Spatio-Temporal Distribution and Abundance of Zooplankton Fauna of Ede-Erinle Reservoir

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Abstract- The study determined the seasonal and spatial variation in the species diversity and abundance of zooplankton fauna in Ede-Erinle reservoir. This was with the view to determining the effects of the physico-chemical characteristics of water on the zooplankton distribution and abundance in the reservoir. A total of 22,628 zooplankters comprising 101 species, 57 genera and five (5) groups (viz. rotifers, cladoceras, copepods, ostracods anddipterans) were collected and identified. The rotifers were the most specious (57 species) while the ostracods were the least (4 species). The copepods were the most abundant (44.8%) while the Dipteran larvae (0.20%) were the least abundant. All the classes of zooplankton occurred in all the stations monitored except the dipteran larvae which were not found in two stations. However, spatial distribution of species varied significantly ($p < 0.05$) within each class. In contrast, all zooplankton classes occurred in the two all seasons, but seasonal species distribution also differed significantly ($p < 0.05$).

Index Terms- Hydrobiology, Aquatic life, Zooplankton, Water quality, Diversity

I. Introduction

The plankton community is a heterogeneous group of tiny plants (phytoplankton) and animals (Zooplanktons) adapted to float in the sea and freshwaters. Their intrinsic movements are so feeble that they remain essentially at the mercy of water current. The plankton population which occurs in an ecosystem is an indication of the physico-chemical characteristics of the water body (Pradhan *et al*., 2008). The overall quality of a water body can be determined from the species diversity and abundance of its plankton community. (Ahmad and Singh, 1989; Dhawan and Karu, 2002; Islam and Bhuiyan, 2007; Rahman and Hussain, 2008; Radhakrishnan *et al*., 2009; Poongodi *et al*., 2009). Plankton species are ubiquitous in nature, existing in all types of water habitat, no matter their quality, be it in clean freshwater, sea water, and polluted waters like industrial and municipal wastewaters (Jafari *et al*., 2011).

Zooplanktons are microscopic drifting animal-like organisms found either at or near the surface of water bodies. Ovie (2011) defined zooplankton as the free-floating, aquatic invertebrates, which are microscopic because of their usual small sizes that range from a few to several micrometres, rarely exceeding a millimetre. Global aquatic ecosystem can be broadly classified using salinity into Freshwater ecosystem and salt water ecosystem, both of which support zooplankton growth. Freshwater ecosystems are inland waters in which reservoirs fall in to and they have low concentration of salts (< 599mg/L). The saltwater ecosystem has high concentration of salt (averaging about 3.5%) (Tideman, 2000). Freshwater habitats can be further divided into two broad groups, the lentic and lotic ecosystems based on the differences in the water residence time and flow velocity (Wetzel, 2001). Freshwater zooplanktons in the tropics comprise predominantly of rotifers, cladocerans, copepods and occasionally the ostracods and insects (Fernando, 2002).

In the hierarchy of the food web, the zooplanktons are the major mode of energy transfer between phytoplanktons and other aquatic animals including fish. They are, thus, the most important biotic components influencing all the functional aspects of all aquatic ecosystems, viz; food chains, food webs, energy flow/transfer and cycling of matter. Generally, they play an important role in fish nutrition, both in aquaculture and capture fisheries. Suresh *et al*. (2011) reported that different environmental factors that determine the characters of water have great importance upon the growth and abundance of zooplankton. Thus, water quality influences zooplankton abundance, clustering and biomass.

Most of the zooplankton species are cosmopolitan in distribution. Many zooplanktons, particularly the Cladocera, exhibit marked diurnal vertical migrations moving away from direct sunlight while the horizontal spatial distribution of zooplankton in lakes is often uneven and patchy (Wetzel, 2001). Pelagic zooplanktons such as cladocerans and copepods also migrate away from littoral areas (avoidance of shore movements) by behavioural swimming responses to angular light distributions. Non-random dispersion of zooplankton is caused by water movements.

The distribution of zooplankton communities depends on many factors, some of which are change of climatic conditions, physico-chemical parameters and vegetation cover. The change in water quality and limnological characteristics from riverine to middle transition and to lacustrine environments create distinct habitats which have bearing on the distribution and abundance of distinct biota inhabiting each zone (Sthapit *et al*., 2008). For example, calanoida are generally abundant in oligotrophic environments while cyclopoids and cladocerans dominate in eutrophic waters (Margaleff, 1983; Wetzel, 1990). Zooplankton abundances range from less than one individual per litre in most oligotrophic waters to up to 500 individuals per litre in eutrophic lakes (Goldman and Horne, 1983).

Zooplankton species succession and spatial distribution result from differences in ecological tolerance to various biotic and abiotic environmental parameters (Marneffe *et al*., 1998). Studies have shown that the zooplankton community is sensitive to extreme variation in flow; thus species composition is changed and the succession of taxa is redirected after flow recession (Tavernini, 2008). This results in different timing for the emergence of rotifers, cladocerans, and copepods from the inundated dry river beds (Jenkins *et* al., 1980; Boulton, 2003). Therefore, a subdivision of diversity in hierarchical scales in stream ecosystems will result from these factors, which represent the interaction of physical and biological processes. In such water bodies, specific adaptations and strategies are important to cope with the variable and commonly extreme conditions (Seminara *et al*., 2008), and such mechanisms may lead to the spatial and temporal segregation of the zooplankton fauna.

Rotifers are potentially cosmopolitan because resting eggs are easily transferred by birds, grazing animals and the wind, and rapid parthenogenetic reproduction also makes it possible to colonize a suitable biotope (Lair, 1980; Ruttner-Kolisko, 1974; cited by Kutikova, 2002). According to Egborge (1994), the typical pattern of seasonal distribution of rotifers in Nigeria freshwater bodies is one of abundance and peaking in the dry season and low densities or total absence in the rainy season. The cladoceras are found in all sorts of freshwaters. Lakes and ponds contain much larger number of forms than rivers do. The greater number of species belongs to the littoral region, living among weeds and feeding on algae and similar organisms with a few species living near the mud. Copepoda are found in all types of waters at all latitudes (Alekseev, 2002). Most are littoral while only few are typically limnetic.

Being heterotrophic in nature, they play a key role in cycling of organic materials in an aquatic ecosystem (Gupta and Sharma, 2007). Ostracods are mainly bottom dwellers of lakes and live on detritus and dead phytoplanktons. These organisms are food of fish and benthic macroinvertebrates. They are fundamentally important in the transfer of energy and nutrient cycling in aquatic ecosystems (Stemberger and Lazorchak, 1994). Among crustaceans, cladocerans may be the best indicator for biodiversity assessment in ponds and small lakes because they are easy to identify, play a key role in food webs, and respond to environmental gradients (Jeppesen *et al*., 2000). Aside their importances in fisheries, some crustacean plankton (cyclopoids) are also ecologically important in suppressing mosquito larvae. They are also known as intermediate hosts in the transmission of many parasites, especially worms. Some pathogenic human bacteria are carried and nurtured by copepods (Alekseev, 2002).

According to Rajagopal *et al*., (2011) zooplankton plays an integral role and serves as bio-indicator and it is a well-suited tool for understanding water pollution status. Zooplankton play important role in bioremediation of heavy metals and other toxic materials, biomonitering of water pollution (Tyor *et al*., 2014) and act as biomarker for water quality assessment for fish production (Pradhan *et al*., 2008; Purushothama *et al*., 2011; Hoxmeier and Wahl, 2004). Zooplankton communities are typically diverse, occurring almost in all lakes and ponds and are highly sensitive to environmental variation. Hence, zooplankton can speak to condition of water body and can be used to assess overall lake health.

In order to properly manage reservoirs or lakes, monitoring of zooplankton communities is needed to predictively model the ecosystem (Deborah and Robert, 2009).

II. Research Elaborations

The Study Area

Erinle Lake is the largest of all water bodies in Osun State, Nigeria. It has many tributaries of which the major inflow rivers, Awon and Erinle, are the main sources of water. The lake basin which is about 342 km extends in width from Longitude 4° 24' E to 4° 35' E and in length from Latitude 7° 45' N to 7° 58' N. The lake itself is located at Longitude 4° 27' E and 7° 46' N (Fig. 1). The surrounding vegetation has a mixture of savannah, light and thick forest, with scattered cultivations due to various human activities (Akinbuwa, 1999). The substratum of the lake is muddy and sandy with scattered logs of wood. The surface area is about 1.25 km (Akinbuwa, 1999); the highest depth of 7.6m was recorded during the study. The sampling points on the lake are shown in (Figure 2.1).

Selection and Description of Sampling Stations

A reconnaissance survey of Ede-Erinle Reservoir was conducted to identify sampling stations based on important ecological landmarks. Eight sampling sites (Stations A-H) were established along the course of the Reservoir for investigation in this study. Four of the sampling sites (A-D) were established on the reservoir while the remaining four sampling sites (Stations E-H) were established on the two major inflows with Stations E and F located on River Erinle and Stations G and H located on River Awon. A Global positioning system (GPS) handset was used to determine the grid coordinates of the sampling sites.

Sample Collection

Field collection from the sampling stations was conducted four times from September 2014 to June 2015, covering both the dry and rainy seasons. The samplings were conducted in September 2014 (rain season), December 2014 (early dry season), March 2015 (dry season) and June 2015 (early rainy season).

Zooplankton Sampling

Zooplankton distribution and abundance were assessed by straining 30 L of water through a 25 cm diameter zooplankton net with a 45 μm mesh size to a concentrated volume of 30 ml. This was preserved in 4% formalin. Zooplankton species in 3 ml concentrate subsample were identified and counted under the scanning (x40) and low power (x100) magnifications. Identification was done using the descriptive keys of Akinbuwa (1999); Alekseev (2002); Brooks (1959); Edmondson (1959); Cander-Lund and Lund (1995); Durand and Lévêque 1980; Egborge (1994); Korinek (2002); Kutikova (2002); Jeje and Fernando (1982; 1986; 1991); Turner and Da Silva (1992); Victor (2002); Wilson and Yeatman (1959).

Community structure was assessed using the indices of species diversity, Simpson's dominance index (S). Abundance of each species was estimated based by multiplying the number in the final concentrate volume (30 ml for 30 Litres) by 1000 and expressed as Organism per m^3 (Org/m^3).

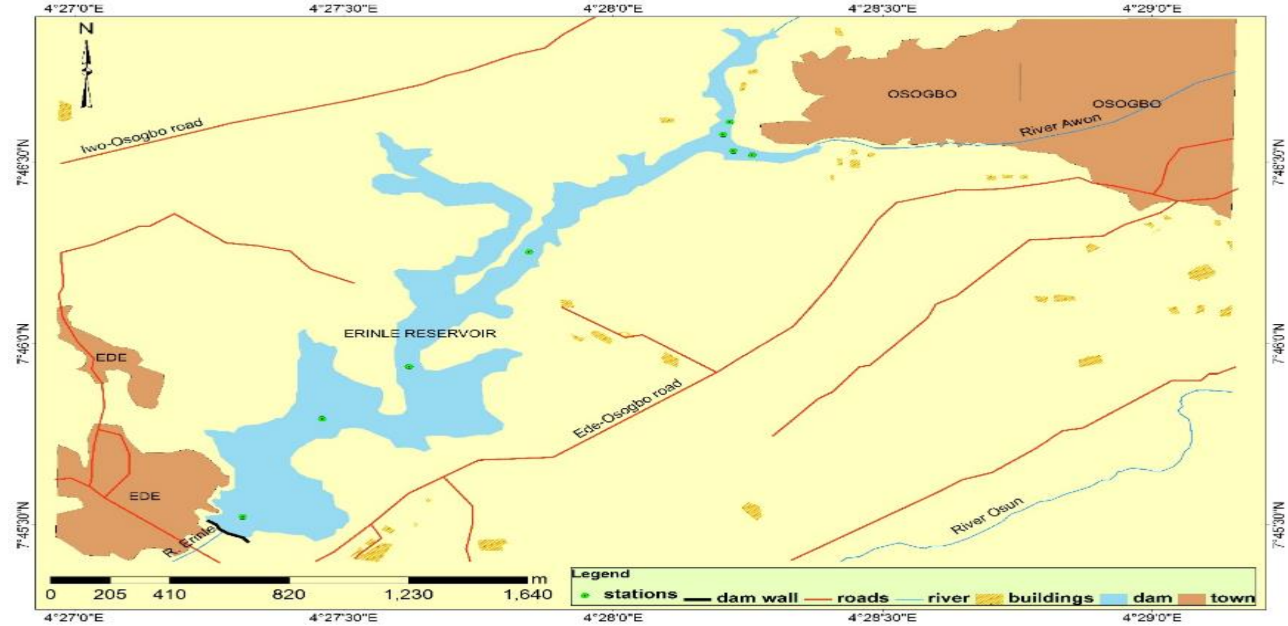

Figure 1: Map of study area showing sampling points

Statistical Analysis of Data

All the data obtained were subjected to appropriate statistical methods using SPSS version 17.0 software. The seasonal and spatial species diversity were analysed using Simpson's diversity index and Shannon and Weiner diversity index (H).

III. RESULTS

Zooplankton Species Diversity, Distribution and Abundance

A total of 22,628 individuals of zooplankton were recovered from the samples during the study period. These comprised five groups of zooplankton species, namely cladocerans, copepods, dipterans, ostracods and rotifers. Numerically, copepods were the most dominant accounting for 41.69% of the total plankton. The dipterans were numerically, the least important accounting for only 0.20% of the plankton (Table I and Fig. 2). Zooplankton abundance in the reservoir thus, followed the order Copepoda > Rotifera > Cladocera > Ostracoda > Diptera. The zooplanktons were present throughout the year and peaked in March (dry season) when nearly half of the plankton (49.76% (11259 Individuals)) was collected. A high species relative abundance of 31.33% was also recorded in the month of June (early rain). Abundances were comparatively low during the rainy and early dry season with species relative abundance of 7.33% and 11.58% respectively (Table II).

Using the Simpson's index of diversity (1 – D), the zooplankton diversity was found to be high both spatially and temporally. The greatest diversity was observed among Cladocera (0.9266) and lowest in Ostracods (0.6653) (Table 4.32). Zooplankton diversity thus, followed the order Cladocera > Rotifera > Diptera > Copepoda > Ostracoda in the reservoir. Nauplii, the developmental stages of Copepoda, were the most common.

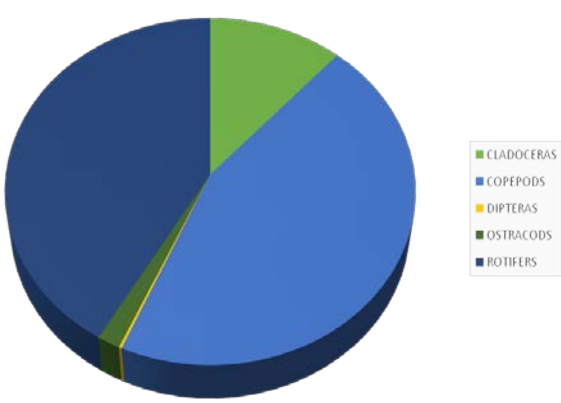

Figure 2: Pie Chart Representation of the Zooplankton Group Abundance

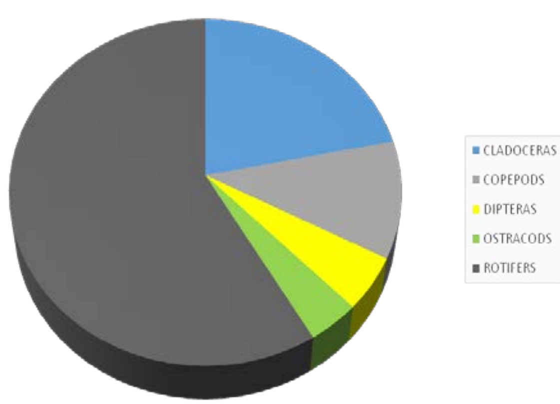

Figure 3: Pie Chart Representation of the Zooplankton Group Richness

Table I: Zooplankton Species Richness, Diversity and Evenness in the Different Zooplankton Groups During the Study Period (September, 2014 – June, 2015).

Indices/Species	Cladoceras	Copepods	Dipteras	Ostracods	Rotifers	Total
Species Richness	22	11	5	4	59	101
Abundance	2632	10142	46	375	9433	22628
Relative Abundance (%)	11.63	44.82	0.20	1.66	41.69	100
Dominance_D ($\Sigma(^n/_N)^2$)	0.07342	0.2531	0.2316	0.3347	0.09723	
Simpson_1-D	0.9266	0.7469	0.7684	0.6653	0.9028	
Shannon_H	2.841	1.77	1.537	1.144	2.965	
Evenness_e^H/S	0.779	0.5335	0.9302	0.785	0.3287	

Table II: Zooplankton Species Richness, Diversity and Evenness across the Seasons During the Study Period (September, 2014 – June, 2015).

Indices/ Seasons	Rainy Season	Early Dry Season	Dry Season	Early Rain Season
Species Richness	30	60	69	74
Individuals	1659	2620	11259	7090
Relative Abundance (%)	7.33	11.58	49.76	31.33
Dominance_D ($\Sigma(^n/_N)^2$)	0.1039	0.07896	0.08497	0.09189
Simpson_1-D	0.8961	0.9210	0.9150	0.9081
Shannon_H	2.688	3.154	3.121	3.208
Evenness_e^$^H/_S$	0.49	0.3906	0.3284	0.3343

Table III: Zooplankton Species Richness, Diversity and Evenness of the Various Stations Sampled During the Study Period (September, 2014 – June, 2015).

Indices/ Station	Station A	Station B	Station C	Station D	Station E	Station F	Station G	Station H
Species Richness	57	49	60	79	64	66	66	64
Abundance	1524	1329	3676	4030	2655	2962	2835	3617
Relative Abundance (%)	6.74	5.87	16.25	17.81	11.73	13.09	12.53	15.98
Dominance_D ($\Sigma(^n/_N)^2$)	0.05718	0.06257	0.0917	0.07351	0.1234	0.0611	0.05067	0.1284
Simpson_1-D	0.9428	0.9374	0.9083	0.9265	0.8766	0.9389	0.9493	0.8716
Shannon_H	3.349	3.164	3.006	3.293	2.98	3.336	3.542	3.035
Evenness_e^H/S	0.4995	0.483	0.3367	0.3407	0.3077	0.4257	0.5232	0.3249

Table IV: Spatio-Temporal Variations in Cladoceras Abundance in Ede-Erinle Reservoir, Osun State, Nigeria (September, 2014 – June, 2015).

Station	Rain		Dry		Overall		T-Test Value	P-Value
	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD		
A	7-47	27±28.28	0-66	33±46.70	0-66	30±31.70	-0.155	0.891
B	0-48	24±33.94	7-40	23.5±23.34	0-48	23.75±23.78	0.020	0.988
C	0-70	35±49.50	0-120	60±84.85	0-120	47.5±58.52	-0.360	0.753
D	3-186	94.5±129.40	7-153	80±103.24	3-186	87.25±95.94	0.120	0.913
E	3-147	75±101.82	3-236	119.5±164.76	3-236	97.25±114.74	-0.330	0.776
F	3-284	143.5±198.70	17-110	63.5±65.76	3-284	103.5±129.36	0.540	0.643
G	3-329	166±230.52	14-161	87.5±103.94	3-329	126.75±152.87	0.440	0.704
H	3-375	189±263.04	0-190	95±134.35	0-375	142±178.958	0.450	0.697
Overall	0-375	94.25±129.90	0-236	70.25±79.67	0-375	82.25±106.70	0.630	0.533
F		0.353		0.259		0.69		
Sig.		0.906		0.954		0.68		

The copepods had the highest abundance among all the zooplanktons with a record value of 10,142 individuals and 44.82% relative abundance during the study period (Table I). The dominant copepods were the nauplii (developmental stages; with approximately 45.13% of the total copeopods), *Diacyclops thomasi, Megacyclops viridis, Metacyclops minutus, Mesocyclops edax, Thermocyclops ermini*, and *Diaptomus* sp. Overall, the number of copepods collected ranged from 50 to 1123 with a mean of 316.94 ± 295.71 Organisms/m^3 (Table V). There was no significant difference in the abundance of organism temporally.

The abundance of diptera recorded at Ede-Erinle Reservoir during the study period ranged from 0-7 and the dominant species discovered was the chironomid larvae. The diptera had the least relative abundance 0.20% in Ede-Erinle reservoir during the study period (Table I). Overall, there was no spatial significant distribution ($p > 0.05$) in the number of dipteras in the reservoir during the study period. Station A and G had significantly the highest number of species among all stations investigated. Conversely, seasonal distribution was significantly different ($p < 0.05$) (Table VI).

As shown in Table VII, the population and abundance of ostracoda was generally low with *Cyclocyprispubera* (having a 75% occurrence (Table IX) and *Cyclocyprisserena* being the dominant species. The relative abundance of ostracods during the study period was low (1.66%) (Table I). The study revealed that the highest number was recorded in station F (26 ± 47.45 Organisms/m^3) and lowest in station H (5.00 ± 10.00 organisms/m^3), although no significant spatial distribution was observed ($p > 0.05$) (Table VII). Temporally, ostracod species were not found in some stations during the rainy season and overall number collected during this season '(4.5 ± 9.702 organisms/m^3) was significantly lower than number collected during the dry season (18.94 ± 24.365 organisms/m^3).

Table V: Spatio-Temporal Variations in Copepod Abundance in Ede-Erinle Reservoir, Osun State, Nigeria (September, 2014 – June, 2015).

Station	Rain		Dry		Overall		T-Test Value	P-Value
	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD		
A	77-174	125.5±68.59	63-240	151.5±125.16	63-240	138.5±83.76	-0.258	0.893
B	79-140	109.5±43.13	103-257	180±108.89	79-257	144.75±78.93	-0.850	0.484
C	97-512	304.5±293.45	143-539	341±280.01	97-539	322.75±235.13	-0.130	0.910
D	96-693	394.5±422.14	97-737	417±452.55	96-737	405.75±357.54	-0.050	0.964
E	96-697	396.5±424.97	60-597	328.5±379.72	60-697	362.5±331.36	0.170	0.882
F	76-425	250.5±246.78	96-597	346.5±354.26	76-597	298.5±255.35	-0.310	0.783
G	72-636	354±398.81	97-523	310±301.23	72-636	332±289.67	0.130	0.912
H	97-853	475±534.57	50-1123	586.5±758.73	50-1123	530.75±539.71	-0.170	0.881
Overall	72-853	301.25±282.74	50-1123	332.63±316.62	50-1123	316.94±295.71	0.296	0.770
F		0.319		0.242		0.728		
Sig.		0.925		0.961		0.650		

Table VI: Spatio-Temporal Variations in Dipteras Abundance in Ede-Erinle Reservoir, Osun State, Nigeria (September, 2014 – June, 2015).

Station	Rain		Dry		Overall		T-Test Value	P-Value
	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD		
A	-	-	-	-	-	-	-	-
B	-	-	3-6	4.50±2.12	0-6	2.25±2.87	-3.000	0.095
C	-	-	0-3	1.50±2.12	0-3	0.75±1.50	-1.000	0.423
D	0-3	1.50±2.12	-	-	0-3	0.75±1.50	1.000	0.423
E	0-3	1.50±2.12	0-3	1.50±2.12	0-3	1.50±1.73	-	-
F	0-3	1.50±2.12	0-3	1.50±2.12	0-3	1.50±1.73	-	-
G	-	-	-	-	-	-	-	-
H	0-6	3.00±4.24	6-7	6.50±0.71	0-7	4.75±3.20	-1.151	0.369
Overall	0-6	0.94±1.81	0-7	1.94±2.54	0-7	1.44±2.23	-1.283	0.209
F		0.633		4.846		2.635		
Sig.		0.72		0.021		0.036		

Rotifera had the richest and second most abundant class of the zooplanktons in Ede-Erinle reservoir during the study period. Its relative abundance was 41.69%) (Table I) and the dominant species included *Brachionus dimitiatus*, *Brachionus angularis*, *Brachionus calyciflorus*, *Asplanchna priodonta*, *Anuraeopsis navicula*, *Brachionus budapestinensis*, *Anuraeopsis fissa*, and *Keratella cochlearis*. Spatially, station B had the lowest number of species while Station C had the highest, but the difference was significant ($p > 0.05$) (Table VIII). However, seasonal distribution was significantly different ($p < 0.05$). The highest mean abundance occurred during the dry season (443.5 $\pm$ 451.752 Organisms/m^3) and the lowest in the rainy season (145.88 $\pm$ 71.054 Organisms/m^3).

Table VII: Spatio-Temporal Variations in Ostracodas Abundance in Ede-Erinle Reservoir, Osun State, Nigeria (September, 2014 – June, 2015).

Station	Rain		Dry		Overall		T-Test Value	P-Value
	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD		
A	-	-	0-40	20±28.28	0-40	10.00±20.00	-1.000	0.423
B	-	-	10-13	11.5±2.12	0-13	5.75±6.75	-7.670	0.017
C	-	-	7-40	23.5±23.34	0-40	11.75±19.12	-1.420	0.290
D	3-23	13±14.14	13-23	18±7.07	3-23	15.5±9.57	-0.450	0.698
E	3-33	18±21.21	0-13	6.5±9.19	0-33	12.25±14.91	0.700	0.555
F	-	-	7-97	52±63.64	0-97	26±47.45	-1.160	0.367
G	0-10	5±7.07	0-20	10±14.14	0-20	7.5±9.57	-0.450	0.698
H	-	-	0-20	10±14.14	0-20	5.00±10.00	-1.000	0.423
Overall	0-33	4.5±9.70	0-97	18.94±24.36	0-97	11.72±19.66	-2.200	0.035
F		0.781		0.471		0.441		
Sig.		0.622		0.832		0.867		

Table VIII: Spatio-Temporal Variations in Rotiferas Abundance in Ede-Erinle Reservoir, Osun State, Nigeria (September, 2014 – June, 2015).

Station	RAIN		DRY		OVERALL		t-test value	P-value
	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD		
A	73-185	129±79.20	7-542	274.5±378.30	7-542	201.75±238.44	-0.523	0.648
B	93-171	132±55.15	80-279	179.5±140.71	80-279	155.75±91.47	-0.440	0.700
C	73-272	172.5±140.71	237-1563	900±937.62	73-1563	536.25±689.98	1.090	0.391
D	146-218	182±50.91	224-1405	814.5±835.09	146-1405	498.25±605.54	-1.070	0.387
E	56-202	129±103.24	105-398	251.5±207.18	56-398	190.25±151.21	-0.750	0.532
F	34-132	83±69.30	346-732	539±272.94	34-732	311±309.43	-2.290	0.149
G	126-190	158±45.26	308-346	327±26.87	126-346	242.5±102.19	-4.540	0.045
H	110-253	181.5±101.12	7-517	262±360.62	7-517	221.75±221.18	-0.300	0.790
Overall	34-272	145.88±71.05	7-1563	443.5±451.75	7-1563	294.69±352.21	-2.600	0.014
F		0.213		0.606		0.628		
Sig.		0.972		0.739		0.728		

Table IX: Species Composition, Richness, Occurrence and % Frequency of Occurrence of Zooplanktons in Ede-Erinle Reservoir, Osun State, Nigeria (September, 2014 – June, 2015). (+ = Presence, - = Absence of Zooplanktons)

	Species Composition	A	B	C	D	E	F	G	H	OCCURENCE	% FREQUENCY
CLADOCERAS	*Diaphanosoma excisum*	+	-	-	+	-	-	+	+	4	50
	Moina micrura	-	-	+	+	+	+	+	+	6	75
	Daphnia magna	-	-	-	+	+	+	+	+	5	62.5
	Diaphanosoma brachyurum	+	+	-	+	+	+	+	+	7	87.5
	Daphnia pulex	+	-	-	-	+	+	+	+	5	62.5
	Daphnia longiremis	+	+	+	-	-	+	-	+	5	62.5
	Daphnia middendorffiana	-	+	+	+	+	+	+	+	7	87.5
	Simocephalus sp	-	-	-	+	-	+	+	+	4	50
	Daphnia longispina	-	-	-	+	+	+	+	+	5	62.5
	Chydorus sphaericus	-	-	-	+	+	+	+	+	5	62.5
	Ceriodaphnia lacustris	-	-	-	-	+	-	+	+	3	37.5
	Bosminia longirostris	+	+	+	+	+	+	+	+	8	100
	Daphnia parvula	-	+	+	+	+	+	+	+	7	87.5
	Diaphanosoma sarsi	+	-	+	+	+	+	+	+	7	87.5
	Simocephalus vetulus	-	+	+	+	+	+	+	+	7	87.5
	Scapholebris mucronata	-	+	+	+	+	+	+	+	7	87.5
	Holopedium gibberum	-	-	-	+	+	+	+	+	5	62.5
	Ceriodaphnia reticulata	-	-	-	+	+	+	+	-	4	50
	Pseudoevadne tergestina	-	-	-	+	+	+	+	+	5	62.5
	Polyphemus pediculus	+	+	+	+	+	+	+	+	8	100
	Podon intermedius	-	+	+	-	-	-	-	-	2	25
	Alona affinis	+	-	+	+	-	-	-	-	3	37.5
COPEPODS	*Diaptomus sp*	-	+	+	+	+	+	+	+	8	100
	Metacyclops minutus	+	+	+	+	+	+	+	+	8	100
	Eudiaptomus gracilis	+	+	+	+	-	-	+	-	5	62.5
	Thermocyclops consimilis	+	+	+	+	+	+	+	+	8	100
	Mesocyclops leuckarti	-	-	-	+	-	-	+	+	3	37.5
	Nauplius	+	+	+	+	+	+	+	+	8	100
	Diacyclops thomasi	+	+	+	+	+	+	+	+	8	100
	Megacyclops viridis	+	+	+	+	+	+	+	+	8	100
	Thermocyclops ermini	+	+	+	+	+	+	+	+	8	100
	Cyclops scutifer	-	-	+	+	+	+	+	+	6	75
	Mesocyclops edax	+	+	+	+	+	+	+	+	8	100

Table 4.42: Species Composition, Richness, Occurrence and % Frequency of Occurrence of Zooplanktons in Ede-Erinle Reservoir, Osun State, Nigeria (September, 2014 – June, 2015). (+ = Presence, - = Absence of Zooplanktons)

	Species Composition	A	B	C	D	E	F	G	H	OCCURENCE	% FREQUENCY
DIPTERAS	*Ceratopogonid sp* larva	-	-	-	-	+	+	-	+	3	37.5
	Chironomid sp larva	-	-	-	+	+	-	-	+	3	37.5
	Hesperocorixa obliqua	-	+	-	-	-	+	-	+	3	37.5
	Chaoborus sp larva	-	+	-	-	-	-	-	+	2	25
	Eristalis sp larva	-	+	+	-	-	-	-	-	2	25
OSTRACODS	*Cyclocypris pubera* O.F. Muller	+	+	+	+	+	+	+	-	7	87.5
	Cyclocypris serena Koch	+	-	-	+	+	+	-	+	5	62.5
	Cyprois occidentalis G.O. Sars	+	-	+	-	-	+	-	-	3	37.5
	Eucypris fuscatus	-	-	-	+	+	-	-	-	2	25
ROTIFERS	*Pompholyx complanata*	+	+	-	-	-	-	-	-	2	25
	Albertia sp	+	+	-	+	+	-	+	+	6	75
	Trichocerca bicristata Gosse	+	+	+	+	+	+	+	+	8	100
	Brachionus angularis Gosse	+	+	+	+	+	+	+	+	8	100
	Brachionus dimitiatus Bryce	+	+	+	+	+	+	+	+	8	100
	Brachionus calyciflorus Pallas	+	+	+	+	+	+	+	+	8	100
	Keratella cochlearis Gosse	+	+	+	+	+	+	+	+	8	100
	Syncheta tremula oblanga Ruther Kolisko	+	+	+	+	+	+	+	+	8	100
	Brachionus budapestinensis	+	+	+	+	+	+	+	+	8	100
	Brachionus pliticelis Muller	-	+	+	+	-	+	+	-	5	62.5
	Brachionus patulus	+	+	+	+	-	+	+	+	7	87.5
	Argonotholca foliacea Ehrenberg	+	+	+	+	+	+	+	+	8	100
	Rotaria neptunia Ehrenberg	-	-	-	+	+	-	-	-	2	25
	Cephalodella gibba Ehrenberg	-	-	+	-	+	+	-	-	3	37.5
	Brachionus falcatus Zacharias	+	+	+	+	-	-	-	-	4	50
	Notholca labis Gosse	-	-	+	+	-	-	-	-	2	25
	Lecane (monostyla) bulla Gosse	-	-	-	+	+	-	+	+	4	50
	Lecane signifera Jennings	-	-	-	+	-	-	+	+	3	37.5
	Brachionus quadridentatus Hermann	-	-	-	+	-	-	-	-	1	12.5
	Trichocerca tigris O.F. Muller	+	-	-	+	+	-	+	+	5	62.5
	Lecane leotina	+	-	+	+	+	+	+	+	7	87.5
	Eothinia sp Harring &Myers	+	-	+	-	+	+	+	-	5	62.5
	Testudinella berzinsi Gillard	+	+	-	+	-	+	-	-	4	50
	Polyathra vulgaris Carlin	-	-	-	-	-	+	-	-	1	12.5
	Habrotrocha angusticollis Bryce	+	-	+	+	-	+	+	-	5	62.5
	Ptygura sp	-	-	-	-	-	+	-	-	1	12.5
	Trichocerca similis Wierzejski	+	-	-	+	+	-	+	+	5	62.5
	Trichocerca elongata	+	-	+	+	+	+	+	-	6	75
	Trichocerca chattoni DeBeauchamp	+	-	+	+	+	+	+	+	7	87.5
	Ascomorpha ovalis Bergendahl	+	+	+	+	+	+	+	+	8	100
	Trichocerca insulana Hauer	+	-	+	-	+	-	-	-	3	37.5
	Asplanchna priodontal Gosse	+	-	+	+	+	+	+	+	7	87.5
	Lepadella cristata Roussellet	+	+	-	-	-	-	-	-	2	25
	Anuraeopsis fissa	+	+	+	+	+	+	+	+	8	100
	Asplanchna brightwelli Gosse	-	-	+	+	+	+	-	+	5	62.5
	Filinia longiseta Ehrenberg	-	-	+	+	+	+	+	+	6	75

Table 4.42 Contd.: Species Composition, Richness, Occurrence and % Frequency of Occurrence of Zooplanktons in Ede-Erinle Reservoir. (September, 2014 – June, 2015). (+ = Presence, - = Absence of Zooplanktons)

	Species Composition	A	B	C	D	E	F	G	H	OCCURENCE	% FREQUENCY
ROTIFERS	*Platyias quadricornis*	-	-	+	-	-	-	+	+	3	37.5
	Keratella tropica Apstein	+	-	-	+	-	-	+	+	4	50
	Filinia terminalis	+	+	+	+	+	+	+	+	8	100
	Horaella brehmi	-	+	+	+	-	+	+	+	6	75
	Asplanchna sieboldi	-	+	+	+	+	+	-	+	6	75
	Lepadella patella	-	-	-	-	-	+	-	-	1	12.5
	Synchaeta pectinata Ehrenberg	+	+	+	+	+	-	-	-	5	62.5
	Keratella lenzi lenzi Hauer	+	+	+	+	-	-	+	-	5	62.5
	Anuraeopsis navicula Rousselet	+	+	+	+	-	+	+	-	6	75
	Brachionus caudatus Barrois & Daday	-	-	-	-	+	-	+	-	2	25
	Hexarthra mira Hudson	-	-	-	+	-	-	-	-	1	12.5
	Polyathra dolichoptera Idelson	+	+	+	+	+	-	-	-	5	62.5
	Lecane (monostyla) styrax Meyer	+	+	+	+	+	+	-	+	7	87.5
	Lecane (Hemimonostyla) inopinata	+	-	+	+	-	-	+	-	4	50
	Lecane luna	+	-	-	-	-	-	-	-	1	12.5
	Lecane (monostyla) sympoda	+	-	-	-	-	-	-	+	2	25
	Trichocercapusilla	+	-	+	+	-	-	-	+	4	50
	Filinia opoliensis	-	+	-	+	-	-	-	-	2	25
	Ploesomahudsoni	-	+	+	+	+	-	-	-	4	50
	SPECIES RICHNESS	**57**	**49**	**60**	**79**	**64**	**66**	**66**	**64**		

IV. DISCUSSION

Although literature is sparse on related studies in our clime, the work of Akinbuwa (1999) on the rotifer fauna and physico-chemical conditions of Erinle Lake and its major inflow at Ede provided suitable baseline information. The study revealed a rotifer fauna of more than 120 species. Nearly 16 years later this study identified a rotifer fauna of 59 species and a total zooplankton species diversity of 101 species. The lower species diversity reported by this study can be explained in several ways. Most important of these is probably the ongoing dredging of the dam which may have destroyed several zooplankton habitats and negatively affected standing crop. In spite of this, the findings of this and the previous study suggest that the lake is very productive and can compare favourably with other highly productive lakes in both tropical and temperate water ecosystems. Most of the species identified in this study were typical tropical assemblages but a few temperate genera like *Synchaeta* and *Notholca* were also recorded. Akinbuwa (1999), Akin-Oriola (2003) and Imoobe and Adeyinka (2010) had earlier reported on similar observations of temperate zooplankton species in tropical waters.

When compared with previous work done by Akinbuwa (1999), only *Anuraeopsis navicula* is a new species addition to the rich rotifer fauna of Ede-Erinle reservoir. In terms of abundance, the copepods dominated the zooplankton community of the reservoir, although this was driven mostly by increased numbers of nauplii (developmental stages). Similar result was documented in the works of Anago *et al.* (2013); Uttah *et al.* (2013); Abowei and George (2011) and Ajuonu *et al.* (2011) amongst others. This was followed closely 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. Copepods dominated most aquatic ecosystems because of their resilience and adaptability to changing environmental conditions and ability to withstand varying environmental stresses (Uttah *et al*., 2013). According to previous workers, the success of the crustaceans could be attributable to their possession of chitinous exoskeleton, which enhances their adaptation to different environmental conditions. Specifically, the copepods are the dominant members of the zooplankton (Uttah *et al*., 2013). However, this result was in contrast to findings in other Nigerian water bodies which reported dominant rotifers in standing crop (Ayodele and Adeniyi, 2006; Jeje and Fernando, 1986). The families Brachionidae, Trichocercidae and Lecanidae were predominant among the rotifers collected from the reservoir and these have also been documented by Egborge (1981), Egborge and Chigbu (1988), Akinbuwa and Adeniyi (1991) Akinbuwa (1999), Ayodele and Adeniyi (2006). These workers suggest that this could be due to the fact that these families are traditional tropical species. Probably for this reason, they are often regarded as indicator species of high trophic levels (Kutikova, 2002).

The spatial distribution and abundance of zooplankton fauna in the reservoir showed that of decrease from the riverine to the lacustrine regions and peak or maxima in the transition region. This pattern however differed from that described by Akinbuwa (1999) which followed a pattern of increase from the riverine to the lacustrine. The maxima species abundance in the transition zone is in accordance with Wetzel (2001). In essence, the distribution and abundance were patchy and uneven across the horizontal axis. Although the hydrology of the lake was not investigated, earlier studies had attributed such pattern to tidal regimes, water current, dispersal or flood (Wetzel, 2001; Akinbuwa, 1999).

Temporal distribution and abundance in zooplankton fauna of Ede-Erinle reservoir revealed a fairly stable pattern all through the year with peaks in the dry and early rainy seasons. This is an example of multi-peak pattern of variation and multi succession usually associated with different genera within each zooplankton group. These phenomena had been described by several workers working in different water systems such as Sokoto River (Holden and Green, 1960), Lake Asejire (Egborge, 1981), University of Ibadan Fish Pond (Etta, 1974); Bas-Zaire in Zaire (De Smet, 1989); Ede-Erinle Lake (Akinbuwa, 1999) and Opa Reservoir (Akinbuwa and Adeniyi, 1996). Besides, Akinbuwa (1999) opined that Ede-Erinle reservoir is one of a few inland freshwater bodies in Nigeria with plankton maxima in both the rainy season and dry season.

Zooplankton Species Diversity

During the course of this investigation, a very high species richness, evenness and diversity of the zooplankton was observed. Besides, the Simpson's index of diversity revealed a high spatio-temporal diversity of 0.8716 to 0.9493 (spatial) and 0.8961 to 0.921(temporal). Similar results were obtained by Adedeji *et al*. (2013). The high diversity observed at Ede-Erinle lake was explained by Jörgensen and Johnsen (1989) as an indication of stable physico-chemical conditions, which suggests that the river is not presently under serious pollution threat. This finding is in agreement with the earlier assertion by Akinbuwa (1999) that the reservoir is fairly clean and unpolluted, hence favourable for zooplankton species growth. Among the different zooplankton groups, rotifers showed highest species richness (59) while the ostracods and dipteras had a record low. Spatially, species richness was highest in station D (transition zone) agreeing with the findings of Wetzel (2001) while disagreeing with the earlier findings of Akinbuwa (1999) on rotifers in Ede-Erinle reservoir.

Temporally, the highest species richness was recorded in the early rainy season while the lowest occurred in the rainy season. Akinbuwa (1999) observed a similar trend and attributed it to the effect of inflow tributary rivers rich in zooplankton being washed down the reservoir during the early rainy season. The low species richness observed during the rainy season could be as a result of release of water from the reservoir due to too high water level coupled with the effect of highest turbidity experienced in the reservoir during the rainy season. High turbidity is known to reduce the activities, productivity and development of zooplankton species and have more effect on larger zooplankton groups like the crustaceans made up of cladoceras and copepods (Threlkeld, 1986; Kirk, 1992).

V. CONCLUSION

The high richness of zooplankton fauna of Ede-Erinle reservoir complements the previous biota study on the reservoir by Akinbuwa (1999) to further substantiate the enormous aquatic productivity and high biota diversity of Ede-Erinle Reservoir. The reservoir water can be considered fairly clean and not under serious pollution threat. The reservoir water can be said to be potable and suitable for pisciculture, irrigation and agricultural uses.

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