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Total hydrobiological studies of Okhuaihe River, Benin City, Southern Nigeria: Zooplankton fauna

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ABSTRACT: In a preliminary investigation of the zooplankton community of Okhuaihe River, Edo State, Nigeria, a total of 515 individuals comprising seventeen taxa were encountered in the river during the study period. Abundance was highest at station 3 (low flow rate) contributing 32.62% and lowest at station 1 (fast flowing) which accounted for 8.16% of total individuals. The overall abundance was significantly different at the four stations ($P<0.05$). An a *posteriori* Duncan Multiple Range (DMR) test showed that abundance at station 1 was significantly lower than those of the other stations ($P>0.05$). The copepoda dominated (53.98%) the samples followed by cladocera (44.29%) and then rotifer (1.75%). The most important taxa were *Thermocyclops negletus, mesocyclops* sp, *Pleuroxus similis, Alona exima* and *Moina micrura.* The taxon richness was highest in station 2 and lowest in station 3. Shannon diversity (H') and evenness (E) were not significantly different ($P>0.05$) among the study stations.

Key Words: Zooplankton, Taxa, Abundance, Distribution, Composition, Okhuaihe River,

Introduction

Zooplankton which are microscopic organisms that are suspended in water (Omudu and Odeh, 2006) occupies a strategic position trophic level in aquatic ecosystems (Adepoju, 1989). They feed on bacterioplankton, phytoplankton, other zooplankton (sometimes cannibalistically), detritus and even nektonic organisms (Jude *et al*., 2005). Zooplankton are sources of food for organisms at higher trophic levels especially fish and therefore, useful indicators of future fisheries health (Davies and Otene, 2009).

They are globally recognized as bio-indicators in the aquatic environment. Their application in biomonitoring (biological surveillance), the systematic use of living organisms or their response to determine the quality of the environment has been reported ((Yakubu *et al*., 2000; Ogbeibu, *et. al*., 2001 Rosenberg, 1998). The Okhuaihe River is an important tributary that feeds Ossiomo River, an important tributary that feeds Benin River. it is the major source of water for domestic and fishing activities for the communities situated on the bank of the river.

Presently, no studies have addressed the faunal resources of the Okhuaihe River, Southern Nigeria. This paper is the first in a series documenting the composition abundance of zooplankton in a wholistic study of the hydrobiological characteristics of the Okhuaihe River, Edo State, Nigeria.

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Materials and Methods

Study Area

Okhuaihe River is situated in Uhunmwode Local Government Area of Edo State (Fig. 1). The river lies perpendicularly to the Benin-Agbor express road, 16 kilometers from Benin City (Long. 05^{o} 45' and Lat. 06^{o} 25'). It is a major tributary of Ossiomo River which empties into Benin River,
which terminates in the Atlantic Ocean. It ranges from 2.0m-60m in depth. It is characterized by the tropical wet and dry seasons, primarily determined by rainfall.

The vegetation of the study area comprised mostly *Ludwigia duccurens, Acroceras zizanoides, Pueraria phaseoloides, Mucuna mucunoides, Musa paradisiaca, Hevea brasiliensis, Monechma ciliata, Rhycospora corymbosa, Sacciolepsis africana, Ipomea involucrate,* and *Dryopteris filixmas.* The main activities of the population include farming, fishing, laundry, bathing (both human and livestock) and large scale sand dredging. Four sampling stations were chosen along the river course, determined by various human activities along the length of the river that are likely to affect the general ecology of the water.

Sampling Stations

Station 1: is located about 25m upstream from the bridge. It has an elevation of 23m and an average depth of 1.3m. The river is fast flowing and shallow at this site. The marginal vegetation is made of grass. The substratum composes mainly of fine sand. Also, some of the villagers carry out fetish activities here.

Station 2: is located 300m downstream of station 1. There is a cassava mill from where the effluents are discharged into the water body. Flow rate is moderate. The substratum is muddy. Fishing is the main Human activity at this station.

Station 3: This station is located 400m away from station 2. The flow rate is low. This station is characterized by vegetations which include *Rhycospora corymbosa* and *Ipomea involucrata*. The substratum is muddy with decaying vegetations.

Station 4: is also located about 550m away from station 3. The water current is low. The substratum is made up of mud, sand and stones. The main human activities at this station include fishing and cassava processing, whose effluents drain into the river. Marginal vegetation includes grasses such as *Acroceras zizanoides, Ipomea* sp, and *Rhycospora* sp.

Sampling for zooplankton fauna, which spanned from July to December 2010 was conducted fortnightly at the study stations between 0800h and 1400h on each sampling day. Quantitative samples was carried out by filtering 100litres of water through 55µm Hydrobios plankton net and preserved in 5% formaldehyde (UNESCO 1974). The zooplankton were sorted in the laboratory under a binocular dissecting microscope (American Optical Corporation, model 570), while sorting, identification, counting and drawings were done using an Olympus Vanox Research Microscope (Model 230485) with an attached drawing tube (Model MKH240-790). Relevant keys and guides as provided by Onabamiro (1952; 1956); Green (1962); Dumont, (1981); Van De Velde (1984) and Jeje and Fernando (1986); were used for the Identification of Zooplankton.

The methods used for analyzing the community structure were the Shannon-Wiener general diversity (H') and evenness (E) indices using the computer BASIC programme SPDIVERS.BAS for diversity indices. The Single Factor Analysis of Variance (ANOVA) was used to test for significant difference in the density of taxa among the stations, and a *posteriori* Duncan Multiple Range (DMR) comparison test was conducted to determine the location of significant difference. All appropriate statistical procedures for test of significance were adopted from Zar, (1984) and Magurran, (1988) as well as SPSS 11.0 Windows application.

At each sampling station, in-situ measurements of temperature were taken using mercury-in-glass thermometer while other physical and chemical parameters such as colour, turbidity, total solids, total dissolved solids, total suspended solids, pH, conductivity, dissolved oxygen. (DO), biochemical oxygen demand (BOD_5), alkalinity, calcium hardness, nitrate, phosphate, sulphate, magnesium hardness and chloride were determined using the standard methods of APHA (1989).

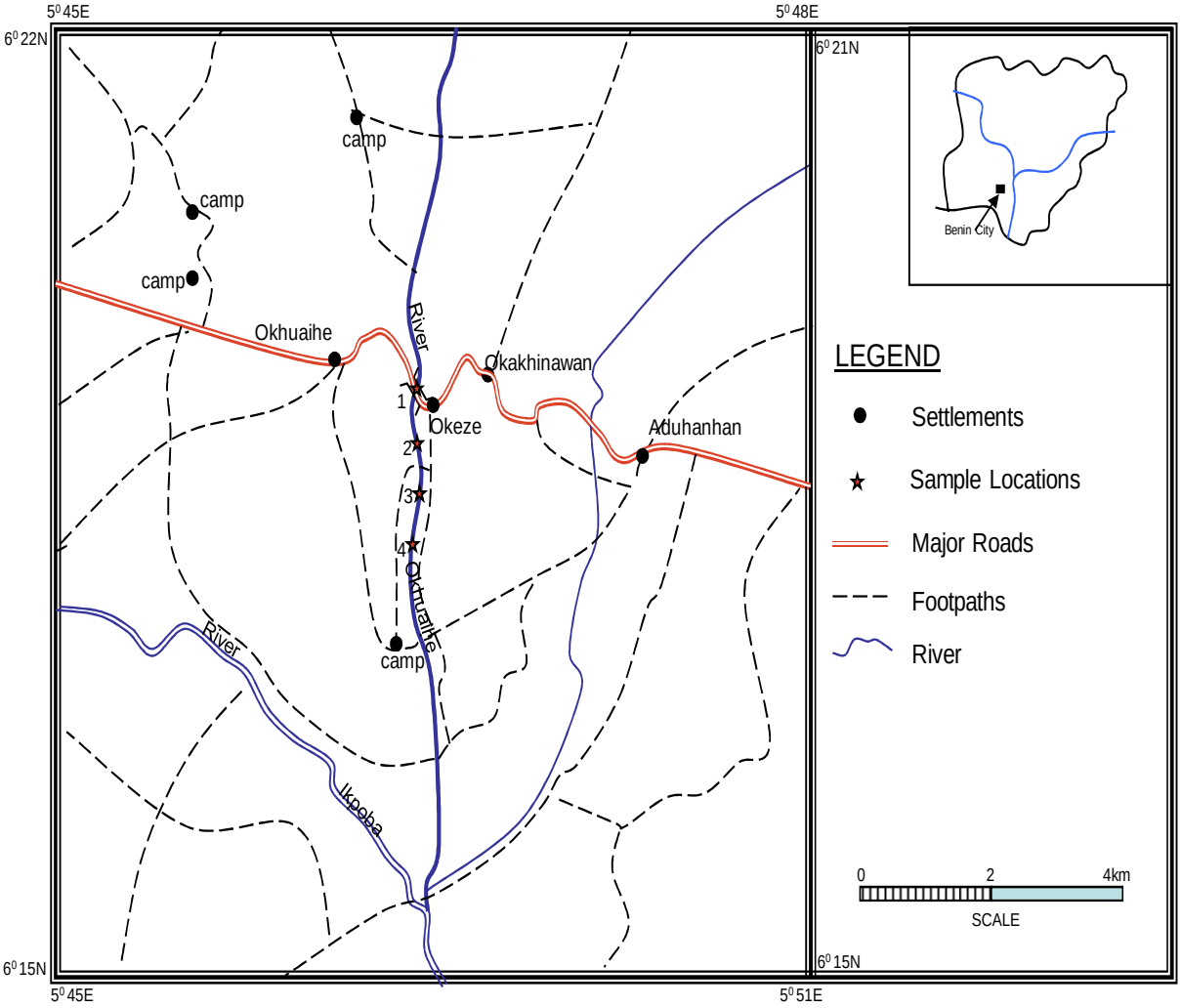

FIG. 1: Map of study area showing the sampled locations

Results

The summary of some physico-chemical data of the study stations is given in Table 1. All parameters with the exception of water temperature and transparency were not significantly different (P>0.05) among all the stations. The water temperature of station 4 was significantly higher (P<0.05) than those of the other stations which were not different (P>0.05) from each other. The transparency of station 3 was significantly higher (P<0.001) than those of other stations which were not significantly different (P>0.05) from each other.

Table 2 shows the taxa composition, abundance and distribution of zooplankton in the study area. Seventeen taxa (515 individuals) were encountered in the river during the study period. Station 1 had 10 taxa, while stations 2 and 4 had 13 taxa each, and 4 had 15 taxa. The overall abundance of zooplankton fauna was highest at station 3 (168) (32.62%) and lowest at station 1(42) (8.16%) (Fig.2). The overall abundance was significantly different at the four stations (P<0.05). An a *posteriori* Duncan Multiple Range (DMR) test showed that abundance at Station 1 was significantly lower than those of stations 2, 3 and 4(P<0.05), which were not different from each other (P>0.05).

Table 1: Summary of some Physical and Chemical parameters of the Okhuaihe River, Edo State, Nigeria.

PARAMETER	STATION 1			STATION 2			STATION 3			STATION 4			P-VALUE
	$\bar{x}$ ± SD	MIN	MAX	$\bar{x}$ ± SD	MIN	MAX	$\bar{x}$ ± SD	MIN	MAX	$\bar{x}$ ± SD	MIN	MAX	
AIR TEMP	24.67 ± 2.07	23	28	24.0 ± 0.89	23	25	24.3 ± 1.03	23	26	26.3 ± 2.58	24	30	P>0.05
WATER TEMP	21.7^{BBi} ± 1.37	20	23	22.8^{B} ± 1.47	20	24	22.8^{B} ± 1.60	20	24	24.0^{A} ± 0.63	**23**	**25**	**P<0.05**
TRANSPARENCY	130.0^{B} ± 0.00	130	130	84.4 ^{B}± 9.27	70	91	146.3^{A}± 42.5	90	190	$126..8^{B}$ ± 40.7	**80**	**160**	**P<0.01**
Colour (CTU)	24.3 ± 20.3	0.0	46	25.8 ± 14.9	0.0	38	24.6 ± 16.3	0.0	43	37.4 ± 37.8	0.0	98	P>0.05
Turbidity (NTU)	6.00 ± 9.52	0.0	20	5.50 ± 5.54	0.0	13	6.80 ± 9.95	0.0	24	7.40 ±9.32	0.0	19	P>0.05
pH	6.37 ± 0.28	5.8	6.5	6.50 ± 0.14	6.3	6.7	6.35 ± 0.32	5.8	6.7	6.43 ± 0.45	5.7	7.1	P>0.05
Conductivity (µS/cm)	15.8 ± 1.99	13.3	18.7	19.1 ± 4.74	13.1	26.4	15.9 ± 2.13	12.6	18.2	17.6 ± 3.12	11.8	20.0	P>0.05
Suspended Solid	1.80 ± 1.30	0.0	3.0	1.00 ± 1.09	0.0	3.0	1.50 ±0.55	1.0	2.0	2.60 ± 2.51	1.0	7.0	P>0.05
Total Dissolved Solid	11.9 ± 1.67	9.8	14.0	14.4 ± 3.64	9.75	19.1	11.8 ± 1.66	9.10	13.3	13.0 ± 2.45	8.6	14.8	P>0.05
Total Hardness as $CaCO_3$	5.83 ± 2.48	3.0	9.0	7.17 ± 4.26	4.0	14.0	11.0 ± 11.5	2.0	33.0	7.83 ±3.71	4.0	13.0	P>0.05
Total Solid	13.47 ± 2.44	9.8	17.0	15.36 ± 2.44	12.8	20.1	13.33 ± 1.38	11.1	15.0	15.17 ± 3.44	8.6	18.6	P>0.05
Total Alkalinity	17.3 ± 13.04	6.1	42.7	17.3 ± 7.13	12.2	30.5	19.3 ± 10.5	6.1	36.6	15.9 ± 4.88	12.2	24.4	P>0.05
Chloride	31.4 ± 10.2	20.9	50.5	26.5 ± 4.37	19.5	32.7	26.9 ± 4.98	20.9	33.4	26.7 ± 3.85	19.5	29.8	P>0.05
Calcium	0.73 ± 0.30	0.4	1.2	1.40 ± 1.12	0.8	3.6	1.87 ± 2.89	0.4	7.6	0.87 ± 0.39	0.4	1.6	P>0.05
Magnesium	0.97 ± 0.51	0.48	1.70	1.09 ±0.85	0.48	2.19	2.02 ± 2.35	0.24	6.32	1.34 ± 0.97	0.48	2.92	P>0.05
Nitrate	0.25 ± 0.18	0.10	0.60	0.21 ± 0.08	0.10	0.30	0.20 ± 0.13	0.10	0.45	0.18 ± 0.09	0.10	0.35	P>0.05
Phosphate	0.08 ± 0.05	0.01	0.15	0.09 ± 0.02	0.06	0.10	0.08 ± 0.02	0.06	0.10	0.12 ± 0.05	0.07	0.20	P>0.05
Sulphate	3.02 ± 0.83	2.0	4.3	3.07 ± 1.31	1.0	4.6	2.72 ±0.79	1.8	3.8	3.47 ± 1.83	1.4	6.7	P>0.05
Dissolved Oxygen	3.95 ± 1.54	2.0	5.8	3.95 ± 1.22	1.8	5.1	4.18 ± 1.27	2.2	6.1	4.03 ± 0.89	2.5	5.2	P>0.05

The relative contribution of the major zooplankton species to the overall abundance at the various stations is shown in Fig. 3. The copepoda dominated the samples at all stations, accounting for 53.98% of the total individual encountered. It was represented by 7 taxa from the family cyclopidae and a single taxa from the family diatomidae. The most important taxa were *Thermocyclops negletus, mesocyclops* sp and *Cryptocyclops* sp. *Tropodiaptomus* sp was the only diatomidae.

The cladocerans contributed 44.29% to the total individual encountered. It was represented by seven taxa from four families: chydoridae had 4 taxa, while sididae, moinidae and bosminidae had 1 taxa each. The cladocerans were most important at stations 3 and 4 where it accounted for 31.46% of the total abundance. The dominant taxa were *Pleuroxus similis, Alona exima* and *Moina micrura.*

The order rotifera comprises 2 families: Brachionidae and Colurellidae, each represented by a single species *Brachionus* and *Colurella.* The rotifers were not prominent; completely absent in station 1; they contributed only 1.75% of the total abundance.

The diversity indices calculated for the study stations are summarized in Table 3. The taxon richness was highest in station 2, followed by stations 4 and 1, while the lowest was recorded in station 3. Shannon diversity (H') was not significantly different (P>0.05) among the study stations. The evenness (E) index was highest in Station 2 and lowest in Station 1, but the values were not significantly different (P>0.05).

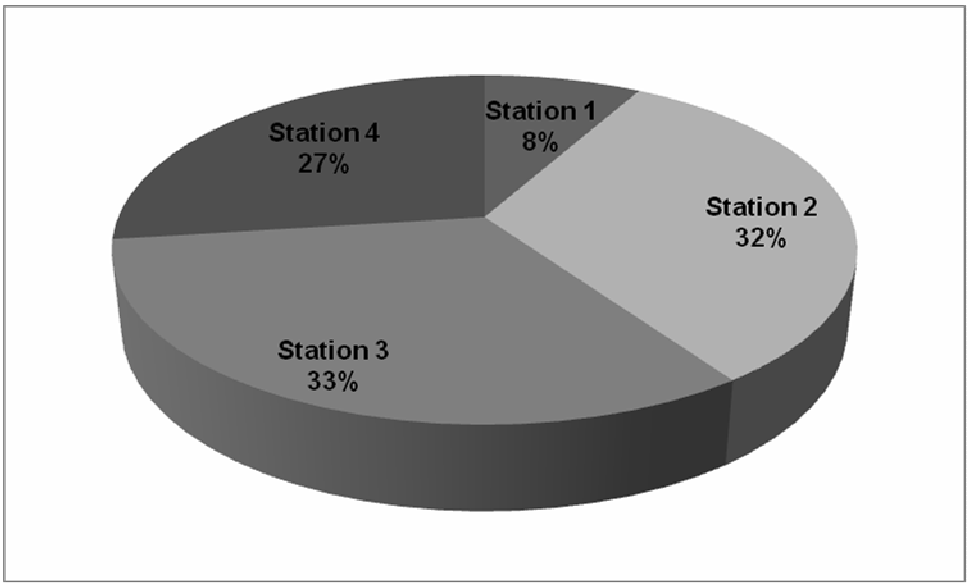

Fig. 2 : Relative abundance of zooplankton fauna in the study station

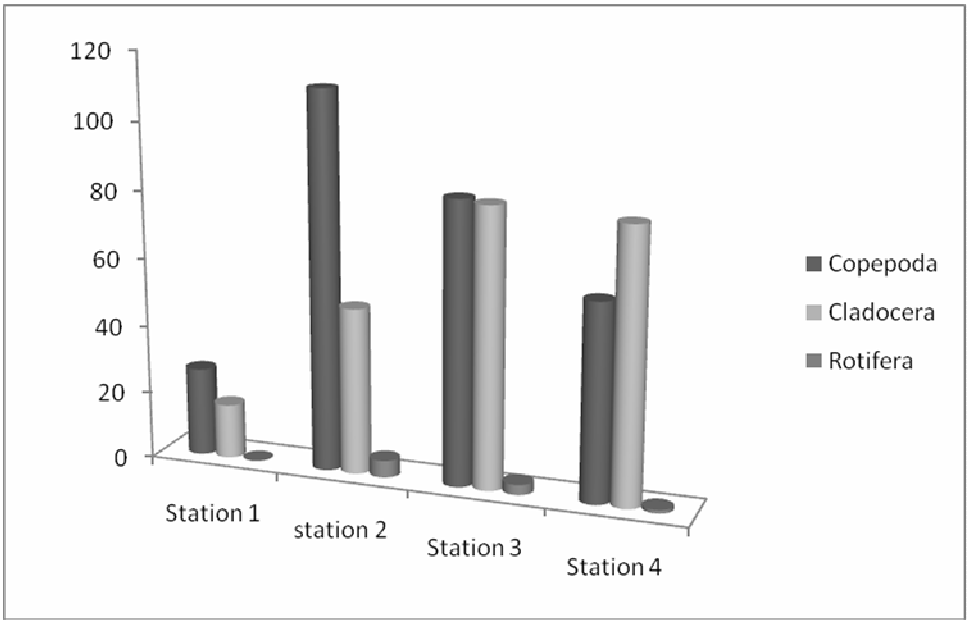

Fig. 3: Spatial variation of major zooplankton fauna in the study station

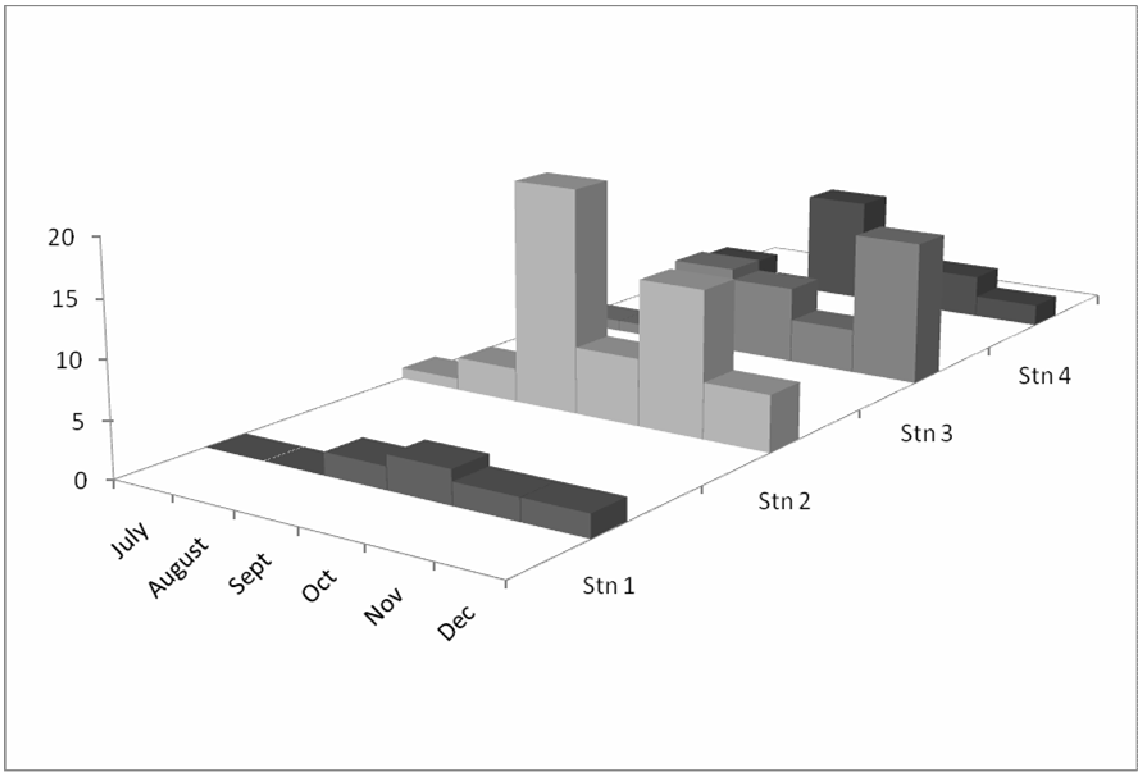

Figure 4: Temporal variations of zooplankton in the study stations.

Table 2: Composition, distribution and abundance of zooplankton fauna in Okhuaihe River, Edo State, Nigeria.

TAXONOMIC GROUPS	Station 1	Station 2	Station 3	Station 4
Class: CRUSTACEA				
Order: Cladocera				
Family: Moinidae				
Moina micrura Kurz, 1874	10	-	17	13
Family: Sididae				
Diaphanosoma excism Richard, 1895	1	18	8	9
Family: Bosminidae				
Bosminopsis deitersi Richard, 1895	-	-	7	13
Family: Chydoridae				
Alona exima Sars, 1862	3	14	10	11
Oxyurella ciliata	2	-	11	18
Pleuroxus similis	-	17	16	10
Pseudochydorus globosus	-	-	13	6
Order: Cyclopoida				
Family: Cyclopidae				
Microcyclops varicans Sars, 1862	2	14	9	6
Thermocyclops neglectus Sars, 1901	4	21	16	-
Mesocyclops leukarti	5	13	14	-
Mesocyclops sp	-	12	11	16
Eucyclops agiloides	6	9	14	-
Eucyclops macrurus	2	15	13	7
Crytocyclops sp Sars, 1863	7	14	6	11
FAMILY DIAPTOMIDAE				
Tropodiaptomus sp	-	13	-	18
Phylum: Rotifera				
Class: Monogononta				
Order: Ploimida				
Family: Brachionidae				
Brachionus sp	-	3	2	-
Family: Collurellidae				
Colurella unicinata Muller, 1773	-	2	1	1

Table 3: Biological Diversity of zooplankton at the study Stations

	Station 1	Station 2	Station 3	Station 4
Number of species	10	13	15	13
Density (Nos. of Individuals)	42	165	163	137
Taxa Richness (d)	2.407	2.350	2.765	3.431
General Diversity (H)	2.108	2.460	2.579	2.449
Evenness index (E)	0.916	0.959	0.952	0.955

Discussion

The Zooplankton species recorded in this study are cosmopolitan and typical of tropical rivers. This is not unusual as the invertebrate communities of lotic ecosystem are a conservative assemblage of types that recur in similar biotopes regardless of geographical location (Bishop 1973).

The total number of zooplankton taxa (17) recorded in this study is low when compared to other tropical rivers (Bidwell and Clarke, 1977; Ogbeibu *et. al*., 2001 Imoobe and Adeyinka 2009; Imoobe and Akoma, 2009). Other studies that also record low zooplankton taxa include that Jeje and Fernando (1981) and Egborge *et. al*., (1994). The density of zooplankton recorded in this study support the fact that flowing water is a poor habitat for zooplankton (Dudgeon, 1995; Idris and Fernando, 1981). The overall composition and abundance of zooplankton fauna varied spatially in the study station. Stations 2 and 3 recorded the highest abundance, while the lowest value was recorded at Station 1. The low abundance of zooplankton in Station 1 characterized by high current velocity which hardly permits stable zooplankton community (Ogbeibu and Edutie, 2002) can explain the significantly lower abundance observed at this station.

The occurrence of copepoda as the most abundant in this study is not unusual as this group have been reported to exhibit high biomass and numerical dominance of few species in tropical waters (Burgis 1973). The dominance of copepods in this study agrees with the findings of Egborge (1981), and Jeje and Fernando (1986). However, Morgan and Boy (1982) and Ogbeibu and Egborge (1995) reported the dominance of calanoids copepods in temporary freshwater ponds.

As in most tropical freshwaters, the cladocera fauna recorded included *Pleuroxus similis* and *Alona exima*, however, the absence of *Moina micrura* from Stations 1 and 2 can be attributed to the fact that it is one of the commonest limnetic cladocera in Nigeria freshwater bodies. It is eurytopic and its indicative of a typical tropical species assemblage (Fernando 1980).

The cladocerans were dominated by the chydoridae. High abundance and species richness of this family is characteristic of tropical freshwater zooplankton (Green 1962; Dumont 1981). The benthic nature of Cladocera and their preference for areas with rich, muddy substratum and macrophytes, a condition characteristic of Stations 2, 3 and 4 were the highest abundance were recorded could explain the high abundance in these stations Fernando, (1980).

Rotifers are typically the most abundant zooplankton in rivers (Pace *et. al*., 1992; Thorp *et. al.*, 1994; Kim and Joo 2000). Conversely their near absence (2 species) in this study where they contributed only 1.75% to the total individuals encountered, can be attributed to two abiotic environmental factors; turbidity and turbulence which characterized the study area during sampling. The rotifers communities in tropical waters are dominated either by Lecanidae (Egborge and Chigbu, 1988; Onwundinjo & Egborge, 1994) or Brachionidae (Green 1960; Egborge, 1994). The low diversity and abundance of this group is not unusual partly because of the short duration of the sampling period which covers only the wet rainy season, the lotic condition of the river which are known to harbour very few zooplankton species (Ogbeibu and Anozia 2007). This finding is far lower than the 45 species reported by Ogbeibu and Edutie (2002) from Ikpoba River.

The zooplankton abundance in the river was low throughout the study period, this was also observed in the calculated Margalef richness (d) and Shannon diversity. Crustacean zooplankton made up of copepods and cladocera dominated the zooplankton community of the river.

Spatial variations in the abundance of zooplankton was not significantly influenced by the effluents from the cassava processing mills located at the banks of Stations 2 and 4, the main factors responsible for the disparity in the abundance and spatial distribution of zooplankton species were the current velocity, and water turbulence resulting from increased run-off into the river during the wet rainy season.

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