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THE CRUSTACEAN ZOOPLANKTON ASSEMBLAGE OF A RELATIVELY PRISTINE UTOR RIVER IN SOUTHERN NIGERIA

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ABSTRACT

The water quality and crustacean zooplankton of Utor River, a relatively pristine freshwater body in Edo State, Nigeria was investigated at four stations. The Utor River is slightly acidic, well oxygenated, oligotrophic and low in solids, conductivity, cations and heavy metals. A total of 380 individuals comprising eleven taxa were recorded, and the highest density was observed at Station 1 (29.9%) followed by Stations 2 (25.0%), while Stations 3 and 4 accounted for 24.2% and 21.1% respectively. Overall density showed no significant difference ($P > 0.05$). Copepoda represented by the family Cyclopoidae contributed 57.89% of the total density. The dominant species were *Cryptocyclops bicolor, Ectocyclops phaleratus* and *Mesocyclops ogunnus.* The Harpacticoida (15% of the population) was represented by one taxon *Bryocamptus birsteini* which was well represented in all the stations. The water quality assessment shows that the river is still relatively pristine and unperturbed. The crustacean zooplankton assemblage was cosmopolitan and dominated by the Copepoda in terms of the number of species and overall abundance, with *Crypptocyclops bicolor* as the most important species. The overall abundance and diversity of zooplankton was relatively low.

Key words: Utor River, Water quality, Cladocera, Copepod, Density

INTRODUCTION

Water quality is assessed using key indicator physico-chemical parameters which are determined by the presence of both suspended and dissolved organic and inorganic compounds. These compounds are toxic, nutrients to aquatic biota, or of aesthetic value to the water body (Boukori *et al*., 1999). The Utor River is a 'first order stream' representing the major source of domestic and potable water supply to Emu community in Esan South-East Local Government Area of Edo State, Nigeria. In a community where there is neither pipe borne water nor borehole water supply, basic information on the physical, chemical and biological qualities of the only source of natural water becomes very crucial. Studies have shown decrease both in the biomass and diversity of zooplankton due to increase acidification (Confer *et al.,* 1983; Engblom and Lingdell, 1984; Aston *et al*., 1985). According to the River Continuum

Concept (RCC) of Vannote *et al.* (1981), the structural and functional characteristics of stream communities are controlled by geomorphology and the physical state of the stream, with headwaters or first order streams notably poorer in plankton than the potamon reaches. Zooplankton are globally recognized as bio-indicators in the aquatic environment. Their application in biomonitoring (the systematic use of living organisms or their response to determine the quality of the environment) has been reported (Rosenberg, 1998; Yakubu *et al*., 2000; Ogbeibu *et al*., 2001).

Unfortunately, only little baseline information on this river exists for comparison of pre- and post-developmental activities and valid assessment of the overall water qualities (Ogbeibu and Anagboso 2004, 2005). This paper is part of a baseline study documenting the hydrobiological characteristics the Utor River, Edo State, Nigeria.

STUDY AREA

The study was carried out in the upper stretch of the Utor River, Emu community (Fig.1), which takes its source from Udo Clan in Igueben Local Government Area, Edo State, Nigeria (6.30^0 - 6.45^0 N and 6.20^0 - 6.45^0 E). It flows southeasterly to form a confluence with River Urobho before emptying into the River Niger. The vegetation of the study area comprised mostly of primary rainforest vegetation such as Indian bamboo (*Bambusa* sp). Riparian settlements in this area are thinly populated. The main activities of the population include farming, fishing and hunting. Four sampling stations lying within a stretch of 5 km were chosen for this study.

Station 1 was the upstream of the study area. The water current was with a current velocity ranging from 20 cm/s to 26 cm/s. The substratum was composed of clay and mud and decaying fallen leaves. No human activity was observed in this station throughout the study period, probably due to its distant location from human settlement. The marginal vegetation was C*yrtosperma* sp*., Culcasia* sp*., Palisota* sp*., Dissotis* sp. and C*ercestis* sp.

Station 2 was about 1km from station 1. The current was relatively faster than that of station 1, ranging from 25 to 40cm/s. The riparian vegetation consists of mixed forest vegetation comprising *Bambusa* sp. *Elaeis* sp*., Hevea* sp., *Scleria* sp., *Palisota* sp., *Pteris* sp. and *Acrocera* sp. The site was relatively free from human activities except farming. Anthropogenic decomposing animals used for fetish worship were observed in this station.

Station 3 was located about 500 m downstream of station 2 with a dilapidated bridged over it. The water current was fastest at this station, ranging from 45 to 60 cm/s, with sandy and rocky substratum. This station witnessed some level of human activity in the form of bathing and laundering during the study period. Three composite samples were collected before, under and after the bridge. The riparian vegetation is composed of plants such as *Scleria* sp., *Pandanus* sp. C*yrtosperma* sp*.*, *Simphonia* sp. and *Nephrolepis* sp.

Station 4 was about 1 km downstream of station 3. The current velocity ranged from 30 to 50 cm/s. The substratum was sandy in nature with muddy patches. Marginal vegetations in this station were mature Oil palm *Elaeis sp.* Other plants and shrubs include Water hyacinth; *Eichhornia crassipes, Cyrtosperma* sp*., Hevea* sp*., Aspilia africana, Calapogonium* sp*., Leersia* sp. and *Cyclosorus* sp. The human activities here were mainly bathing and laundering.

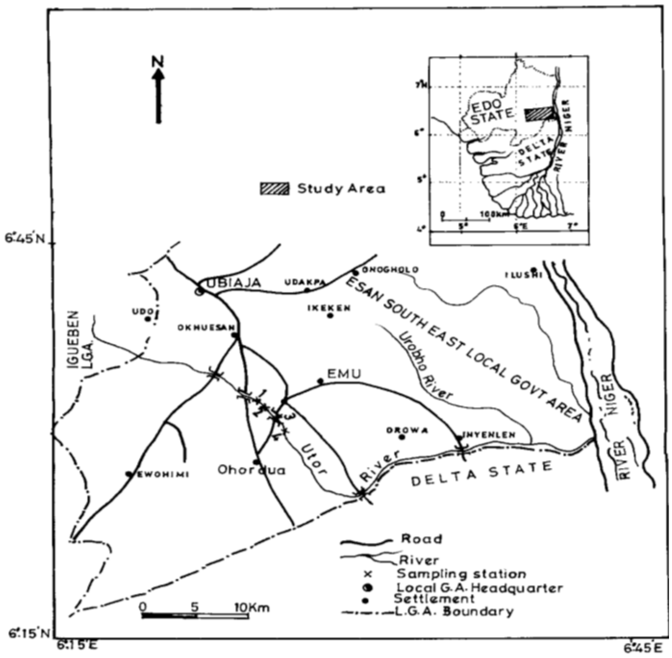

Fig. 1: Map of Esan South-East Local Government Area, Edo State, showing the study stations along Utor River in Emu. (Inset is Edo State showing the location of the study area)

MATERIALS AND METHODS

Water samples were collected in pre- cleaned plastic containers from the sampling stations. Physical and chemical analyses were assessed using standard methods for examination of water and wastewater (American Public Health Association 1998). The flow velocity was determined by the flotation method and the water level by a graduated guage. Quantitative sampling of zooplankton was carried out by filtering 100litres of water through 55 µm 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 were used for the Identification of zooplankton.

Data analysis

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), Ogbeibu (2005) as well as SPSS 16.0 Windows application.

RESULTS

Water quality

A summary of physical and chemical parameters of the study stations is shown in Table 1. All the parameters with the exception of transparency and depth were not significantly different (P > 0.05) among all the stations. The values of transparency at Station 1 was significantly higher (P<0.05) than those of other stations, which were not significantly different (P > 0.05) from each other. Depth was significantly higher (P < 0.001) at Station 3 than at Station 2, which was significantly higher (P < 0.001) than Stations 1 and 4.

Checklist of crustacean zooplankton

A total of 380 individuals comprising eleven taxa were collected (Table 2). All the taxa were represented in the study stations. The highest abundance was observed at Station 1 (29.9%) followed by Stations 2 (25.0%), while stations 3 and 4 accounted for 24.2% and 21.1% respectively. (Fig.2). The Analysis of Variance (ANOVA) showed that there was no significant difference (P> 0.05) in the overall abundance at the four stations. The Cladocera represented by 3 families made up of 4 taxa contributed 27.11% of the total number of individuals encountered. The Family Chydoridae was represented by 2 taxa: *Alona eximia* and *A. quadrangularis* while the families Macrothricidae and Sididae had only 1 taxon each, *Grimaldina brazzai* and *Diaphanosoma excisum* respectively. Abundance was highest at Station 2 (28.16%) and lowest at Station 1 (22.33%). The most important taxa were *Alona quadrangularis* and *Diaphanosoma excisum.* The overall abundance of Cladocera was not significantly different (P> 0.05) among the stations.

The Copepoda accounted for 57.89% of the total abundance. It was represented by the family Cyclopoidae which had 6 taxa from two subfamilies; Mesocyclopinae (5) and Eucyclopinae (1). Abundance was highest at station 1 (31.70%) and lowest at Station 3 (20%). The most dominant species were *Cryptocyclops bicolor, Ectocyclops phaleratus* and *Mesocyclops ogunnus.* Analysis of Variance revealed that there was no significant difference in abundance (P> 0.05) between the study stations.

The order Harpacticoida contributed 15% to the total abundance. The family Canthocampidae was the only group encountered in this study. It was represented by only one taxon *Bryocamptus birsteini* which was well represented in all the stations. The Analysis of Variance (ANOVA) showed that there was no significant difference (P> 0.05) in the overall density at the four stations.

Table 1: Summary of mean (**± SE, n =12**), minimum and maximum values of some physical and chemical parameters of the Utor River

Parameters	Station 1 Mean ± S.E	Station 2 Mean ± S.E	Station 3 Mean ± S.E	Station 4 Mean ± S.E	P-value
Air temperature (^{0}C)	28.9±0.37	29.55±0.43	29.6±0.34	29.65±0.28	P >0.05
Water temperature (^{0}C)	26.03±0.12	26.1±0.12	26.25±0.11	26.23±0.11	P >0.05
Transparency (m)	0.54^a±0.02	0.43^b±0.02	0.39^b±0.02	0.43^b±0.03	P<0.01
TDS (mgl^{-1})	33.94±4.11	34.53±4.54	35.18±3.97	36.97±4.19	P >0.05
TSS (mgl^{-1})	19.65±2.75	18.78±2.51	20.59±2.63	23.99±3.42	P >0.05
Total solid (mgl^{-1})	53.58±6.61	53.25±6.71	55.77±6.35	62.77±7.34	P >0.05
pH	6.22±0.15	6.33±0.13	6.24±0.14	6.04±0.14	P >0.05
Turbidity (NTU)	16.47±2.48	17.58±2.79	18.38±3.21	20.74±3.59	P >0.05
Depth(cm)	94.86^c±1.70	153.9^b±2.36	174.82^a±6.04	85.33^c±3.82	P<0.001
Conductivity (µS/cm)	63.7±7.10	61.90±6.97	67.85±7.18	69.70±7.96	P >0.05
Dissolved oxygen (mgl^{-1})	6.74±0.32	6.71±0.29	6.89±0.28	6.00±0.31	P >0.05
BOD_5 (mgl^{-1}) at 20^{0}C	2.98±0.24	3.08±0.23	3.17±0.19	2.57±0.20	P >0.05
Total alkalinity (mgl^{-1})	41.35±2.56	44.53±2.99	40.43±3.05	36.83±2.19	P >0.05
Salinity (mgl^{-1})	23.55±2.26	22.13±1.78	24.04±1.52	23.38±2.0	P >0.05
Nitrate (mgl^{-1})	0.43±0.06	0.39±0.06	0.44±0.06	0.44±0.06	P >0.05
Sulphate (mgl^{-1})	0.25±0.03	0.26±0.03	0.26±0.02	0.28±0.03	P >0.05
Phosphate (mgl^{-1})	0.67±0.08	0.67±0.09	0.68±0.08	0.67±0.06	P >0.05
Magnesium (mgl^{-1})	2.90±0.63	2.98±0.66	2.99±0.59	2.87±0.62	P >0.05
Sodium (mgl^{-1})	7.24±1.16	7.92±1.46	7.14±1.03	6.07±1.06	P >0.05
Potassium (mgl^{-1})	3.55±0.58	3.94±0.91	3.63±0.56	3.24±0.52	P >0.05
Calcium (mgl^{-1})	5.38±1.00	5.01±0.99	5.54±0.96	5.12±1.05	P >0.05
Copper (mgl^{-1})	0.19±0.03	0.16±0.03	0.18±0.03	0.25±0.04	P >0.05
Zinc (mgl^{-1})	0.73±0.09	0.62±0.09	0.74±0.06	0.95±0.08	P >0.05
Cadmium (mgl^{-1})	0.05±0.02	0.04±0.02	0.053±0.02	0.08±0.03	P >0.05
Total Iron (mgl^{-1})	0.22±0.02	0.19±0.01	0.19±0.01	0.24±0.02	P >0.05
Lead (mgl^{-1})	0.14±0.02	0.11±0.01	0.13±0.02	0.20±0.04	P >0.05
Chromium (mgl^{-1})	0.07±0.01	0.06±0.01	0.08±0.02	0.08±0.01	P >0.05

Table 2: Distribution, abundance and frequency of occurrence of the crustacean zooplankton

Zooplankton taxa	Stations and abundance				Total
	1	2	3	4	
Order: Cladocera					
Family: Chydoridae					
Alona eximia Kiser, 1948	4	8	6	5	23
A. quadrangularis Muller, 1785	8	7	8	8	31
Family: Macrothricidae					
Grimaldina brazzai Richard, 1882	4	8	5	3	20
Family: Sididae					
Diaphanosoma excisum Sars, 1885	7	6	6	10	29
Order: Cyclopoida					
Family: Cyclopoidae					
Mesocyclops ogunnus Onabamiro, 1957	8	5	5	9	27
Microcyclops varicans Sars, 1863	6	7	5	8	26
Thermocyclops decipiens Kiefer, 1929	9	5	5	7	26
Thermocyclops oblongatus Kiefer, 1929	8	7	5	4	24
Cryptocyclops bicolor Sars	32	21	17	19	89
Ectocyclops phaleratus Koch	7	7	7	7	28
Order: Harpacticoida					
Family: Canthocampidae					
Bryocamptus birsteini Borukskii, 1940	20	14	11	12	57
Number of individuals	113	95	80	92	
Number of Species	11	11	11	11	
Margalef's index (d)	2.12	2.20	2.28	2.21	
Shannon-Wiener index (H')	2.16	2.29	2.30	2.28	
Evenness (E)	0.90	0.95	0.96	0.95	

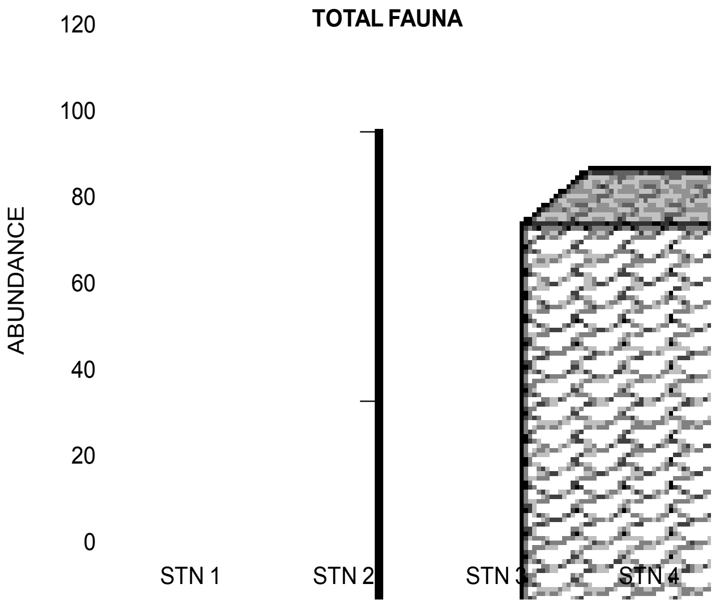

Fig. 2 Spatial variation in total zooplankton in study stations of the Utor River

Diversity indices.

The diversity indices calculated for the four stations are shown in Fig. 3 and Table 2. The taxa richness (d) was highest at Station 3 followed by station 4 while the least value was recorded at station 1. Shannon-Wiener diversity (H') was highest at Station 3, followed by stations 2, 4 and 1, while Evenness Index (E) was also highest at Station 3 and lowest at Station 1. The Hutcheson t-test for Shannon Diversity did not reveal any significant difference (P>0.05) among the stations.

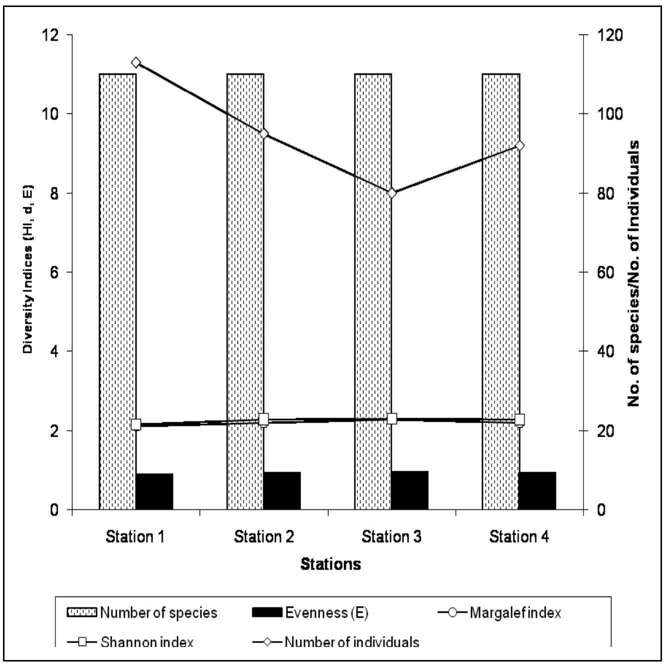

Fig. 3 Diversity indices of zooplankton community in all stations

DISCUSSION

The water quality of the Utor River represents one of a quasi-pristine condition as earlier described by Ogbeibu and Anagboso (2004). The indicator parameters like total suspended solids, total dissolved solids, total solids, turbidity, dissolved oxygen, BOD_5 and nutrients were at their baseline levels similar to systems that have not been grossly impacted by anthropogenic activities (Ogbeibu *et al*., 2001; Edokpayi *et al*., 2000).

The Utor River can be said to be relatively low in its assemblage of crustacean zooplankton. Most of the species recorded here are cosmopolitan, and have been previously recorded elsewhere in Nigeria (Morgan and Boy, 1982; Jeje and Fernando, 1986; Ogbeibu, 1991, Ogbeibu and Egborge, 1995; Ogbeibu *et al*. 1996; Imoobe and Ogbeibu, 1996; Ogbeibu and Ezemonye, 2001; Ogbeibu and Obanor, 2002; Omoigberale and Ogbeibu, 2007).

Eleven taxa comprising 7 copepods and 4 cladoceran species recorded in this study support the assertion that flowing water is a poor habitat for zooplankton (Dudgeon, 1995; Idris and Fernando, 1981). The moinids and calanoids were completely absent from the water samples studied. The presence of a species will depend on its environmental tolerance, but the resources available to it will determine its abundance. If competition or predation is reduced or the food supply or suitable habitat increased, the species will become more abundant.

The dominant zooplankton in freshwater ecosystems includes the microcrustaceans made up of cladocerans and copepods amongst others (Wetzel, 1983). Other studies on lotic ecosystems have also shown the poor diversity and abundance of tropical zooplankton (Egborge, 1981; Idris and Fernando, 1981; Jeje and Fernando, 1986; Egborge *et al*., 1994; Ogbeibu *et al.,* 1996). Bidwell and Clark (1977) recorded 24 and 9 species of Cladocera and copepods respectively from Lake Kainji, Nigeria, Burgis *et al*. (1973), reported 7 cladoceran species from lake George, Uganda and Ogbeibu *et al.* (1996) reported 25 cladocerans and 9 copepods from a temporary pond in southern Nigeria.

Cladocera were dominated by the Chydoridae and Sididae. The highest abundance was recorded at station 2 followed by station 3. The dominant species was *Alona quadrangularis.* The high abundance and species richness of Chydoridae is characteristic of tropical freshwater zooplankton (Imoobe and Egborge, 1997; Dumont, 1981; Mamaril and Fernando, 1978; Green, 1962). Species of Cladocera recorded in this study appear to have preference for sites with low current velocity, rich organic substratum and macrophytes, a condition characteristic of stations 2 and 3 where high abundance of Cladocera was encountered. Dominance of Chydoridae can also be attributed by the fact that they are benthic, while some other groups are less likely to be completely benthic (Fernando, 1980).

The number of species of copepod recorded in this study is comparable to the species composition in some other Nigerian water bodies. Similar studies (Imevbore, 1965; Imoobe and Adeyinka, 2009) recorded 6 species from Eleiyele reservoir, Ibadan and 12 species of copepod from Ovia River respectively. Cyclopoida were the only copepods encountered in this study. These were however lower than the 21 species reported by Gabriel (1986) for the tidal

Warri River. The higher number of species recorded in this system can be explained by its coastal nature, having a mixture of marine, brackish and freshwater forms.

The dominance of cyclopoids represented mainly by *Cryptocyclops bicolor* and *Ectocyclops phaleratus* is in contrast with the findings of Ogbeibu *et al*. (2001), Imoobe, and Adeyinka (2009) on a stretch of Ovia River, Benin City, that recorded *Microcyclops varicans* and *Thermocyclops* sp. as the dominant cyclops. The complete absence of the calanoids was not surprising as they are known to be dominant in temporary ponds (Ogbeibu and Egborge, 1995). Fernando (1980) reported the presence of Calanoida in some temporary waters and their rarity in rivers, while Morgan and Boy (1982) reported only Calanoida in some temporary freshwater ponds in North-west Africa.

A clear disparity was observed in the spatial distribution of the zooplankton in this study. Stations 1 and 2 harboured more individuals while, all the species were ubiquitous, a reflection of environmental homogeneity of the system. The abundance and diversity of zooplankton have been observed to vary according to limnological features and the trophic state of freshwater bodies (Jeppesen *et. al*., 2002). Stations 1 and 2 which had the highest abundance were characterized by low flow velocity and muddy clay substratum.

The low abundance of zooplankton species in this study can be attributed to its first stream order status, extensive canopy from the primary forests surrounding the river at the study stretch, and its oligotrophic nature. According to the River Continuum Concept (RCC) of Vannote *et al.* (1981), there is a continuous gradient of physical conditions and geomorphology from the headwaters to the mouth of any river. The RCC posits that the structural and functional characteristics of stream communities are controlled by the physical state of the stream (i.e. width, depth, velocity flow, volume and entropy gain). Headwaters or first order streams are poor in plankton but rich in benthic macroinvertebrate shredders, grazers, collectors and predators as documented by Ogbeibu and Anagboso (2005) for the Utor River.

CONCLUSION

The Utor River represents an important source of potable water supply for the inhabitants of Emu community. The water quality assessment shows that the river is still relatively pristine and unperturbed. The crustacean zooplankton assemblage was cosmopolitan and represented species that have been reported in ecologically equivalent ecosystems. The community was dominated by the Copepoda in terms of the number of species and overall abundance, with *Crypptocyclops bicolor* as the most important species. The overall abundance and diversity of zooplankton was relatively low.

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