conclusion

The phytoplankton are responsible for a percentage of all primary production in any given water body. The zooplankton, fish and other organisms in turn graze upon the phytoplanktons. Therefore, the availability of phytoplankton directly affects the abundance and distribution of zooplankton. The seasonal and spatial distribution of the plankton in this study shows they are sensitive to changes in levels of nutrients and other interactions with one another and with other factors. As such the plankton can be good indicators of water quality.

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