Ecological Assessment of Zooplankton Diversity in A Tropical Rainforest River in Akwa Ibom State, Nigeria.

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Abstract: Ecological assessment of zooplankton diversity in Ikpe Ikot Nkon River, Akwa Ibom State, Nigeria was conducted for twelve months between October, 2017 and September, 2018. The objective of the study was to investigate the abundance and species composition of zooplankton from three sampling stations in the study area. A total of twenty-five (25) taxa, comprising 906 individual zooplankton species, belonging to four (4) taxonomic groups were identified. Rotifer dominated with 32.9 %, followed by cladoceran 30.4 % and protozoa which contributed 17.7 % of total abundance of zooplankton species identified during the study. Station 1 had the highest number of individual species (456), followed by station 2 (268) and station 3 (182) with the relative abundance of 50.4%, 29.6% and 20% respectively. *Pleuroxus levis* were observed to be the most abundant species which accounted for 9.16%, followed by *Zoeo larvae* 7.50 %, *Daphnia pulex* 7.39 %, *Trichocera similis* 7.17 % and the lowest was *Bosmina longirotris* 0.22 %. Seasonally, high number of species were recorded during the wet season (546) over the dry season (360) with the relative abundance of 60.3 % and 39.7 % respectively. Based on these findings, it could be concluded that the low species of zooplankton obtained in this study were influenced by the ecological characteristics of the water body.

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1. Introduction

Zooplanktons are the primary consumers of aquatic ecosystems, constitute extremely diverse assemblage of aquatic organisms, which some are planktonic during the larval and become nektonic in the adult stage. Shivashankar and Venkataramana (2013) defined zooplanktons as microscopic forms of life with little or no resistance to water current and are free floating organisms. Ovie (2011), also defined zooplanktons as the free floating aquatic invertebrates, often described as microscopic due to their nature in sizes that range from a few to several micrometers and are rarely exceeding a millimeter.

The dominant zooplankton species includes Rotifers, Copepods, Ostracods and Cladocerans; their abundance and distribution generally depend on the inherent physico-chemical characteristics and geomorphological nature of the environment. Odeite (1993) affirmed that plankton growth and distribution depended on the carrying capacity of the environment and on the nutrients concentration. Essein-Ibok and Ekpo (2015) affirmed that zooplankton abundance in Mbo River, Nigeria were associated with the seasonal fluctuations in some physical and chemical factors which include dissolved oxygen, hydrogen ion-concentration, total hydrocarbons and nutrients concentration.

Zooplankton plays a vital role in aquatic ecosystems; it formed the second step on aquatic food chains, and a major source of food and protein required by fish for growth. Dorak (2013), reported that zooplankton organisms are said to be good bio-indicators of water quality because they are strongly influenced by environmental modifications. In Nigeria, several studies on zooplanktons have been conducted and reported which among them include Eyo *et al.* (2013) reported on the ecology and diversity of zooplankton in the Great Kwa River, Ikomi and Anyanwu (2010) reported on the zooplankton of Ogba River, Benin City, Essien-Ibok and Ekpo (2015) during their studies on the physico-chemical factors influencing zooplankton community structure of a tropical river, Niger Delta, and Essenowo *et al* (2017) during their studies on evaluating the physico-chemical characteristics and plankton diversity of Nwaniba River, but there is dearth of information on zooplankton composition and diversity of Ikpe Ikot Nkon River. The river has been subjected to domestic and agricultural activities, and it is the major source of water for drinking, irrigation and other domestic purposes to the inhabitants of these communities. The objective of this study is to investigate the taxonomic composition of zooplankton diversity and abundance in Ikpe Ikot Nkon River,

which will help in the sustainable management and development of aquatic ecosystem.

2. Material and Methods

2.1 Study Area

Ikpe Ikot Nkon River is one of the major rivers in Ini Local Government Area, Akwa Ibom State, Nigeria. It lies between the latitude of 5^0 24.0''59.0N and longitude of 7^0 46''55.7 E (Figure 1). The river takes its course from Nkari River which flows in a North-west direction and discharge into Eniong River in Odukpani, Cross River State. The flood plains are fertile, wet and very productive in dry and wet seasons; and the river received allochtonous inputs of organic and inorganic wastes from the surrounding vegetation and a non-point pollutants of anthropogenic sources due to agricultural land used. The climate of the area is characterized by a long wet season usually lasting from May to November and a short period of dry weather from December to April.

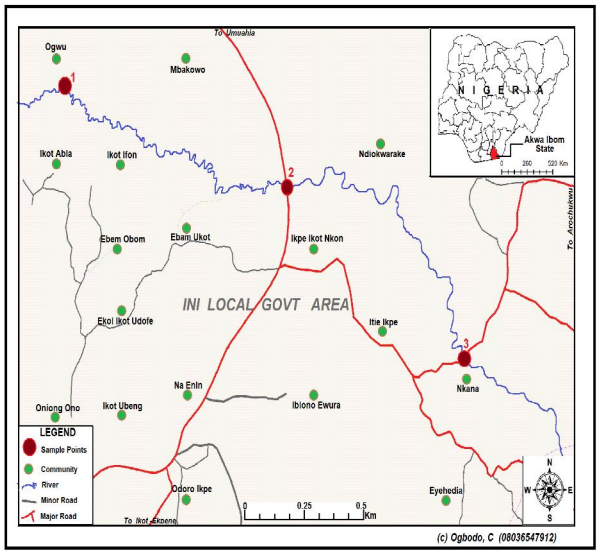

Figure 1: Map of the Study Area Showing the Sampling Stations

2.2 Samples Collection and Analysis

Zooplankton were randomly collected from three different selected stations along the river course (upstream-station 1, midstream-station 2 and downstream –station 3). Station 2 is 2km down away from station 1 and station 3 was also 2km downstream away from station 2. The samples were collected on monthly interval between October, 2017 and September, 2018, between the hours of 8.00am and 12.00noon each sampling day. Zooplankton samples were collected by filtering 100 litres of water fetched with a rubber bucket through standard plankton hydrobios net of 55µm mesh size. The concentrated samples were fixed and preserved in 4% buffered formalin solution with a few drops of Lugol's iodine solution before taken to the laboratory for analysis. In the laboratory, quantitative sample from the three sampling stations were concentrated to 10ml. From the 10ml, 1 ml from each sample were examined under a compound microscope at different magnifications (x40, x100 and x400), and all individual taxa present were sorted, counted, and identified based on the identification guide of Edmondson (1966), Altaff (2004), Korinek (1999), Newell and Newell (1966).

2.3 Relative Abundance (%)

Relative abundance (%) was calculated as follows:

$$\% \text{ RA} = \frac{n\,(100)}{N}$$

Where:

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

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

2.4 Diversity Indices of Zooplankton Species

The diversity indices of zooplankton fauna were determined using margalef's index (D), Shannon-weiner index (H) and Evenness (E) according to Ogbeigbu (2005). All calculations of diversity indices were made using PAST (Paleontological Statistics, Version 3.0) software.

2.4.1 Margalef's Index (D)

The margalef's index (d) was used to determine the richness of zooplankton species in each of the stations. It is express as:

$$d = \frac{S-1}{\ln (N)}$$

Where: S = Total numbers of species (taxa)

N= Total numbers of individual's species

In= Natural logarithm

2.4.2 Shannon–weiner Index (H)

The species diversity was calculated by using Shannon –weiner index (H). It is express as:

$$H = -\sum_{i=1}^{S} Pilnpi$$

Where: pi =S/N

S= Number of individual of one species

N= Total number of all individuals in the sample

In = Logarithm to base e.

2.4.3 Evenness index (E)

This was used to determine the degree of uniformity of species in each sampling stations. It is express as:

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

Where:

H= the number derived from

Shannon-weiner index
S= the number of species
In= the natural logarithm

3. Results

3.1 Zooplankton Species Composition

Zooplankton species composition encountered and identified in this study are presented in Table 1. Relative abundance of zooplankton groups is shown in figure 2. A total number of 25 taxa comprising of a total of 906 individual's zooplankton species, belonging to four (4) taxonomic groups were identified. Rotifera was the most abundant taxa recorded with the highest number of taxa (9) with 298 individual's species and the relative abundance accounted for 32.9 %; followed by cladoceran (7), individual species (275) and relative abundance of 30.4 %; copepoda (5), individual species (173), relative abundance of 19 %, and the least were protozoa (4) with a total number of 160 individuals, relative abundance accounted for 17.7% respectively.

Total number of species in relation to sampling stations revealed that station 1 had the highest number of individual's zooplankton species (456), station 2 (268) and station 3 (182) with their relative abundance of 50.4 %, 29.6 % and 20 % respectively. *Microcodon* species was the most abundant zooplankton recorded in station 1 and the lowest was *Keratella quadrata*. *Pleuroxus plevis* were the highest in terms of species occurrence in station 2, followed by *Trintinnopsis lacustris* and the least was *Metacyclops minutus*. *Trichocera similis* were recorded higher in number in station 3, followed by *Alona exima*. *Pleuroxus levis* of cladoceran were the highest in terms of zooplankton species abundance recorded across the stations which accounted for 9.16 %, followed by *Zoeo larvae* (7.50 %) of copepod and *Daphna pulex* of cladoceran (7.39%), *Trichocera similis* of Rotifera accounted for 7.17%, and the least was *Bosmina longirotris* with the relative abundant of 0.22%. Higher Zooplankton abundance were recorded at the peaked during the wet season month of September with average abundance of 132 individuals followed by August (106) and April (99). A total of 83 individuals were recorded in the month of October, and the lowest number of zooplankton species was recorded in the month of December and March during the study period (Figure 3).

In seasonality, higher zooplankton species were obtained during wet season over the dry season in all the sampling stations (Figure 4). A total of 546 individual's zooplankton species were identified across the station in wet season, while 360 were identified during the dry season with relative abundance of 60.3% and 39.7% respectively. Rotifera were observed to be high in both dry and wet seasons in station 1, while cladoceran were recorded higher in station 2 in both seasons. Species diversity index shows that Margalef value ranged between 3.041 and 3.425. Station 2 recorded the lowest value of 3.041, while the highest values were recorded in station 1, Shannon-weiner and Evenness values were higher in station 1 (2.385 and 0.771). The lowest were recorded in station 3 (2.034 and 0.718) respectively.

Table 1: Relative Abundance and Composition of Zooplankton in Ikpe Ikot Nkon River identified during the study period (October, 2017 - September, 2018).

Species Composition	ST. 1	ST. 2	ST.3	Total	R.A %
COPEPODA					
Zoeo larvae	32	23	13	68	7.50
Neuplius larvae	17	-	-	17	1.87
Metacyclops minutus	7	3	-	10	1.03
Mesocyclops leukati	22	13	16	51	5.62
Tropocyclops prasinus	12	8	7	27	2.98
TOTAL	**90**	**47**	**36**	**173**	**19.0**
PROTOZOA					
Sphaerophysa sp	13	8	3	24	2.64
Paramecium caudatum	38	10	7	55	6.07
Carchesium polypium	19	-	-	19	2.09
Trintinnopsis lacustris	20	34	8	62	6.83
TOTAL	**90**	**52**	**18**	**160**	**17.7**
ROTIFERA					
Keratella quadrata	3	-	6	9	0.99

Species Composition	ST. 1	ST. 2	ST.3	Total	R.A %
Asplanchna priodonata	18	10	-	28	3.09
Microcodon sp	43	-	12	55	6.07
Brachionus caudatus	8	-	3	11	1.21
Trichocera similis	28	13	24	65	7.17
Filinia longiseta	18	11	-	29	3.20
Lecane bulba	16	12	12	40	4.41
Notholca labis	7	16	8	31	3.42
Dicranophorus caudatus	18	9	3	30	3.31
TOTAL	**159**	**71**	**68**	**298**	**32.9**
CLADOCERA					
Bosmina longirotris	-	2	-	2	0.22
Daphnia pulex	39	18	10	67	7.39
Daphnia longis	26	-	-	37	4.08
Macrothrix spinosa	-	19	-	19	2.09
Pleuroxus levis	29	36	18	83	9.16
Daphnia magna	23	-	-	23	2.53
Alona exima	-	23	21	44	4.85
TOTAL	117	98	60	275	30.4
No. of taxa	22	18	16		
No. of Individuals	456	268	182		
Margalef index (D)	3.425	3.041	3.076		
Shannon-weiner (H)	2.385	2.177	2.034		
Evenness (E)	0.771	0.753	0.718		

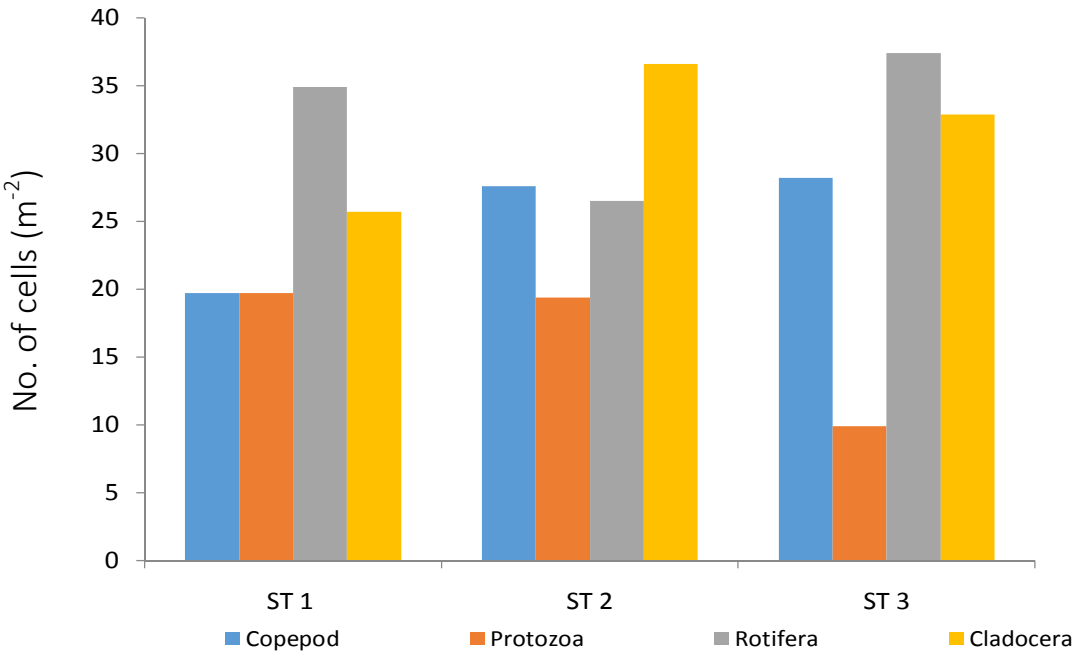

Fig. 2 Relative Abundance of Major Taxonomic Groups of Zooplankton at the three Sampling Stations.

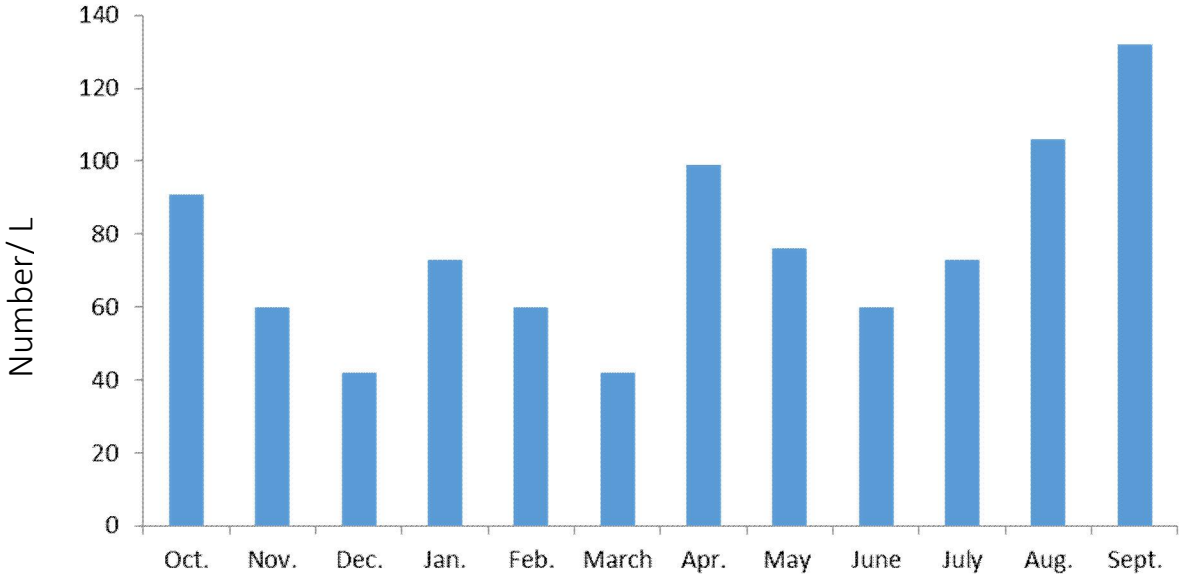

Fig.3. Monthly Variation of Zooplankton Composition during the Study period

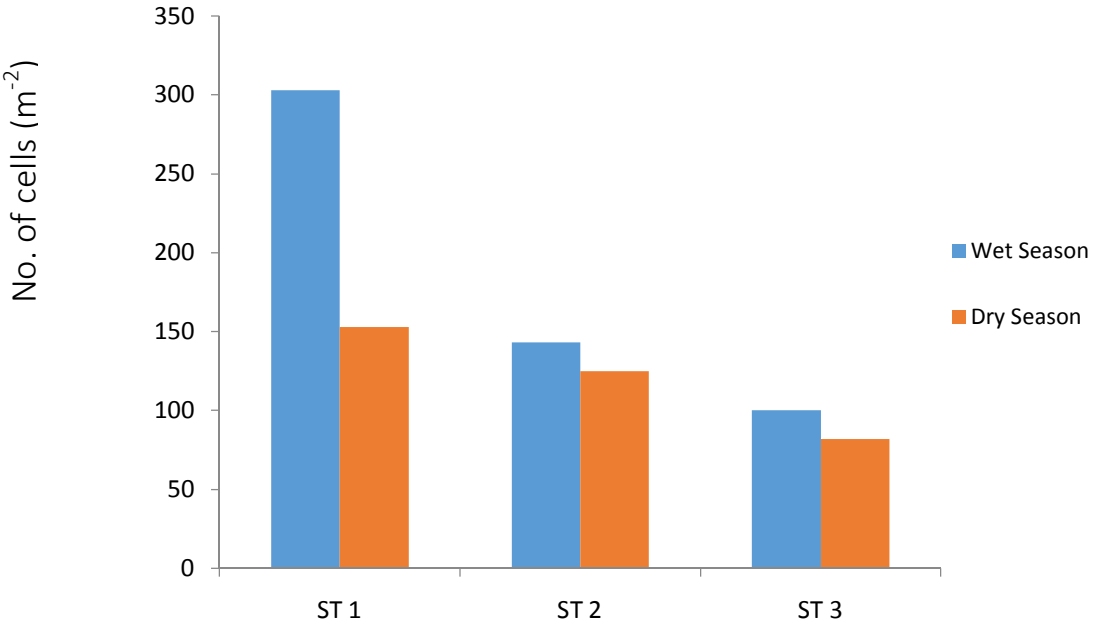

Fig. 4 Seasonal Abundance of Zooplankton at the three Sampling Stations during the period of study.

4. Discussions

The findings of the present investigation revealed that anthropogenic perturbations have impacts on composition, diversity and abundance of zooplankton species. In this study, a total of 25 taxa, comprising of 906 individual's zooplankton, belonging to four (4) taxonomic groups were identified. The zooplankton species recorded in this study were dominated by rotifera and cladoceran, while the least group were protozoa. The dominant of rotifera when compared with copepoda and protozoa evidenced during this study is a characteristic of tropical lakes and rivers. This is in agreement with the reports of Edema *et al.* (2002) in Okhuo River; Neves *et al.* (2003) from two marginal lakes of the river Cuiaba (Brazil); Eyo *et al.* (2013) from Great Kwa River, IIoba and Ruejoma (2014) in Ekpan River Delta State. Also, this finding supported the reports of Imoobe and Akoma (2009) and Imoobe and Adeyinka (2010), who recorded rotifera as the most dominant species from a tropical forest River and contradict with the findings of Akin-Oriola (2003) in Ogunpa and Ona Rivers, who reported higher dominant of copepods species.

The 25 species of zooplankton recorded in this study is lower than the reported 66 species of zooplankton by Ekwu and Sikoki (2005) from Lower Cross River Estuary; 44 species reported by Eyo *et al.* (2013) and higher than the 20 species reported by Ohimain *et al.* (2002) from Warri River, Niger Delta and 10 species reported by Yakubu *et al.* (2000), and 24 recorded by Zabby *et al.* (2008) from Imo River, Niger Delta, Nigeria. High Zooplankton species were recorded in station 1 and the least was in station 3. These differences in species composition and abundance may be attributed to the ecological differences in habitat structure, location, period of investigation, food availability and anthropogenic activities in these stations. Highest species of zooplankton recorded in September and August during the wet season may be attributed to the high concentration of nutrients favourable for zooplankton growth. Similar report had been recorded by Essien-Ibok and Ekpo (2015); Essien-Ibok *et at.* 2010; Adesalu *et. at*., 2010; and Nwankwo, (2004), where they reported high abundance of zooplankton species during the wet season, where the authors attributed to high concentration of nutrient elements such as phosphate and nitrate in the water body brought in via surface run-off.

The seasonal trend in zooplankton species composition obtained in this study is in consonance with the findings of Essien-Ibok and Ekpo (2015), Kemidirim (2000), Davies *et. al*., (2009) and Imoobe (2011). High zooplankton species were recorded in wet season over the dry season. This may be attributed to seasonal fluctuations of nutrients, increased in water currents, dissolved oxygen and low human activities. High nutrients concentration in the wet season may be linked to precipitation which carried wastes rich in phosphate and nitrate through surface runoff from the surrounding agricultural lands into the water body. High concentration of these nutrients during the wet season may be attributed to high zooplankton species composition and abundance as reported by Balugun and Ladigbolu (2010); Ekpo (2013) in a related research and contradicts with the findings of Ogbeibu (1998), who reported high abundance of zooplankton species during dry season due to stability of water current and low content of nutrients in the water body.

High values of Margalef index; Shannon and Evenness were recorded in station 1, while station 3 had lowest values of these aforementioned indices. The low values in these diversity indices in station 2 and 3 is believed to have emanated from severe stress imposed by anthropogenic activities in this station of the river. The high diversity recorded for shannon and margalef in station 1 may entail that this station was relatively stable and stress free, and high evenness value observed in station 1 may reflect that there was uniformity in the distribution of zooplankton in this station.

5. Conclusion

Based on the investigation, the zooplankton composition of Ikpe Ikot Nkon is low when compared with research carried out in other water bodies in Nigeria. The variation in species composition among the sampling stations indicate that the river is polluted, and the assessment of community and ecosystem stability using overall diversity showed that station 1 is the most complex and stable station.

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