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Limnological features of Ikere Gorge Reservoir, Iseyin south-western Nigeria: Plankton composition and abundance

Kehinde Festus Olasehinde[1*], Ayoade Adedolapo Abeke[2]

[1]*Institute for Human Resource Development, University of Agriculture, Abeokuta, Ogun State*

[2]*Department of Zoology, University of Ibadan, Ibadan, Oyo State Nigeria*

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Abstract

A study of plankton composition of Ikere gorge reservoir Iseyin, South Western Nigeria was conducted from July to December 2007. The plankton taxa encountered were- Protozoa (10), Rotifera (9), Copepoda (4) Cladocera (4), Ostracoda (1), Insecta (1), Arachnida (1), Cyanophyceae (7), Bacillariophyceae (8), Chlorophyceae (22) and Euglenophyceae (1). Chlorophyceae were more abundant among phytoplankton throughout the study period with highest species richness index (2.4) while Copepods dominated the zooplankton fauna. No mark spatial variation was observed except for Bacillariophyceae. Rotifera, Ostracoda, Cyanophyceae, Bacillariophyceae and Chlorophyceae are higher during the raining season months than dry season months but only Chlorophyceae showed significant difference. Some indicators of pollution, *Microcystis*, *Anabaena*, and *Oscillatoria*, were encountered. The high relative abundance of Chlorophyceae and Copepoda is an indication that the reservoir will support fish production.

***Corresponding Author:** Kehinde Festus Olasehinde ✉ gloriousolad004@yahoo.com

Introduction

The knowledge of plankton composition of any water body is of paramount importance based on its vital roles to the productivity of water body. The state of any water body can easily be estimated based on the plankton community of such water and plankton had been used as indicator of water quality. Micro algal components respond rapidly to perturbations and are suitable bio-indicators of water condition which are beyond the tolerance of many other biota used for monitoring (Nwankwo and Akinsoji, 1992). Dakashini and Soni (1982) used the distribution of diatoms to reflect the average ecological condition of water bodies. Munawar (1972) used the Euglenoids as biological indicators of pollution. Other algae generally associated with organically enriched waters include *Scenedesmus* (Vanlandingham, 1976), *Cladophora*, *Euglena*, *Nitzschia*, *Phacus* and *Closterium* (Clasterlin and Reynolds, 1977; Munawar, 1972, 1974). Phytoplankton is very important for the growth and development of young fishes but their excess growth also causes death to fish. They have been discovered to deplete the quality of oxygen in any water body they inhabit (Graham, 1986). Zooplankton constitutes the major food item of the pelagic fishes particularly their larvae (Olaniyan, 1975; Quasim, 1977) and they inturn feed on phytoplankton. It has been observed that small crustaceans seem to be the most suitable invertebrates for introduction into reservoirs rich in phytoplankton.

Some reports exist on the plankton populations of several water bodies in Nigeria. These include those of River Sokoto (Green, 1960); Eleyele reservoir, Ibadan (Imevbore, 1965) and River Osun (Egborge, 1972). Others include New Calabar River (Nwadiaro and Ezefili, 1986; Chindah, 1998); Oguta Lake (Nwadiaro and Oji, 1986), and Nkisa and Orashi Rivers River State (Yakubu *et al*., 2000). Studies on the identification of Nigerian planktonic organisms include the works of Adeniyi (1978), Jeje and Fernando (1986), Kadiri (1988) and Opute, (2000).

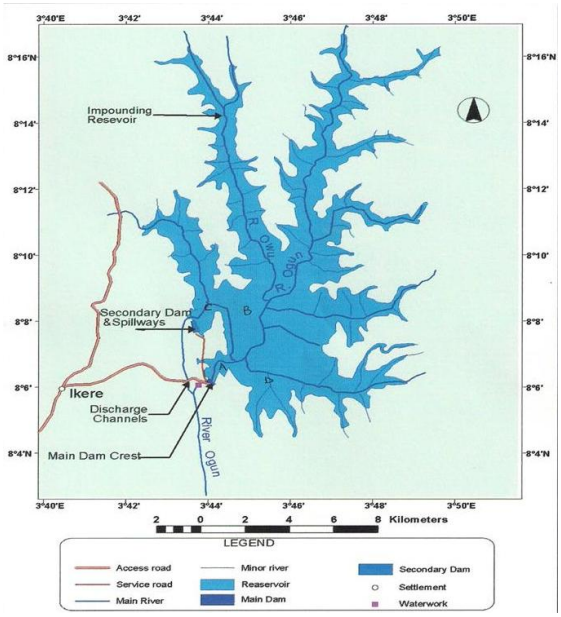

Fig. 1. Map showing Ikere Gorge Reservoir.

Plankton composition, abundance and distribution are affected by season as well as the prevailing physico-chemical condition of the water body. There is little or no previous study on the plankton composition of Ikere gorge reservoir and knowledge of this will enhance its effective management and productivity.

The aim of this research work is to provide baseline data on plankton composition of Ikere gorge reservoir on which there is dearth of information.

Materials and methods

Study area

Ikere gorge reservoir is a man-made lake, located in upper Ogun River 8 kilometers east of Ikere village and 40 kilometers North East of Iseyin in Oyo State, Nigeria. Ikere gorge reservoir takes its source between longitude 80 101 and 80 201 and latitude30 401 and 30 501 N (Fig. 1). Toward the Southern part of the reservoir were hills primarily made of rock and gravels. The rivers that run down to the dam have gravels and sand as their major substrate (Adebisi, 1981). The water bed comprised mainly of fine and coarse sand particles and gravels. Along the bank of the reservoir are distributed forest and savanna trees and aquatic grasses and

shrubs. There were several pieces of dead wood projecting out of the water. July and September are the period of heavy rainfall and November is the onset of dry season in the western part of Nigeria. The reservoir experienced frequent current as a result of wind that blows on it from time to time. Sometimes, the current results to wave action which frequently spread across the reservoir and sometime it could be violent particularly during the raining season. The reservoir was formed by damming River Ogun - main source- River Owu and River Amaka which are minor tributaries. River Ogun is part of the dense network of inland water course that flows southwards into Lagos Lagoon. The reservoir has a storage capacity of 565 x 106m3. The reservoir was constructed by Ogun-Osun River Basin Development Authority in 1990. It was constructed primarily for the following purposes: Provide water to Iseyin, Okeho, and Iganna and environ, supplement out water supplies to Abeokuta and Lagos, provide irrigation water for 12,000ha, to generate 6 megawatt of hydro-electricity. Also, about 90% of the people comprising of people from seven villages around the reservoir have fishing as their primary occupation.

Four sampling stations were selected along the length of the reservoir for the present study.

Station A: this is located at the core of the reservoir around the workshop (a 50m tower built at the core of the reservoir) toward the embankment of the reservoir.

Station B: this is located at the region where River Owu, one of the Ogun river tributaries, entered into the reservoir. It is about 3.5 kilometers away from station A. Fishing is the only noticeable human activity in Stations A and B.

Station C: this site is located very close to the spillway and the landing centre of the fishermen. It is about five hundred meters away from station B.

Station D: this is at the eastern part of the reservoir and very close to the landing centre of the fishermen at a village called Bendel. It is about two kilometers east of station A. Domestic activities like bathing, fetching of water, washing of cloth and fishing nets takes place in Stations C and D.

Collection and analyses of plankton

Plankton were collected with plankton net (75meshes/linear cm), which is 50cm deep and with circular opening diameter 20cm. A standard sweep was made by dragging the net along the side of the water for about 2 meters, turned and dragged back through the same distance (Oladimeji and Wade, 1984). The samples collected were preserved immediately in 4% formalin. Identification was made with the works of Pennak, (1978); Kadiri, (1988); Jeje and Fernando (1992); Okusanmi and Odu, (1992); Yoloye, (1994); Graham and Wilcox (2000); and Opute (2000). The counting of the plankton was done by counting each cell as individual, that is, total count (Tash, 1971).

Data analysis

Analysis of variance (ANOVA) was used to test for statistical difference between the mean of the plankton of the four stations (Ogbeibu, 2005). Student t-test was used to determine the difference between the plankton in the rainy season and dry season months. The bio-diversity indices used to determine the diversity of the plankton were Shannon and Weiner diversity index (H1), Equitability/Evenness (E), and Species richness index (d) (Ogbeibu, 2005).

Results

Composition and relative abundance of plankton

There were 67 genera of plankton encountered out of which 38 were phytoplankton and 29 were zooplankton (Table 1). Chlorophyceae (82%) were more abundant than other phytoplankton followed by Bacillariophyceae (12%), Cyanophyceae (7%) and Euglenophyceae (0.02%) was the least abundant (Fig.2). Out of 21 genera of Chlorophyceae, Staurastum (52.06%) were encountered most frequently in all the sites followed by Eudorina (14.26%), Closterium (13.53%), Volvox, (5.30%) and Protococcus (3.03%). Apiocyst, Cladophora,

Table 1. Plankton composition, distribution and abundance in Ikere gorge reservoir, Iseyin.

Plankton	Abundance/ml					Percentage
			PHYTOPLANKTON			
Chlorophyceae	A	B	C	D	Total	%
Apiocyst	2	0	0	0	2	0.05
Chlorella	27	9	7	3	46	1.09
Chlorococcum	3	2	4	7	16	0.38
Cladophora	0	12	4	0	16	0.38
Chlamydomonas	6	0	2	19	27	0.64
Closterium	255	227	60	39	572	13.53
Cosmarium	26	29	14	1	70	1.66
Eudorina	45	291	213	54	603	14.26
Gonatozygon	16	13	6	9	44	1.04
Microspora	29	17	21	17	84	1.99
Monostroma	1	2	0	3	6	0.14
Mougeotia	12	11	10	11	44	1.04
Pleurotaenum	15	12	20	14	61	1.44
Protococcus	51	24	35	18	128	3.03
Richterella	3	0	0	0	3	0.07
Sphaerocystis	0	8	0	0	8	0.19
Spirogyra	3	17	4	7	31	0.73
Staurastum	705	725	458	313	2201	52.06
Tetraedron	0	1	0	3	4	0.09
Tetraspora	3	0	0	0	3	0.07
Ulothrix	17	10	5	3	35	0.83
Volvox	74	62	52	36	224	5.3
TOTAL	**1293**	**1472**	**915**	**548**	**4228**	**100**
			Cyanopyhceae			
Anabaena	40	46	25	5	116	31.44
Coelospharium	0	3	0	0	3	0.81
Microcystis	72	36	58	5	171	46.34
Nostoc	0	4	0	0	4	1.08
Oscillatoria	5	3	1	1	10	2.71
Polycystis	3	3	2	1	9	2.44
Total	**120**	**95**	**86**	**68**	**369**	**100**
			Bacillariophyceae			
Asterionella	3	13	2	0	18	3.31
Cymbella	51	44	42	24	161	20.6
Diatoma	16	15	9	5	45	8.27
Eunotia	0	1	4	0	5	0.92
Navicula	9	1	1	0	11	2.02
Nitzschia	30	7	22	9	68	12.5
Stephanodiscus	46	33	34	28	141	25.92
Synedra	32	38	17	8	95	17.46
Total	**187**	**152**	**131**	**74**	**544**	**100**
Euglenophyceae						

***Euglena* spp**	3	1	3	2	9	100
			ZOOPLANKTON			
			Protozoa			
Bursella	0	1	0	0	1	2.13
Chilodonella	1	0	4	1	6	12.77
Coleps	0	1	2	1	4	8.51
Glaucoma	4	1	6	0	11	23.40
Podophrya	4	1	0	0	5	10.64
Stylodium	0	0	0	1	1	2.13
Tokophyna	0	1	0	0	1	2.13
Trachlophlum	2	0	0	0	2	4.26
Uroglenopsis	4	0	5	0	9	19.15
Xanthidium	3	3	0	0	6	12.77
Total	**18**	**8**	**17**	**3**	**47**	**100**
			Rotifera			
Asplanchria	1	0	0	0	1	1.35
Branchionus	6	1	4	0	11	14.86
Dicranophorus	11	0	2	0	13	17.57
Forcipate jaw	1	0	0	0	1	1.351
Keratella	12	2	1	0	15	20.27
Lecane	2	2	6	0	10	13.51
Philodina	1	1	0	0	2	2.70
Pleosoma	5	0	0	6	11	14.86
Trechocerca	2	1	2	6	11	14.86
Total	**41**	**7**	**15**	**11**	**74**	**100**
			Copepoda			
Calanoid	24	25	22	53	124	27.87
Cyclopoid	79	79	62	49	269	60.45
Harpacoid	4	3	3	4	14	3.15
Nauplius larvae	19	23	17	14	73	16.40
Total	**126**	**130**	**104**	**85**	**445**	**100**
			Cladocera			
Daphnia spp	44	27	28	4	103	66.03
Diaphonosome	10	4	10	4	28	17.95
Moina	1	1	2	0	4	2.56
Total	**55**	**32**	**40**	**29**	**156**	**100**
			Insecta			
Insecta spp	19	29	15	14	77	100
			OSTRACODA			
Cypridopsis	4	1	0	0	5	100
			Arachnida			
Water mite	2	4	6	3	15	100

Table 2. Seasonal variation in plankton abundance of Ikere gorge reservoir, Iseyin using student t-test.

PLANKTONIC GROUPS	PLANKTON SEASONAL ABUNDANCE (ml)		STUDENT t-test	
Groups	Raining Season Months	Dry Season Months	t-value	Probability(p)
PHYTOPLANKTON				
Cyanophyceae	338	31	2.143	P>0.05
Bacillariophyceae	342	202	0.694	P>0.05
Chlorophyceae	4026	202	2.524	P>0.1*
Euglenophyceae	1	8	-0.1610	P>0.05
ZOOPLANKTON				
Protozoa	32	15	0.086	P>0.05
Rotifera	66	8	1.732	P>0.05
Copepoda	266	179	-0.061	P>0.05
Cladocera	106	50	0.587	P>0.05
Ostracoda	5	0	1.279	P>0.05
Arachnida	10	5	0.238	P>0.05
Insecta	38	39	-0.977	P>0.05

*Significant at 10%

Table 3. Spatial variation in mean plankton abundance of Ikere gorge reservoir, Iseyin.

PLANKTON ABUNDANCE (cell/ml)					ANOVA	
Groups	**A**	**B**	**C**	**D**	**F –value**	**Probability(P)**
PHYTOPLANKTON						
Cyanophyceae	120	95	86	68	0.111	P>0.05
Bacillariophyceae	214	161	138	35	2.872	P>0.01*
Chlorophyceae	1293	1473	915	939	0.445	P>0.05
Euglenophyceae	3	1	3	2	1.533	P>0.05
ZOOPLANKTON						
Protozoa	18	8	17	3	0.799	P>0.05
Rotifera	41	7	15	11	1.112	P>0.05
Copepoda	126	130	104	85	0.296	P>0.05
Cladocera	55	32	40	29	0.683	P>0.05
Ostracoda	4	1	0	0	1.042	P>0.05
Arachnida	2	4	6	3	0.414	P>0.05
Insecta	19	29	15	14	0.171	p>0.05

*Significant at 10%.

Monostroma, Richterella, Sphaerocystis and Tetraedron were encountered either once or twice during sampling in few stations (Table 1). Microcystis (46.34%) and Anabaena (31.44%) were encountered more frequently in all the stations among Cyanophyceae and Coelospharium (0.81%) and Nostoc (1.08%) occurred only in station B. Stephanodiscus (25.92%) Cymbella (20.60%), Synedra (.46%) and Nitzschia (12.50%) were encountered more frequently in all the stations among Bacillariophyceae while Asterionella (3.31%), Eunotia (0.92%) and Navicula (2.02%) occurred only in few stations. Euglenophyceae occurred less frequently in all the stations.

Copepoda (54%) were more abundant than other zooplankton followed by Cladocera (19%), Rotifera and Insecta, (9% each), Protozoa (6%), Arachnida (2%) and Ostracoda (1%) was the least abundant (Fig.3). Among the Protozoa, Bursella (2.13%), Stylodium (2.13%), Tokophyna (2.13%) were encountered once during sampling. Also, Asplanchria (1.35%) and Forcipate jaw (1.35%) were encountered once during sampling among Rotifera. All the four genera of the Copepoda were encountered frequently in all the four stations. Daphina occurred in all the stations throughout the period of sampling. Likewise Insecta and Arachnida occurred throughout the sampling station. Ostracoda was rarely encountered during the sampling period.

Seasonal and spatial variation of plankton in Ikere gorge reservoir

All the plankton taxa were more abundant in rainy season except Euglenophyceae and significant difference between the seasons was only recorded in Chlorophyceae, Table 2. Variations were recorded in the abundance of plankton taxa with sites and more plankton were encountered in site B. Only Bacillariophyceae differed significantly between stations (P>0.01).

Biotic diversity indices

For phytoplankton, Chlorophyceae had the highest Species Richness Index (d=2.4) and highest Shannon Index (2.0). Bacillariophyceae had the highest Evenness Index (0.9), Fig.4. For Zooplankton, Protozoa had the highest Species Richness Index (2.3), Rotifera had the highest Evenness Index (0.9) and both Protozoa and Rotifera had the highest Shannon Index (2.0). (Fig. 5)

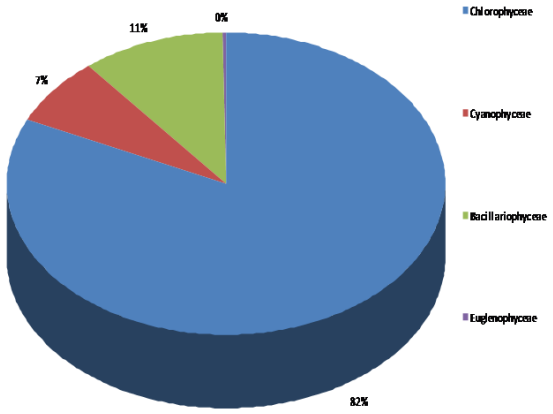

Fig. 2. Abundance of Phytoplankton Taxa of Ikere Reservoir, Iseyin.

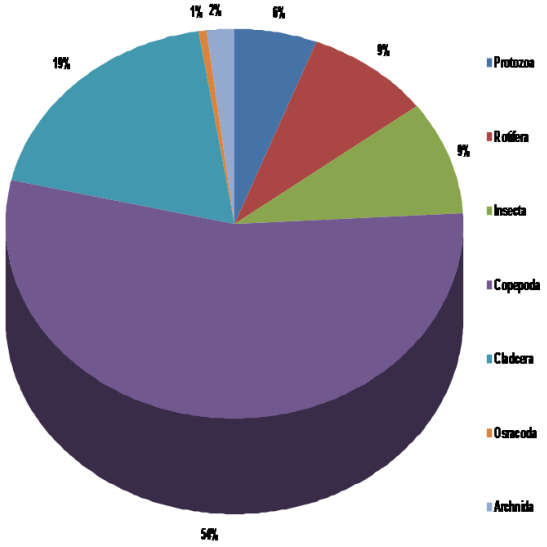

Fig. 3. Abundance of Zooplankton Taxa of Ikere Reservoir, Iseyin.

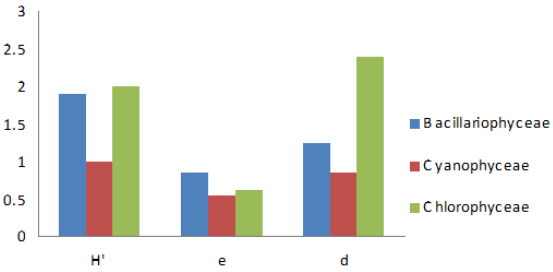

Fig. 4. Phytoplankton Diversity Indices of Ikere Gorge Reservoir.

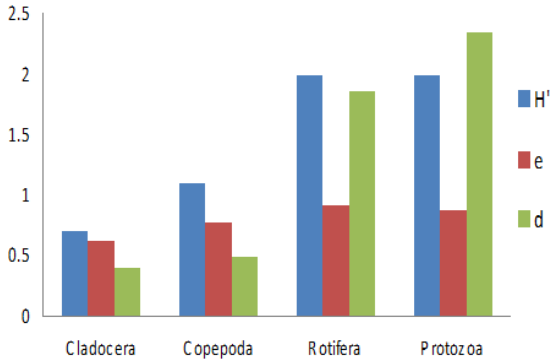

Fig. 5. Zooplankton Diversity Indices of Ikere Gorge Reservoir.

Discussion

There were more species of Chlorophyceae encountered during the study than any other group and this indicates that the water is productive. Bacillariophyceae has been reported to dominate water with low nutrient levels while Cyanophyceae identifed with water of high organic nutrient level but Chlorophyceae was identified with water of moderate nutrient (Osuji et al., 2003). Water with high relative abundance of Chlorophyceae has been identified as being productive (Barnabe, 1994). Seasonallity had significant effect on Chlorophyceae and this is due to drastic change in transparency which greatly affect Chlorophyceae abundance. Tranparency is the major factor that determine the photic property of water and the water with low transparency receive little light illumination which directly affect the density of green algae. Kehinde and Ayoade (in press) reported higher transparency of Ikere Gorge reservoir in rainy season months which coincided with period of abundant Chlorophyceae. Cyanophyceae being the least abundant of the three main phytoplankton encountered suggest that the water is not polluted. High abundance of Cyanophyceae normally signifies polluted water as observed by Oben (2000). Eutrophication has been identified as one of the major controling the abundance of Cyanophyta (Akin-Oriola, 2003a). They proliferate and sometime form noxious bloom in fresh water enviroments (Reynolds, 1984). Cyanophyceae peak abundance that was obtained in rainy season months may be as a result of influx of nutrients into the reservoir. Some of the genera encountered; Microcystis, Anabaena, Oscillatoria, are identified with polluted water and are used as index of pollution (Sowunmi, 2001; Akin-Oriola, 2003a and Aneni and Hassan, 2003). Bacillariophyceae exhibited the greatest diversity and equitability in the reservoir during this study and this was also observed by Aneni and Hassan (2003) in Kudeti and Onireke stream. They further emphasized that seasonal fluctuation has an impact on overall equitability on phytoplankton species.

The investigated impoundment seems rather poor quantitatively in rotifers composition and the few species of rotifer encountered during the study is in contrast to what is obtainable in Nigerian water as rotifers dominate the zooplankton community. Rotifers occurred mostly during the raining season and this may be attributed to the influx of water from the tributaries into the reservoir. Akinbuwa and Adeniyi (2008) also reported the maximal abundance of rotifers during the raining season in Opa reservoir. The most abundant rotifers recorded agreed with the work of Sowunmi (2001), who found Lecane, Branchionus and Keratella as dominant species. In the work of Ayodele and Adeniyi (2005) who investigated the six impoundments on River Osun, Branchionus, Keratella and Lecane dominated the Rotifers assemblage. The highest Evenness index and highest biodiversity index recorded for Rotifera had been reported also by many authors among who are Aneni and Hassan (2003). The ability of rotifers to undergo vertical migration, which minimizes competition, was attributed by Moss (1988) as responsible for their high species diversity. The high Evenness index implies that rotifers were more evenly distributed in the resevoir than any other zooplankton. The dominance of Copepod among the zooplankton of the reservoir during this study may be attributed to the presence of food. This agrees with the works of Oben (2000) in Awba reservoir, and Sowunmi (2001) in Ologe lagoon, Nigeria. The

Cyclopoid being dominant group of Copepods agrees with Akin-Oriola (2003a) where Cyclopoid dominate the copepods in Ogunpa and Ona rivers. Oben (2000) who investigated three manmade lakes namely Awba, Golf and Main Lakes found that Cyclopoid (Thermocyclop) dominated the Copepod community. The further dominance of Copepod during the dry season confirms their preference for lentic condition particularly the Cyclopoid. Many works have revealed that Cladocera occurred and abound most in water with high organic nutrient. In the work of Saliu and Eruteyal (2006) who investigated the gutter in Lagos metropolis found that Cladocera was the most abundant zooplankton in the gutter with high organic constituent. In the work of Oben (2000), Cladocera occurred most in Golf Lake a situation attributed to high organic nutrient. Golf lake had the highest BOD over the two other lakes investigated 26mg/l an index of high organic enrichment. The low concentration of Cladocera encountered in this reservoir may be as a result of low organic nutrient. Low species spectra of Cladocera recorded was also observed by Jeje and Fernando (1992), in Niger-Sokoto River; Akin-Oriola (2003a) in Ona and Ogunpa River, and Aneni and Hassan (2003) in Kudeti and Onireke stream in Oyo State. High concentration of Cyanophyta have been identified as one of the major factors affecting the abundance of Cladocera as they cannot effectively grazed upon the filamentus blue-green alga (Fernando, 1980; Akin-Oriola, 2003; Aneni and Hassan, 2003). Since the level of blue green algae is low in this reservoir during the study, this may not necessary contribute to the low abundance of Cladocera. Other factor like size-selective fish predation may also contribute to the low abundance of Cladocera. Monthly variation in protozoan abundance during this period may be due to changes in water level and oxygen content (Green, 1963), high organic content (Sowunmi, 2001) and the phytoplankton concentration (Michael, 1969). The higher abundance of protozoan in August (a rainy season month) coincided with the period of flood as well as high abundance of phytoplankton. The protozoan maximal apparently coincided with full flood and early dry season as observed by Egborge, (1970) and Sowunmi, (2001) for different inland water. Homogenity exists within the reservoir despite the wide surface area and this can be atributed to frequent water current across the reservoir. Station B which had the highest species richness could be due to the proximity of this station to where River Owu join River Ogun. The poor community structure obtained from station D may be as a result of lower level of nutrient concentration in this station as reported by Kehinde and Ayoade (in press).

Conclusion

Cyanophyceae is the least abundant of the three main phytoplankton encountered which indicate that the reservoir is not polluted. The high relative abundance of Chlorophyceae as well as crustacean indicates that the Ikere gorge reservoir is highly productive.

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