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Research Article

The Physico-chemistry and Plankton Diversity of Awba Reservoir University of Ibadan, Ibadan Nigeria

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Abstract: The physico-chemical parameters and plankton diversity of Awba Reservoir, University of Ibadan was sampled from April to July, 2011. Surface water samples were collected for physico-chemical parameters. Values of the physico-chemical parameters observed ranged as follows: water temperature, 24-26.5°C; air temperature, 22-23. °C; transparency, 0.2-0.4 m; pH, 7.3-8.4; total dissolved solids, 143.8-159.5 mg/L; conductivity, 290.8-391.5 µmhos/cm; salinity, 0.11-0.19%; dissolved oxygen, 0.7-1.8 mg/L and alkalinity, 0.8-1.7 mg $CaCO_3$/L. Thirty six taxa of plankton were encountered. Phytoplankton consisted of five families namely; Cyanophyceae, Chlorophyceae, Euglenophyceae, Bacillariophyceae and Dinophyceae. Three groups of zooplankton encountered were copepods, cladocerans and rotifers. The presence of pollution indicator species such as, *Microcystis*, *Phacus*, *Oscillatoria*, *Surirella Closterium*, *Aphanocapsa*, *Anabeana* and *Euglena* show that the Reservoir is likely polluted.

Keywords: Physico-chemical parameters, plankton, pollution and Awba reservoir

INTRODUCTION

Reservoirs are very large natural or artificial lakes that provide habitat and food for many species of fish and wildlife (Dinar *et al*., 1995). They are constructed for domestic use where large natural lakes are sparse and unsuitable for human exploitation, enhancement of fisheries and improvement of water transport. Freshwater ecosystems have been used for the investigation of factors controlling the abundance and distribution of aquatic organisms (Atobatele and Ugwumba, 2008; Esenowo and Ugwunba, 2010). Changes in the physico-chemical parameters may positively or negatively affect the biota of water bodies in a number of ways such as their survival and growth rate and these may eventually result in disappearance of some species of organisms or its reproduction (Edward and Ugwumba, 2010). Light penetration, temperature, water current and salinity affect the distribution of plankton and other organism (Spodniewska, 1974).

Planktonic communities are influenced by the prevailing physico-chemical parameters and these determine their abundance, occurrence and seasonal variations (Rothhaupt, 2000). Plankters respond quickly to environmental changes because of their short life cycle, hence, their species composition are more likely to indicate the quality of the water which they are found. The relative abundance of chlorophyll is indicative of productive water (Jenkerson and Hickman, 2007). Diatomic species such as *Nitschia*, *Gyrosignma* and *Epithemia* are known to avoid acid water and very low concentration of calcium and magnesium (Mason, 1990). Dense surface blooms of blue-green algae are regarded as indicator of potential productivity in fish pond, while increase of *Cyclotella* species is an indicator of acidification (Mason, 1991).

Awba Reservoir, University of Ibadan is a man-made lake that serves as a source of water supply to the water treatment plant for domestic uses in the University. The Awba Stream serves as a sink for the disposal of untreated effluents from the student residential halls, Zoological Garden, Faculty of Science laboratories and its environment. Knowledge of physico-chemical parameters and plankton of any body of water is not only useful in assessing its productivity, but would also allow for a better understanding of its biota. Several studies have been carried out in Awba Reservoir, Ita (1993) earlier studied the food and feeding relationship of the fishes in the lake and the feeding cycle of *Tilapia zilli*, while Ugwumba and Ugwumba (1993) also studied the physico-chemical hydrology and plankton of Awba Reservoir. Physico-chemical parameters and biota of any water body is known to change overtime and so the need to know the prevailing conditions the physic-chemical parameter and plankton abundance of the Awba Reservoir.

MATERIALS AND METHODS

Study area: Awba Reservoir lies between latitude 7° 26^1-7° 27^1 N and longitude 3° 53^1-3° 54^1 E, south

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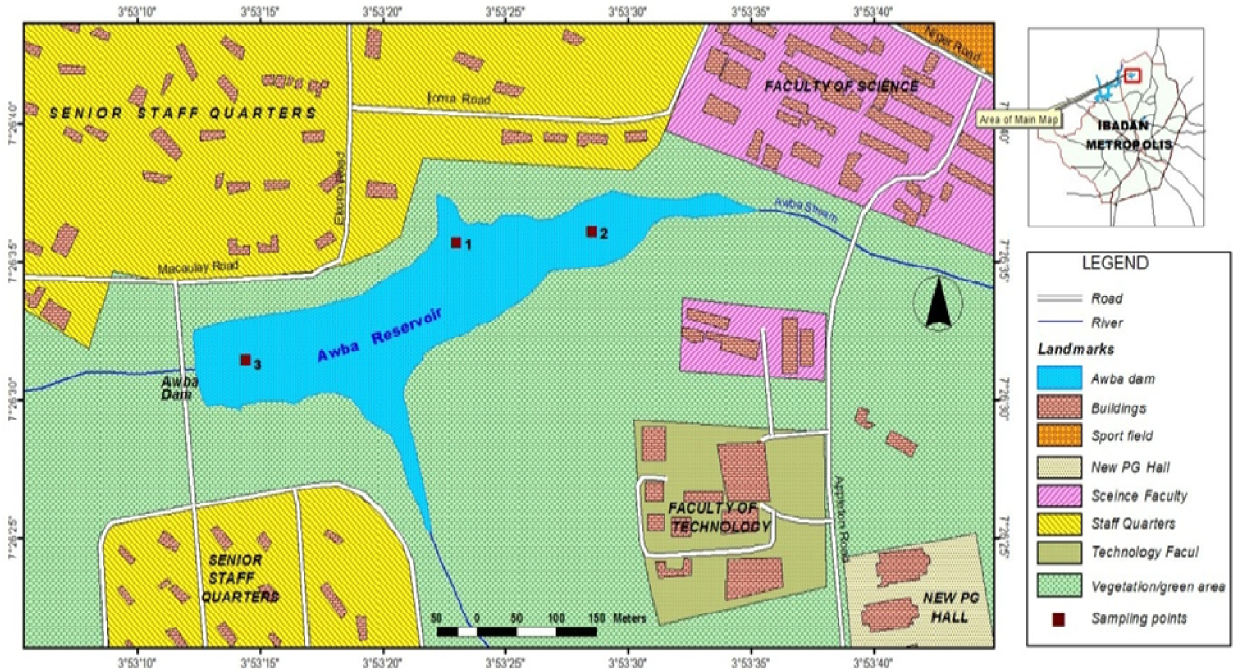

Fig. 1: Map of University of Ibadan showing Awba reservoir and sampling stations (■ 1-3)

western of the University of Ibadan (Fig. 1). The reservoir was constructed in 1964 and expanded to its present size in 1971 by damming the Awba Stream at a point where it flowed through a natural valley. The dam is about 8.5 m high, 110 m long with a crest of about 12.2 m. The reservoir has a maximum length of about 700 m and a maximum depth of 5.5 m with a surface area of about 6 ha (Ugwumba and Ugwumba, 1993). Throughout the year, the water remains relatively constant, while excess water is made to spill away.

Three sampling stations were chosen for the study in the reservoir. Station 1 was located at the entrance point to the reservoir facing Macaulay Road and behind Faculty of Science Lecture Theatre. Station 2 was located at the back of Imo Street adjacent to the reservoir and close to Faculty of Technology. Station 3 is positioned near the dam wall.

Determination of physico-chemical parameters: Surface water samples were collected monthly from April-July, 2011. The physico-chemical parameters determined were pH, conductivity, total dissolved solids, dissolved oxygen, alkalinity and salinity. Temperature and transparency were measured *in situ*. Air and surface water temperature was determined using a centigrade mercury-in-glass thermometer of range 10-110°C and the results were expressed in degrees Celsius (°C). The hydrogen ion concentration (pH) was determined in the laboratory using Buffered electronic pH meter. Salinity, TDS and conductivity were measured using an Extech meter Model ExStik EC400. Transparency was measured using a secchi disc. Dissolved oxygen concentration was determined using using the azide modification of the iodometric method as reported by Greenberg *et al*. (1998). Alkalinity was measured with LaMotte Freshwater Aquaculture Test Kit Model AQ-2. The results were expressed as mg/L.

Plankton samples were collected with a plankton net (55 µm) mesh size, just below the surface water. Samples collected in 250 mL bottles were immediately fixed and preserved in 4% formalin solution in the field according to Onyema (2007). The preserved plankton samples was allowed to settle first and 5 mL of the sample was withdrawn and placed in Sedge-wick rafter counting chamber using a pipette and observed under the microscope. Keys provided by Prescott (1954), Whitford and Schumacher (1973), Needham and Needham (1962), Jeje and Fernando (1986, 1991), Maosen (1978), APHA/AWWA/WEF (1998) and Nwankwo (2004) were used for identification of the plankton species. The total number of organisms per millilitre for each sample was determined by simple calculation after counting the number in the 5 mL sub-sample examined. Cells of phytoplankton were counted. Biological data for plankton was analyzed using quantitative indices to determine the relative abundance and diversity of species and groups using PAST software.

RESULTS

The physico-chemical parameters of Awba reservoir: Table 1 shows the mean, standard error and range of physico-chemical parameters of Awba Reservoir measured during the study period. Figure 2 to 8 shows the monthly variation of the measured physico-chemical parameters for the study period. The lowest mean air and water temperatures were recorded in June while the highest mean temperature was in April. Transparency was highest in April and lowest in July

Table 1: The mean, standard error and range of physico-chemical parameters of Awba reservoir

Parameters	Mean±S.E	Range
Dissolved Oxygen (mg/L)	1.03±0.370	0.7-1.8
Alkalinity (mg $CaCO_3$/L)	1.24±0.420	0.8-1.95
Conductivity (μmhos/cm)	347.43±36.95	290.75-391.5
Total Dissolved Solids (mg/L)	153.56±5.31	143.7 -159.5
Salinity (ppt)	0.10±0.000	0.11- 0.19
pH	7.98±0.380	7.3 -8.4
Air temperature (°C)	22.75±0.78	22 -23.5
Water temperature (°C)	25.12±1.00	24-26.5
Transparency (m)	2.70±0.660	0.2- 0.4

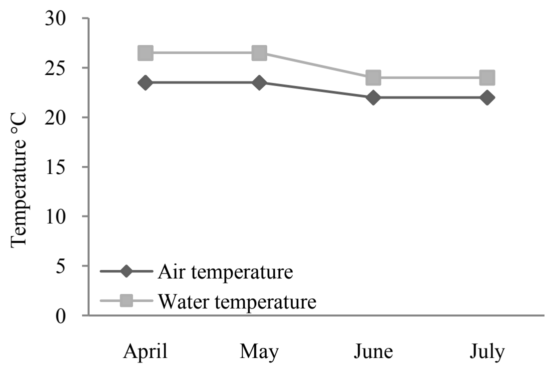

Fig. 2: Monthly variation of temperature

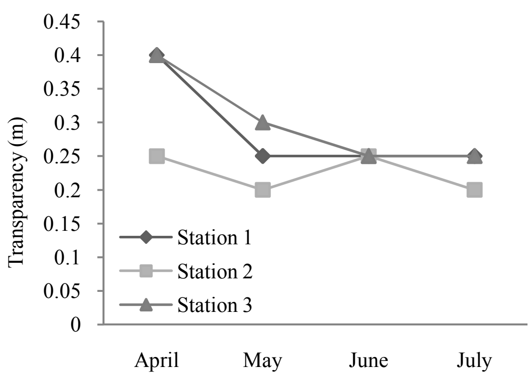

Fig. 3: Monthly variation of transparency (m)

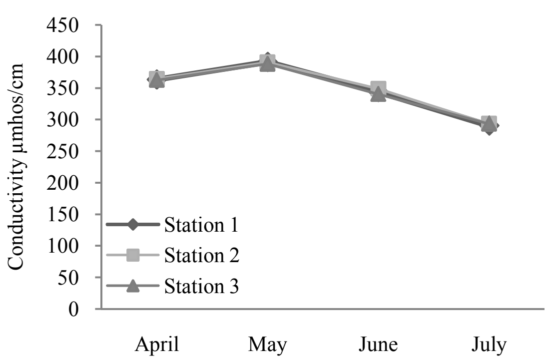

Fig. 4: Monthly variation of conductivity (μmhos/cm)

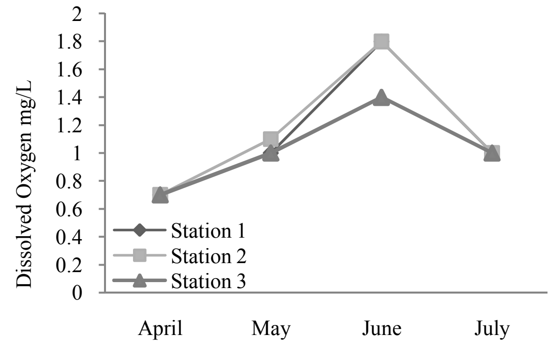

Fig. 5: Monthly variation of dissolved oxygen (mg/L)

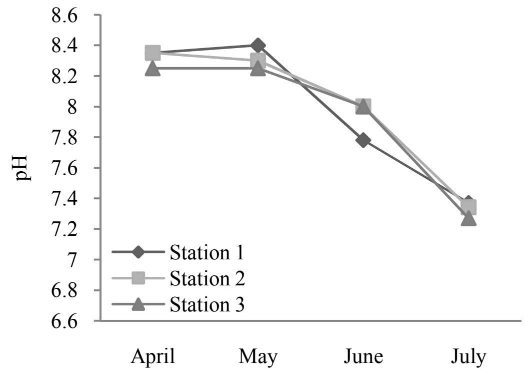

Fig. 6: Monthly variation of pH

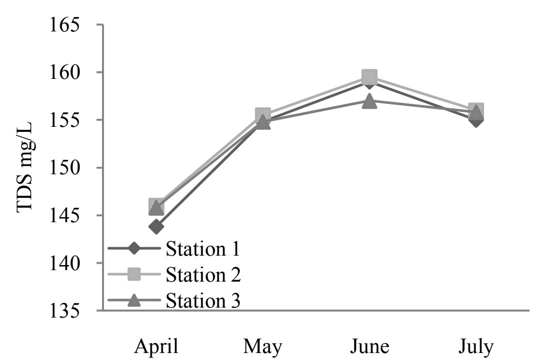

Fig. 7: Monthly variation of TDS (mg/L)

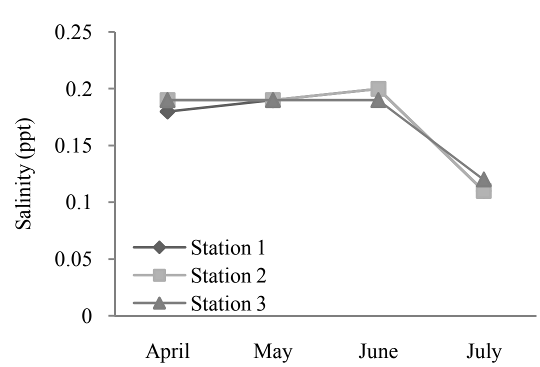

Fig. 8: Monthly variation of salinity (ppt)

Table 2: Correlation co-efficient (r) matrix for the physico-chemical parameters during the study period

	DO	Alkalinity	Conductivity	TDS	pH	Air temp	Water temp	Transparency
DO								
Alkalinity	0.859							
Conductivity	-0.081	0.138						
TDS	0.805	0.819	-0.278					
pH	-0.283	-0.093	0.916	-0.536				
Air Temp	-0.572	-0.471	0.814	-0.684*	0.884			
Water Temp	-0.757	-0.738	0.556	-0.912	0.748	0.911		
Transparency	-0.441	-0.495	0.269	-0.731	0.453	0.465	0.614*	

*: Correlation is significant at ($p<0.05$)

Table 3: The relative abundance of phytoplankton encountered in the reservoir

	No of cell/mL	%
Cyanophyceae		
Microcystis aeruginosa	61157	4700
Anabaena circularis	6196	4.900
Anabaena subcylindrica	46548	35.41
Oscillatoria tenius Agardh	5995	4.810
Oocystis eremosphaeria	2960	2.300
Oocystis solitaria	2728	2.100
Aphanacapsa delicatissima	6868	5.120
Chroococcus cohaerens	8909	6.960
Chlorophyceae		
Scenedesmus bijuga	4904	3.840
Scenedesmus quadricauda	26328	20.00
Ankistrodesmus falcatus	8665	6.800
Microspora floccosa	4772	3.730
Coelastrum sphaericum	7628	5.930
Hyalodiscus sp.	4145	3.200
Closterium setazeum	9126	7.110
Cosmarium sp.	4889	3.820
Staurastrum comptum	3297	2.560
Staurastrum trifidum	3768	3.010
Staurastrum limneticum	648	0.460
Staurastrum sp.	4278	3.320
Gonatozygon monotaenium	6290	4.870
Chlorosarcina minor	5504	4.300
Sphaerocystis schroeteri	5592	4.350
Treubaria triappendiculata	961	0.730
Treubaria crassispina	4940	3.760
Nitzschia sp.	4799	3.750
Euglenophyceae		
Euglena oxyuris schmarda	3728	2.890
Euglena caudata	9122	7.100
Trachelomonas lacustris	3284	2.540
Trachelomonas ensifera	8890	6.840
Trachelomonas tambowica	8680	6.830
Trachelomonas horrida	4913	3.900
Trachelomonas similis stokes	5231	4.060
Trachelomonas hispida	2439	1.930
Trachelomonas spp	5250	4.160
Phacus longicauda	16973	12.87
Phacus suecicus	4500	3.460
Phacus orbicularis	10543	8.310
Bacillariophyceae		
Synedra fasculata	5574	4.31
Cyclotella comta	7587	5.93
Cyclotella kutzingiana	2132	1.53
Stephanodiscus hantzschii	6777	5.10
Suireria tenera	9068	7.14
Tabellaria sp.	4474	3.39
Tabellaria sp.	4723	3.73
Dinophyceae		
Peridinium bipes steia	3394	2.65
Peridinium sp.	1495	1.17
Didinium bolbianii	1942	1.49
Oodinium limneticum	5645	4.32

with mean value of 2.70±0.66. Variation in conductivity recorded a highest mean value in May at Station 2 while the lowest was in July at Station 1.

Table 4: The relative abundance of Zooplankton encountered at the reservoir

	No/mL	%
Cladocera		
Moina sp.	4046	22.16
Copepoda		
Mesocyclops leuckarti	18628	94.92
Thermocyclops neglectus	18854	95.34
Nauplius larvae	5218	29.50
Gastropod egg	3522	19.45
Rotifera		
Ascomorpha saltans	2802	15.54
Platyias sp.	6833	37.74

Dissolved oxygen was lowest in April and highest in June. The highest alkalinity level was recorded in June while the lowest was in April. The lowest TDS value was recorded in station 1 in April while the highest was in station 2 of June. The salinity value of 0.1 ppt. (parts per thousand) was obtained during the study period and this value remained constant with a small increase to 0.19 in station 1 in June. Correlation coefficient (r) values for physico-chemical parameters are presented in Table 2. Air Temperature correlated negatively with TDS ($r = -0.684$; $p<0.05$) while transparency correlated significantly with water temperature ($r = 0.614$; $p<0.05$).

Phytoplankton composition and abundance: Five groups of phytoplankton namely Cyanophyceae, Bacillariophyceae, Chlorophyceae, Dinophyceae and Euglenophyceae were encountered in the reservoir. The most abundant phytoplankton was the blue-green algae, *Microcystis* with a relative abundance of 47% and the least was the dinoflagellate *Peridinium* with a relative abundance of 1.17% (Table 3). Four colonial forms of Cyanophyceae; *Microcystis*, *Aphanocapsa*, *Oocystis* and *Chroococcus* and two filamentous forms; *Anabaena*, *Oscillatoria* were encountered.

Zooplankton composition and abundance: The zooplankton encountered were Rotifera, Crustacea and gastropod eggs. Rotifers included *Ascomorpha* and *Platyias* while Crustaceans were Cladocera and Copepoda. The cladocerans included *Miona* while copepods comprised of *Thermocyclops*, *Mesocyclops* and nauplius larvae. The most abundant zooplankton was the copepod *Thermocyclops* with a relative abundance of 95.34% and the least abundant was the cladoceran, *Moina* with 22.16% relative abundance (Table 4).

DISCUSSION

Physico-chemical parameters: The physico-chemical parameters of Awba Reservoir show variation. These variations may be associated with patterns of water use and rainfall (Ayoade *et al*., 2006). Temperatures were relatively lower in June-July than in April-May. Water temperature values followed closely changes in air temperature. This may be attributed to the sampling time which was between 8:00 and 10:00 am, when the water is warmer than air. The relationship between surface water temperature and transparency were significant positively. This could be possible because light heats the surface of the water before penetrating into other depths. Temperature is an important factor that influences primary production in reservoir (Lewis, 2000). The dissolved oxygen value for the reservoir was very low. This depression in dissolved oxygen level could be due to chemical and biological oxidation process in water. Sources of dissolved oxygen in the aquatic environment include the atmosphere and photosynthesis. This depends on its solubility while a loss of oxygen includes respiration, decay by aerobic bacteria and decomposition of dead decaying sediments (Gupta and Gupta, 2006).

The pH range shows that the reservoir is tending towards alkalinity. Idowu and Ugwumba (2005) recorded pH values ranging from 6.9-9.6, while Ayoade *et al*. (2006) reported a pH range of 6.2-8.5 in Awba Reservoir. This suggests that the reservoir water is good for fish production. Accumulation of free carbon dioxide due to little photosynthetic activities of phytoplankton will lower the pH value of the water while intense photosynthetic activities of the phytoplankton will reduce the free carbon dioxide content resulting in increased pH values (Egborge, 1981; Gupta and Gupta, 2006).

The values of salinity recorded throughout the study period were constant. Salinity was low and show no relationship with other physico-chemical parameters since the reservoir is fresh water and the salt content of a fresh water body is usually low. The fluctuations in total alkalinity of tropical water bodies depend on the location, season, plankton population and nature of the bottom deposits. The values of alkalinity obtained were very low.

The mean value of conductivity (347.44±36.96 µmhos/cm) shows that the conductivity level is intermediate. Conductivity levels below 50 µmhos/cm are regarded as low; those between 50-600 µmhos/cm are medium while those above 600 µmhos/cm are high conductivity (Adeleke, 1982). Akin-Oriola (2003) opined that the conductivity of Awba Reservoir could be regarded as intermediate (239.65±74.31 µhomS/cm).

The Total Dissolved Solid (TDS) values obtained during the study periods were relatively constant all through the stations. This may be due to organic and inorganic substances dissolved and washed into the reservoir by runoffs. The correlation between TDS and air temperature suggests that the dissolved solids in the dam are mainly ionic.

The decrease in transparency from April to July may be due to the increase in turbidity of the water as a result of run-off carried into the reservoir. This agrees with Olaniyan (1969) who reported that the pattern of change of transparency varies inversely with that of turbidity and rainfall and that higher transparency leads to deeper light penetration and consequently a wider depth of photosynthetic activity of phytoplankton.

Plankton composition: The most abundant phytoplankton group in the reservoir during the study period was the Cyanophyceae (blue-green algae). This agrees with the observations of Ugwumba and Ugwumba (1993) that blue-green algae dominated the reservoir. Blue-green algae, mainly *Microcystis* dominated the phytoplankton in Awba Reservoir. *Microcystis* have been reported to dominate the phytoplankton group in Lake George, Uganda (Burgis *et al*., 1973) and Lake Asejire, Nigeria (Egborge, 1979) while *Anabeana*, a filamentous form of blue-green algae was reported to dominate phytoplankton in Lake Rudolf, Kenya and diatoms in Lake Albert (Fish, 1955). The occurrence of *Microcystis*, *Anabaena* and *Aphanocapsa* is a clear indication that Awba reservoir is polluted. This could be as a result of anthropogenic activities, such as chemicals and wastes washed into it from Chemistry and Zoology Departments, washing of clothes and bathing done sometimes around the dam. Cole (1978) reported that in lakes where domestic, agricultural and industrial pollution is accelerated, growth of blue-green algae results in noxious water bloom of such form as *Microcystis* and *Anabaena*. A similar observation was made by Egborge (1972) that *Anabaena* and *Microcystis* are indication of Eutrophication following upwelling in Lake Kainji, Nigeria. The presence of *Oscillatoria* indicates the presence of high concentrations of organic matter and low oxygen content. Rao (1955) reported that *Oscillatoria* are favored by the high concentration of organic matter and low oxygen content.

Crustaceans, mainly copepods dominated the zooplankton community of the reservoir. This was followed by rotifers. Egborge (1981) reported that there was alternation in abundance between crustaceans and rotifers in Lake Asejire resulting in abundance of all zooplankton year round in the Lake. In the present study, copepods were the most abundant throughout the study period. The Cladocerans were represented by *Moina* sp.

The physico-chemical characteristics of the Awba Reservoir varied from station to station. The variations observed showed the effects of these parameters on the water quality and plankton abundance. The presence of pollution indicator phyto and zooplankton species shows that the reservoir is under pollution stress. Immediate action needs to be taken to reduce the increasing levels of anthropogenic activities which have resulted in the pollution of the reservoir thereby reducing the water quality and making the reservoir water unfit for human consumption.

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