

Ecology and Diversity of Zooplankton in the Great Kwa River, Cross River State, Nigeria

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Abstract: Ecology and diversity of zooplankton in the Great Kwa River, located in Cross River state (Southern Nigeria) was studied based on bi-monthly samples collected for six months (May to October, 2012). The objective of the study was to determine the abundance and species composition of zooplankton from four sampling stations in the study area. A total of forty-four (44) taxa belonging to seven (7) taxonomic groups were recorded: 1 Heterodonta and Salpid (2.27%), 2 Chaetognaths and Decapods (4.55%), 7 Rotifera (15.91%), 11 Cladocera (25.0%) and 20 Copepods (45.45%). Total number of species in relation to sampling stations was highest in Esuk Atu with 34 species (27.2%), followed by 33 species in Anantigha station (26.45), followed by 32 species in Obufa Esuk station (25.6%) and lowest in Abitu station with 26 species (20.8%). Absolutely constant species (AS) were found only in Cladocera (*Daphnia magna*, *Daphnia pulex* and *Daphnia rosea*) and Copepoda (*Calanus calanus*, *Calanus finmarchicus*, *Diatomus gracilus*, *Enteropira autifrons*, *Enteropira elongatus*, *Paracalanus parvus* and *Pseudocalanus elongatus*). Based on these findings, it could be concluded that the relatively high zooplankton species diversity in the Great Kwa River is an indication of the healthy state of the river.

Keywords: Diversity, Zooplankton composition, Great Kwa River; Sampling stations

1. Introduction

The term zooplankton is derived from two Greek words, zoon meaning "animal", and planktos meaning "drifters" [1]. Zooplankton plays a significant role in aquatic food web by linking the primary producers (by consuming phytoplankton, mainly various bacterio-plankton and sometimes zooplankton) and higher trophic levels [2]. According to [3], zooplanktons are heterotrophic planktonic animals floating in water which constitute an important food source for many species of aquatic organism. Zooplankton by their heterotrophic activity plays a key role in the cycling of organic materials in aquatic ecosystems and used as bio-indicators. Zooplanktons are not only useful as bio-indicators to help us detect pollution load, but are also helpful for ameliorating polluted waters [4]. In Nigeria, several studies on zooplankton abundance, composition and diversity have been conducted extensively in water bodies including rivers and lakes [5], [6], [7], [8]. The Great Kwa River is one of the major tributaries of the Cross River Estuary. [9] reported that this important river takes its rise from the Oban Hills in Nigeria, flows southwards and discharges into the Cross River Estuary around latitude 4°45'N and longitudes 8°20'E. However, due to lack of sewage treatment facilities and increase in human population in Calabar municipality, the river ecology is under pollution threat especially as heavy rains wash human and industrial waste into the river [10]. The objective of our study was to investigate the composition and diversity of zooplankton communities in the Great Kwa River with aim of contributing to the knowledge of zooplankton diversity in the river.

2. Material and Methods

2.1 Study Area

The Great Kwa River is one of the major tributaries of the Cross River Estuary. It takes its course from the Oban Hills in Aningeje, Cross River State, Nigeria which flows southwards and discharges into the Cross River Estuary around latitude 4°45' N and longitude 8°20 ' E [9]. The lower reaches of the river drain the eastern coast of the Calabar municipality, the capital of Cross River State of Nigeria. The study was conducted in four sampling stations (Fig. 1) including: Esuk Atu (station 1), Obufa Esuk (station 2), Esuk Anantigha (station 3) and Esuk Abitu (station 4).

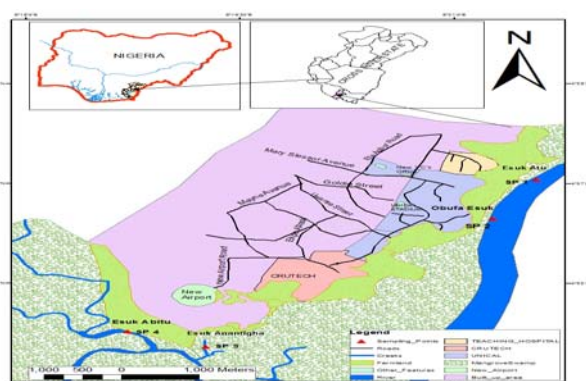


Figure 1: Map of the study area (Great Kwa River) showing the four sampling stations including Esuk Atu (station 1), Obufa Esuk (station 2), Esuk Anantigha (station 3) and Esuk Abitu (station 4)

2.2 Sampling and Zooplankton Analysis

The four sampling stations were sampled twice monthly between May and October, 2012 for zooplankton. Sampling

was carried out between 0700 and 1100hrs starting from Esuk Atu (station 1), Obufa Esuk (station 2), Esuk Anantigha (station 3) and Esuk Abitu (station 4) in that order. Quantitative zooplankton samples were collected by filtering 100 litres of water fetched with a rubber bucket through a 55 µm mesh standard plankton hydrobios net [11]. Zooplanktons were preserved in 4% buffered formalin solution before transporting them to Fisheries and Aquaculture Laboratory, University of Calabar for zooplankton analysis. In the laboratory, quantitative sample from the four stations were concentrated to 10 ml. From the 10 ml, 1 ml from each sample was taken and all individual taxa present were counted. Specimens were sorted, counted using Zeiss binocular microscope at different magnifications (X40, X100 and X400) and identified using relevant literatures [12], [13], [14], [15], [16], [17].

2.3 Species composition (%):

Species composition (%) was calculated as follows:

$$\% SC = n (100)/N$$

Where;

n = the total number of zooplankton species in each taxonomic group.

N = the total number of zooplankton species in all taxonomic group.

2.4 Relative abundance (%):

Relative abundance (%) was calculated as follows:

$$\% RA = n (100)/N$$

Where;

n = the total number of individuals in each zooplankton taxonomic group.

N = the total number of individuals in the entire zooplankton taxonomic group.

2.5 Frequency of occurrence (FO)

Frequency of occurrence (FO) of zooplankton species was evaluated using occurrence constancy index which is based on a four-degree scale: absolute constant species (AS) - > 75%, constant species (S) - 51 -75%, absolute species (A) - 26 - 50% and accidental species (P) - < 25%.

2.6 Zooplankton ecological indices in the Great Kwa River

Ecological indices of zooplanktons in the Great Kwa river was determined using margalef's index (D) Shannon-weiner index (H), Evenness (E) and Simpson indices according to [18] as follows:

2.6.1 Margalef's Index (d)

Margalef's Index (d) is given as:

$$d = S - 1/ \ln (N)$$

Where S is the total number of species, ln the Natural log and N is the total number of individuals.

2.6.2 Shannon-weiner index (H)

Shannon-weiner index (H) is given as:

$$H = \frac{N \log N \sum_{i=1}^s f_i \log f_i}{N}$$

Where N is the total number of individual, f_i is the number of individuals in species and s is the total number of species.

2.6.3 Evenness (E)

Evenness (E) is given as:

$$E = \frac{H}{\log S}$$

Where H is Shannon-weiner index and S is the total number of species.

2.6.4 Simpson index (D)

Simpson index (D) is given as:

$$D = \sum_{i=1}^s \frac{ni(ni - 1)}{N(N - 1)}$$

3. Results

3.1 Zooplankton Species Composition in the Great Kw a River

A total of forty-four (44) species of zooplankton belonging to seven (7) taxonomic groups were recorded during the six - month sampling period of the study (Table 1). The groups Heterodonta and Salpida were represented by one species consisting of 2.27% composition by species (Table 2), followed by Chaetognatha and Decapoda represented by two species consisting of 4.55% species by composition. This was followed by Rotifera represented by seven species (15.91%), eleven species of Cladocera (25.0%) and twenty species of Copepoda (45.45%). Total number of species in the study area in relation to sampling station (Table 3) was highest in Esuk Atu with 34 species (27.2%), followed by 33 species in Anantigha station (26.45), followed by 32 species in Obufa Esuk station (25.6%) and lowest in Abitu station with 26 species (20.8%).

3.2 Zooplankton species diversity indices

In the present study, species diversity and richness (Table 4) was noted to be high in the four sampling stations. Margalef index (D) ranged from 4.36 (Abitu station) to 5.65 (Esuk Atu), Shannon-weiner index (H) ranged from 2.87 (Abitu station) to 3.12 (Anantigha station), Evenness (E) ranged from 0.63 (Esuk Atu) to 0.68 (Abitu and Anantigha station). Simpson index ranged from 0.93 (Abitu station) to 0.94 (Obufa Esuk, Esuk Atu and Anantigha station).

4. Discussions

According to [19], zooplankton stability in any aquatic body of water is of profound importance because they represent important and sometimes unique food source for fish and many aquatic vertebrates. In this study, a total of 1463 individuals were observed in the four sampling stations during the six-month sampling period (465 from Obufa Esuk station, 344 from Anantigha station, 345 from Esuk Atu station and 309 from Abitu station). A total of forty-four species of zooplankton belonging to seven (7) taxonomic groups indicates high species diversity in the study area. The taxonomic groups noted in this study include: Heterodonta, Salpida, Chaetognatha, Decapoda, Rotifera, Cladocera and Copepoda. Species composition (%) was found to be highest in Copepod (45.45%) with relative abundance of 64.52%, followed by Cladocera (25.0%) with relative abundance of 29.46% and lowest in Heterodonta and Salpida (2.27%) with relative abundance of 0.21% and 0.34%. The dominance of Cladocera and Copepoda observed in this study agrees with the report of [20] from Schelde estuary in Belgium that Cyclopoed copepods and several Cladocerans dominated the freshwater and lower brackish water transect of the estuaries. Also, this findings supports [21] who reported Cladocera and Copepoda dominance in Calabar River. According to [22], Copepod Crustaceans are free-living filter feeder zooplankton and this account for their use in bio-monitoring of pollution. In this study, a total of 44 species of zooplankton were recorded in the four sampling stations. This result is higher than the reported 10 species of zooplankton by [23] from Num River, 28 species of zooplankton by [21] from Calabar River, 24 species reported by [24] from Imo River all in the Niger Delta but lower than 66 species reported by [6] in the lower Cross river estuary, Nigeria. Number of species in relation to sampling station recorded in this study was highest in Esuk Atu with 34 species (27.2%), followed by 33 species in Anantigha station (26.45), followed by 32 species in Obufa Esuk station (25.6%) and lowest in Abitu station with 26 species (20.8%). According to [18], diversity indices employed in ecological studies take into account the total number of species encountered in the sample, expressed as richness and the how the species abundances are distributed among the species (evenness). In the present study, species diversity indices of the four sampling stations are relatively high considering the small number of samples taken. The relatively high species diversity and the dominance of Copepoda and Cladocera in the four sampling stations are common to similar water bodies in Nigeria [21]. Range obtained for species diversity indices such as Margalef index (D), Shannon-Weiner index (H), Evenness (E) and Simpson index in this study is similar to findings of [6] but lower than

range obtained by [25] who reported Shannon-Weiner range of 3.65 - 3.66 in a Nigerian forest river. Also, Evenness (E) obtained in this study is also lower than 0.99 - 0.993 reported by [25] in a Nigerian forest river. Frequency of occurrence in terms evaluated in terms of occurrence constancy in the present study showed that only Cladocera and Copepoda had absolute constant species (AS). Cladocera had three absolute constant species (*D. magna*, *D. pulex* and *D. rosea*) whereas Copepoda had seven had absolute constant species (*C. calanus*, *C. finnarchicus*, *D. gracilis*, *E. autifrons*, *E. elongatus*, *P. parvus* and *P. elongatus*).

4.1 Conclusion

In conclusion, this study recorded a total of 44 zooplankton species belonging to 7 taxonomic group in the following order of dominance: Copepods > Cladocerans > Rotifers > Decapods > Chagtoagnathans > Salpidans > Heterodontans. The composition of zooplanktons in the four sampling stations was similar, however with some variations. These findings indicate the unpolluted nature of the Great Kwa River and also provide useful information on the composition and ecology of zooplankton species which could be potentially used as bio-indicators to monitor water quality in the Great Kwa River.

Table 1: Species composition and occurrence constancy of zooplankton in the Great Kwa River in relation to sampling stations, Frequency of occurrence of a particular species on a four-degree scale: absolute constant species (AS) - > 75%, constant species (S) - 51 -75%, absolute species (A) - 26 - 50% and accidental species (P) - < 25%. No. of sampling (n) = 12.

Taxa	Zooplankton species	Esuk Atu Station	Obufa Esuk station	Anantigha Station	Abitu Station
Chaetognatha	<i>Sagitta elegans</i>	P	P	-	-
	<i>Sagitta serratodentata</i>	-	P	-	-
Cladocera	<i>Bosmina longirostris</i>	P	P	P	P
	<i>Conchoecia elegans</i>	P	-	-	-
	<i>Daphnia ambigua</i>	A	S	P	P
	<i>D. hyaline</i>	P	S	A	P
	<i>D. magna</i>	AS	AS	A	AS
	<i>D. pulex</i>	AS	AS	AS	S
	<i>D. rosea</i>	P	AS	A	S
Copepoda	<i>E. nordmanni</i>	P	S	P	P
	<i>Eradne spinifera</i>	P	A	A	A
	<i>Philomedes globosa</i>	-	-	P	-
	<i>Podon polyphemides</i>	P	-	P	-
	<i>Cyclops strenuous</i>	P	P	P	-
	<i>C. vicinus</i>	-	-	P	-
	<i>Calanoides carinatus</i>	P	P	P	P
	<i>Calanus calanus</i>	AS	AS	AS	AS
	<i>C. finnarchicus</i>	A	AS	S	AS
	<i>Cyclopina longicornis</i>	A	S	S	P
	<i>Diaptomus gracilis</i>	AS	AS	AS	AS
	<i>Enterpira acutifrons</i>	A	S	AS	A
	<i>Eucalanus elongates</i>	AS	AS	AS	AS
	<i>Euchaeta marina</i>	P	P	P	P
	<i>Eurytemora</i>	-	P	P	-
<i>Limnocalanus</i>	-	-	P	-	
<i>Miracia effereta</i>	P	-	-	-	
<i>Metridia lucens</i>	-	P	-	-	
<i>Oithona halgolandica</i>	P	P	P	P	
<i>Parapontella</i>	P	P	P	P	
<i>Pseudodiaptomus</i>	A	A	P	P	

	Paracalanus parvus	AS	AS	AS	A
	Pseudocalanus	AS	AS	AS	AS
	Temona stylifera	P	-	-	-
Decapoda	Caridion gordonii	P	P	-	-
	Pasiphaea tarda	-	-	-	P-
Heterodonta	Tellina fibula	P	P	-	-
Rotifera	Asplancha girodi	P	P	S	P
	A. Pridonta	-	-	S	-
	Conochilus unicornis	P	P	-	-
	Keratella longispina	-	-	-	P
	K. quadrata	P	P	S	P
	K cochlearis	-	-	S	P
	Squatinella rustrum	P	-	S	-
Salpida	Salpa democratic	P	P	P	-

Table 2: Number of species, species composition (%) and relative abundance (%) of zooplankton taxonomic group in Great Kwa River

Taxonomic group	Total No. of species	Species composition (%)	%Rel. abundance
Chaetognatha	2	4.55	0.27
Cladocera	11	25.00	29.46
Copepoda	20	45.45	64.52
Decapoda	2	4.55	0.62
Heterodonta	1	2.27	0.21
Rotifera	7	15.91	4.58
Salpida	1	2.27	0.34
Total	44	100.00	100.00

Table 3: Number of species, species composition (%) and relative abundance (%) of zooplankton in the Great Kwa River in relation to sampling stations

Station	Taxonomic group	Total No. of species	Species composition (%)	% Rel. abundance
Obufa Esuk Station	Chaetognatha	2	6.25	0.64
	Cladocera	8	25	30.97
	Copepoda	16	50	63.01
	Decapoda	1	3.125	0.65
	Heterodonta	1	3.125	0.43
	Rotifera	3	9.375	4.09
	Salpida	1	3.125	0.21
	Total	32	100	100
Anantigha Station	Chaetognatha	0	0	0
	Cladocera	10	30.3	28.49
	Copepoda	17	51.52	65.12
	Decapoda	0	0	0
	Heterodonta	0	0	0
	Rotifera	5	15.15	5.81
	Salpida	1	3.03	0.58
	Total	33	100	100
Esuk Atu Station	Chaetognatha	1	2.94	0.29
	Cladocera	10	29.41	29.56
	Copepoda	16	47.06	64.06
	Decapoda	1	2.94	1.16
	Heterodonta	1	2.94	0.29
	Rotifera	4	11.77	4.06
	Salpida	1	2.94	0.58
	Total	34	100	100
Abitu Station	Chaetognatha	0	0	0
	Cladocera	8	30.77	28.15
	Copepoda	13	50	66.67
	Decapoda	1	3.85	0.65
	Heterodonta	0	0	0
	Rotifera	4	15.38	4.53
	Salpida	0	0	0
	Total	26	100	100

Table 4: Species diversity indices of zooplankton taxonomic group in the Great Kwa River in relation to sampling stations

	Sampling stations			
	Esuk Atu	Obufa Esuk	Anantigha	Abitu
Taxa (s)	34	32	33	26
Individuals	345	465	344	309
Maralef index (D)	5.65	5.05	5.48	4.36
Shannon-weiner index (H)	3.06	3.05	3.12	2.87
Evenness (E)	0.63	0.66	0.68	0.68
Simpson index	0.94	0.94	0.94	0.93

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