



## **Spatial and Temporal Variation in Zooplankton Composition and Abundance in a Tropical Freshwater Ecosystem in the Niger Delta, Nigeria.**

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**Abstract:** The spatial and temporal variation in zooplankton abundance of Mbo River was investigated for 10 months from November 2017, to August, 2018. Zooplankton samples were collected from three stations and analyzed using standard methods. The study recorded 1539 zooplankton individuals made up of 7 taxa, 32 genera and 33 species. They included Copepoda (16 species) >Rotifera (8 species)>Cladocera (6 species) >Protozoa (5 species)>Chordata (3 species) >Gastropoda (2 species) and Polychaeta (1 species). Copepoda occurred at all stations and was the most abundant taxon with the highest frequency of occurrence (63.8 %) followed by Rotifera (24.1%). Others following included: Chordata (8.1%), Protozoa (3.2%), Cladocera (2.2%) and Gastropods (0.9%). Cladocera and Gastropods were rare during the study. The zooplankton groups that showed significant differences across the sampling stations ( $p < 0.05$ ) included Rotifera, Copepoda, Chordata, and Protozoa while Gastropoda, Polychaeta and Cladocera did not show significant differences across the sampling stations ( $p > 0.05$ ). Also, there were significant differences ( $p < 0.05$ ) in the abundance of zooplankton groups in both dry and rainy seasons. The dominant species found were: *Lecane quadridentata* (4.0%); *Naupilius larva* (3.24%), *Microsetalla rosea* (3.37), *Naupilius copepod* (14.4%), *Cyclopoia copepod* (15.8%); fish larva (6.88%); *Arcella vulgaris* (1.42%) and *Daphnia longispina* (0.91%). The distinction in the presence and numeric abundances of species particularly *Keratella sp* (2.33%), *Brachionus sp* (3.64%), *Trichocerca sp* (1.75%), *Paracalamus parvus* (1.36%) across stations is quite indicative of pollution status and salinity condition of the stations. It further underscores the adaptability of diverse species to different environmental conditions. In conclusion, the river hosts a vast diversity of indigenous planktons. Hence, there is need for periodic assessment of zooplankton in the river since this may help identify significant changes in plankton composition which may result from anthropogenic disturbances leading to poor water conditions. Also, extensive researches on the zooplankton's population is paramount to maintaining high environmental quality control and sustainable fisheries development.

[Effiong, YI., George, UU., Oboho, DE., Mbong, EO. **Spatial and Temporal Variation in Zooplankton Composition and Abundance in a Tropical Freshwater Ecosystem in the Niger Delta, Nigeria.** *N Y Sci J* 2021;14(4):1-12]. ISSN 1554-0200 (print); ISSN 2375-723X (online). <http://www.sciencepub.net/newyork>.  
1. doi:[10.7537/marsnys140421.01](https://doi.org/10.7537/marsnys140421.01).

**Keywords:** Zooplankton, Tropical, Freshwater Ecosystem, Composition, Abundance, Niger Delta, Nigeria

### **1.0 Introduction**

Zooplankton is an integral component of aquatic ecosystem and comprises microscopic animal life that passively floats or swims freely. They are classified into micro zooplankton (20-200 $\mu$ m), micro zooplankton (200 $\mu$ m-2mm) and macro-zooplankton (>2mm) (Anene, 2003). They graze on primary producers and inorganic debris in the water column and therefore contribute the most important link in the energy transfer between phytoplankton and higher aquatic organism (Iloba, 2002). Zooplankton migrates upward from deeper strata as darkness approaches and return to the deeper area at dawn (Carney, 1990). Distribution of zooplankton and their variation at different zone of water body is known to

be influenced by physicochemical parameters of water (Goswami, 2012).

Zooplankton richness is the number of species present in a given area sampled. Removing just one species from an ecosystem damages the flow of energy in that system (Verma and Agarwal, 2007). Sharma (2011) reported that increase of primary production is accompanied by increase in zooplankton abundance. Zooplankton communities of fresh water bodies constitute an extremely diverse assemblage of organisms represented by most of the invertebrate phyla. However, the typical zooplankton assemblage of an aquatic ecosystem commonly comprises protozoa, rotifera, copepod and cladocera and their distribution and diversity are influenced by seasonal variation of physico-chemical properties,

biotic factors including feeding and ecology (Egborge, 1994).

Freshwater zooplankton are generally smaller in size and represented by fewer animals' phyla than their marine counterparts (Yakubu *et al.*, 2000; Rajagopal *et al.* 2010). The most common group of organisms in the zooplankton community are the copepods (small insect like crustaceans which range from 0.5mm to 6mm). They are known to reach large concentrations and they form the main food source for higher trophic levels.

Several studies have been reported on zooplankton in Nigeria. Iloba and Rujoma (2014) investigated the zooplankton dynamics of Ekpan River; Akin-Oriola (2003) monitored zooplankton abundance and composition in Ogunpa and Ona rivers respectively; Imoobe (2011) studied the diversity and seasonal variation of zooplankton of Okhuo River, Edo State; Imoobe and Adeyinka (2009) assessed the zooplankton trophic state of a tropical forest River in Nigeria; etc. Therefore, this study is aimed at understanding the composition and abundance of zooplankton in Mbo River, Niger Delta, Nigeria.

## 2.0 Materials and Methods

### 2.1 Study Area

Mbo River (Fig. 1.0) is one of the major rivers in Akwa Ibom State, Nigeria, traversing across

two local government areas; Mbo and Udung Uko Local Government Areas and lies within latitude  $4^{\circ}30'$  to  $5^{\circ}30'$  North and longitude  $7^{\circ}30'$  to  $8^{\circ}30'$  West on the south eastern Nigeria coastline. It is a near coastal river located within the Cross-River Basin and drains into the Cross-River Estuary at Ibaka in the Bight of Bonny, with which it maintains a permanent mouth thus exposing the river system to tidal ebb and flood. It forms part of the Atlantic Drainage system (Anukam, 1997) east of the Niger which comprises the Cross, Imo, Qua Iboe and Kwa Rivers. Mbo River which is within the Niger Delta Zone of Nigeria is located within tropical rain forest region characterized by tropical humid climate with distinct dry (November-March) and wet (April-October) seasons. The dry season is characterized by prevalence of dry tropical continental winds from the Sahara Desert while the wet season is typified by moist tropical wind from the Atlantic Ocean.

The vegetation cover of the drainage basin is dominated by dense Nipa palm (*Nypa fruticans*) which is aggressively displacing the mangrove trees (*Rhizophora* spp) (Orok *et al.*, 2010). Mbo River is an important ecosystem because it supports the local economic activities such as agriculture, fishery, eco-tourism and water supply for domestic use (at its upstream reaches).

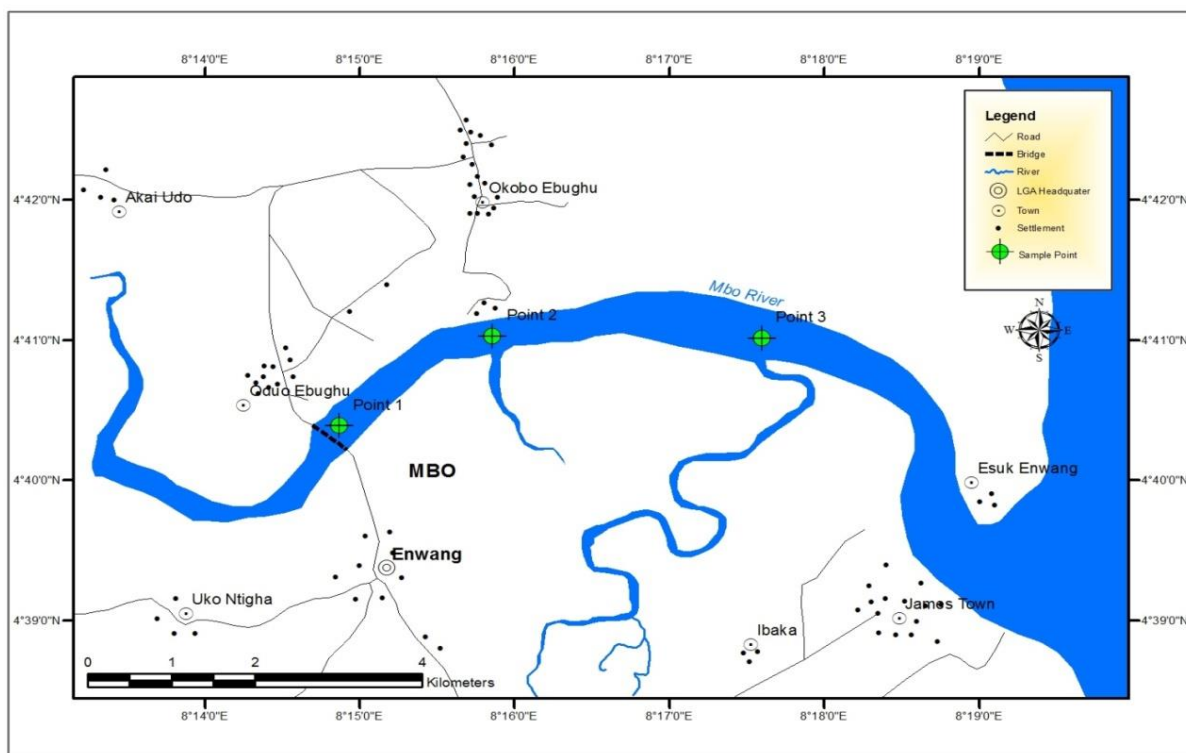


Figure 1: Map of the Study Area Showing Sampling Stations

## 2.2 Sampling Stations

Three sampling stations along the stretch of the river were established. (Fig. 1). The stations were chosen along the river gradient. Station 1 is located at Esuk Uloh. Station 2 is located between the bridge head and the defunct fishing terminal, at Esuk Egbughu where the virgin forest is located which is believed to be highly contaminated (mid-stream). The average depth of this site is about 4.1m. The fringing vegetation is mainly *Nypa fruticans* because mangrove species have been either replaced by the Nypa palm or felled for construction and fire wood for smoking of fish and for domestic use. This station records intense human activities such as inflow of domestic sewage, intense fishing and faecal discharge which could impact negatively on this location along the river. Other activities here include the use of motorized boat for commercial services and a small landing port for medium sized sea faring boats, with lots of mechanical repairs going on here. Station 3 (Esuk Ukontenge Creek) is located about upstream of Mbo River. The average depth for this station is about 3.5m. The fringing vegetation is mainly of red mangrove (*Rhizophora* spp).

## 2.3 Sample Collection and Sampling Regime

Sampling was carried out fortnightly at the three sites from November 2017 to August 2018 inclusive, during the mid-morning hours (8:00am to 12 noon). Plankton samples were collected using a plankton net of mesh size 25 $\mu$ m. The plankton net was immersed below the water surface, towed for 5 minutes at each sampling station, until a sufficient quantity of plankton was collected. For qualitative estimation of plankton, 1 litre of surface water was filtered through the plankton net and preserved with 1 % Lugol's iodine solution to fix the samples.

## 2.4 Analysis of Sample

In the laboratory, quantitative sample from the three stations were concentrated to 10ml. 0.2ml of the concentrated sample was pipetted out from a calibrated pipette into a glass slide. A cover slip was carefully placed, and observed under a binocular compound microscope at 10 $\times$  and 40 $\times$  magnification. Lugol's solution was used for staining the samples to enhance proper discernment of the zooplankton species based on morphological features, as individual species normally takes up the stain, thereby exposing the organelles for proper identification according to Akpan, (1994). The numerical abundance of plankton was done by direct count method. The zooplankton taxa were identified

using keys and guides given by Jeje and Fernando (1986) and APHA (1985), Fernando (2002).

## 2.5 Data Analysis

Statistical package for Social Sciences (SPSS) software was used in the statistical analyses while the data were presented as mean and standard error. Analysis of variance (ANOVA) was used to compare abundance among the different species of zooplankton and seasons. Duncan multiple range test (DMRT) was used to test for level of significant differences among the variables. Data obtained from zooplankton group were empirically analyzed using the formula:

$$\% Ra = n/N \times 100 \text{ (Ali et al., 2003).}$$

Where:

%Ra = relative abundance

N = number of individuals

N = total number of all individuals.

Tables, and bar charts were used where necessary to present result.

## 3.0 Results

### 3.1 Spatial Distribution and Abundance of zooplankton Community in Mbo River

Spatial distribution of zooplankton species in the study area is outlined in Table 1. The study recorded 1539 zooplankton individuals made up of 7 taxa, 32 genera and 33 species. These included: Copepoda (16 species) > Rotifera (8species) > Cladocera (6species) > Protozoa (5species) > Chordata (3 species) > Gastropoda (2species) and Polychaeta (1species). Copepoda was the most dominant taxon in terms of abundance and diversity forming 63.8 % across the stations. Rotifera ranked second in terms of percentage share to the zooplankton density and contributed about 21.4% of the community followed by Chordata (8.1%), Protozoa (3.2%), Cladocera (2.2%), Gastropods (0.9%) and Polychaeta (0.3%) (Fig 2). The dominant species in the zooplankton groups were: *Lecane quadridentata* (4.0%) (Rotifera); *Naupilius larva* (3.24%), *Macrosetalla rosea* (3.37%), *Naupilius copepod* (14.4%), *Cyclopoia copepod* (15.8%) (Copepoda); fish larva (6.88%) (Chordata); *Arcella vulgaris* (1.42%) (Protozoa) and *Daphnia longispa* (0.91%) (Cladocera). The zooplankton groups that showed significant differences across the sampling stations ( $p < 0.05$ ) include Rotifera, Copepod, Chordata, Protozoa, while Gastropoda, Polychaeta and Cladocera did not show significant differences across the sampling stations ( $p > 0.05$ ) (Table 2).

**Table 1: Spatial Variation of Zooplankton in Mbo River, Nigeria**

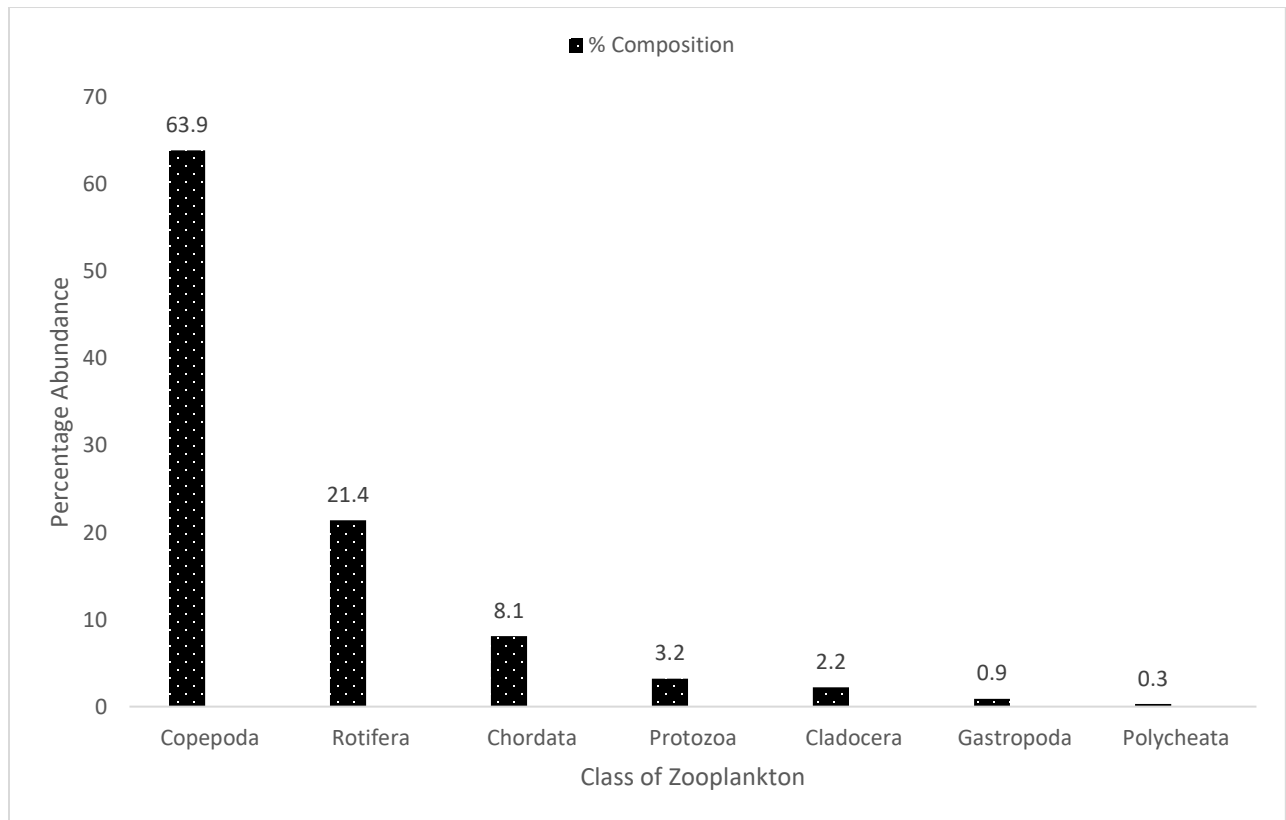
	Station 1	Station 2	Station 3	Total	% Freq
<b>ROTIFERA</b>					
<i>Platycas ptidus</i>	23	3	19	46	2.98
<i>Keratella tropica</i>	19	5	12	36	2.33
<i>Brachonus plicatilis</i>	27	6	23	56	3.64
<i>Euchlanis</i> spp	26	5	15	46	2.98
<i>Dicranophorus</i> spp	20	3	16	39	2.53
<i>Lecane quadridentata</i>	34	6	23	62	4.02
<i>Trichocerca tropica</i>	13	2	12	27	1.75
<i>Filinia longiseta</i>	7	2	9	18	1.16
<b>Sub-total</b>	<b>169</b>	<b>32</b>	<b>129</b>	<b>330</b>	<b>21.4</b>
<b>COPEPODA</b>					
<i>Nauplius larva</i>	20	5	26	50	3.24
<i>Calanoides carinatus</i>	16	5	15	36	2.33
<i>Cyclops vicinus</i>	18	3	10	30	1.94
<i>Euchaeta marina</i>	19	3	14	39	2.53
<i>Oithona setigera</i>	16	5	19	40	2.59
<i>Oriceace venusta</i>	23	4	15	42	2.72
<i>Euytemora</i> spp	24	3	22	49	3.18
<i>Upogebia</i> spp	16	4	8	25	1.62
<i>Microsetella rosea</i>	26	4	22	52	3.37
<i>Oncaea nifera</i>	13	3	11	27	1.75
<i>Paracalanus parvus</i>	15	1	5	21	1.36
<i>Eucalanus elongatus</i>	15	5	18	38	2.46
<i>Pseudocalanus elongatus</i>	14	2	9	25	1.62
<i>Cyclopoia copepod</i>	118	26	100	244	15.85
<i>Episctuna lascustris</i>	17	4	21	42	2.72
Nauplii copepod	105	23	92	222	14.42
<b>Sub-total</b>	<b>475</b>	<b>100</b>	<b>407</b>	<b>982</b>	<b>63.80</b>
<b>GASTROPODA</b>					
Gastropoda larva	3	0	4	7	0.45
Cypria javana	2	0	5	7	0.45
<b>Sub-total</b>	<b>5</b>	<b>0</b>	<b>9</b>	<b>14</b>	<b>0.91</b>
<b>POLYCHAETA</b>					
Polychaeta larva	1	0	4	5	0.32
<b>Sub-total</b>	<b>1</b>	<b>0</b>	<b>4</b>	<b>5</b>	<b>0.32</b>
<b>CHORDATA</b>					
Fish larva	47	13	46	106	6.88
Lamellibranch larva	2	0	1	3	0.19
Gastropod larva	6	1	8	15	0.97
<b>Sub-total</b>	<b>55</b>	<b>14</b>	<b>55</b>	<b>124</b>	<b>8.05</b>
<b>PROTOZOA</b>					
<i>Arcella vulgaris</i>	12	2	8	22	1.42
<i>Cyclophyxis</i>	5	0	4	9	0.58
<i>Imperessa</i>					
<i>Diffugia</i> spp	2	0	2	4	0.25
<i>Cleliadium</i> ciliate	7	1	4	12	0.77
<i>Tintinolum</i> sp	1	1	1	3	0.19
<b>Sub-total</b>	<b>27</b>	<b>4</b>	<b>19</b>	<b>50</b>	<b>3.24</b>
<b>CLADOCERA</b>					
<i>Daphnia longispa</i>	4	7	3	14	0.91

Chromogaster ovalis	2	0	1	<b>3</b>	<b>0.19</b>
Filinia longiseta	3	0	3	<b>6</b>	<b>0.38</b>
Monosytyta reticulate	1	1	1	<b>3</b>	<b>0.19</b>
Keratella cochlearie	0	0	1	<b>1</b>	<b>0.06</b>
Notholea longispa	5	1	1	<b>7</b>	<b>0.45</b>
<b>Sub-total</b>	<b>15</b>	<b>9</b>	<b>10</b>	<b>34</b>	<b>2.20</b>
<b>Grand Total</b>	<b>747</b>	<b>159</b>	<b>633</b>	<b>1539</b>	<b>100</b>
<b>% composition</b>	<b>48.6</b>	<b>10.3</b>	<b>41.1</b>	<b>100</b>	

**Table 2: Spatial Distribution and Abundance of Zooplankton (unit/L) in Mbo River**

Taxon	Station 1	Station 2	Station 3	Total	Total % composition	F	p	Decision Rule
<b>ROTIFERA</b>	169	32	129	330	21.4	12.22	0.00**	p < 0.05, ** significant
<b>COPEPODA</b>	475	100	407	982	63.9	12.88	0.00**	p < 0.05, ** significant
<b>GASTROPODA</b>	5	0	9	14	0.9	0.194	0.825*	p > 0.05 * not significant
<b>POLYCHAETA</b>	1	0	4	5	0.3	0.125	0.883*	p > 0.05 * not significant
<b>CHORDATA</b>	55	14	55	124	8.1	5.407	0.011**	p < 0.05, ** significant
<b>PROTOZOA</b>	27	4	19	50	3.2	3.547	0.043**	p < 0.05, ** significant
<b>CLADOCERA</b>	15	9	10	34	2.2	0.508	0.607*	p > 0.05 * not significant
<b>Total</b>	<b>747</b>	<b>159</b>	<b>633</b>	<b>1539</b>				
<b>% composition</b>	<b>48.6</b>	<b>10.3</b>	<b>41.1</b>		<b>100</b>			

(a) Key: \*not significant @ p > 0.05, \*\*significant @ p < 0.05



## Figure 2: Percentage Composition of Zooplankton Community in Mbo River

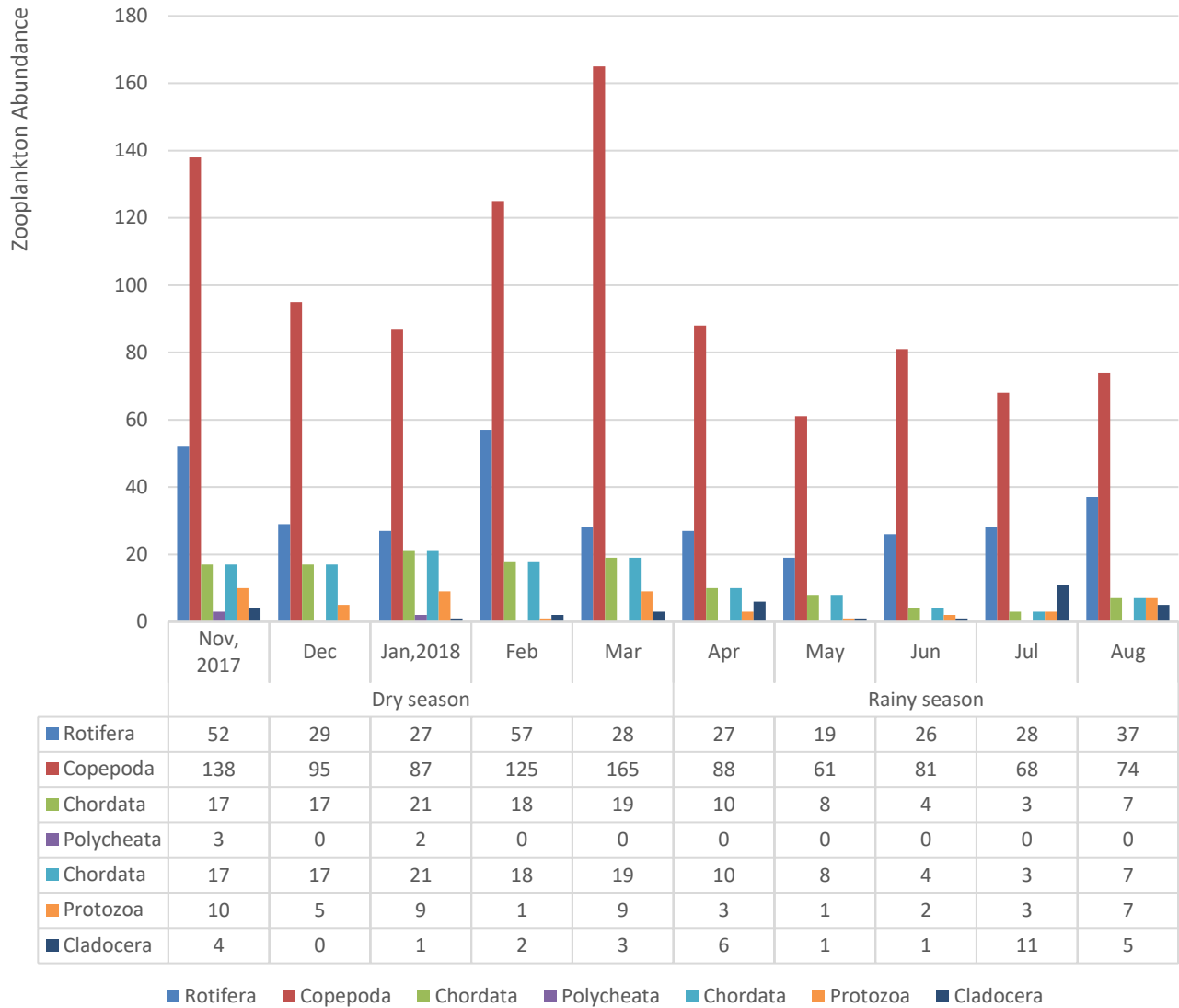
### 3. 2 Seasonal variation of Zooplankton community in Mbo River

A total of 1539 individuals were recorded for the zooplankton community in Mbo River with more individuals 952 (61.8%) recorded in the dry season while 587 individuals (38.2%) were recorded in the rainy season. Zooplankton abundance recorded the highest values in dry season while clear decline was recorded in the rainy season. The highest abundance was recorded in November and March (dry season) while the lowest abundance was recorded in May (rainy season) (Figure 3).

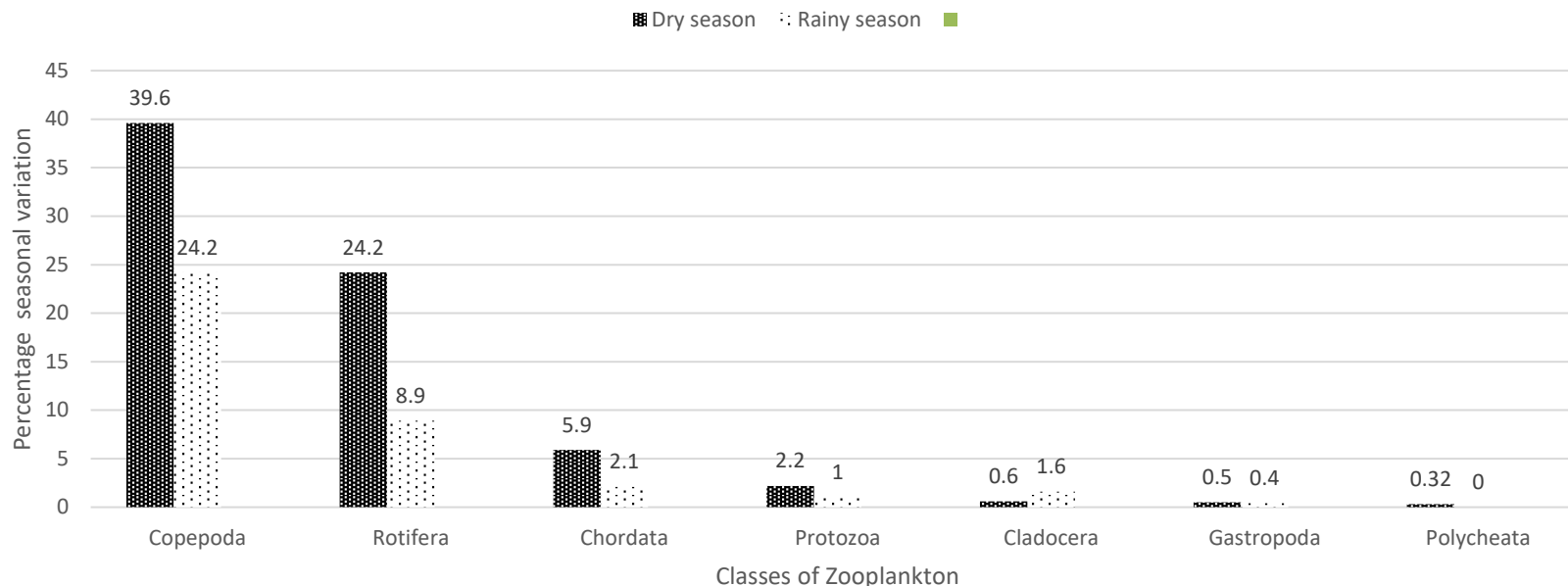
Specifically, percentage distribution in the dry season showed Copepoda (39.6%), Rotifera (24.2%), Chordata (5.9%), Protozoa (2.2%), Cladocera (0.6%), Polychaeta (0.32%) and Gastropods 0.5% of the total zooplankton, while the rainy season distribution indicated Copepoda (24.2%), Rotifera (8.9%), Chordata (2.1%), Protozoa (1.0%), Cladocera (1.6%), Polychaeta (0.0%) and Gastropods (0.4%) (Figure 4). All the zooplankton groups showed higher percentage values in the dry season except for Cladocera that showed higher values in the rainy season. Also, Polychaeta was absent in the rainy season. Rotifera, Copepoda and Polychaeta recorded significant differences ( $p < 0.05$ ) in the abundance of zooplankton groups between the season, while Chordata, Protozoa, Cladocera and Gastropoda revealed insignificant differences between seasons. However, there was significant difference between the dry and rainy season abundance and distribution of zooplankton group in the study area (Table 3).

In the dry season, Copepoda species dominated the zooplankton community of Mbo River with *Cyclopoia copepod* and *Nauplii copepod* making

the highest percentage contribution in the dry season. Rotifera was found to be the second highest taxa in the community with the largest contribution from *Lecane quadridentata* in February. Among the Cladocera group, the dominant species was *Nothola longispa*. No *Cladocera species* was found in the dry season except in December. The species: *Monostyta reticulate* and *Keratellaco chlearie* were completely absent in the dry season. *Arcella vulgaris* was the dominant species among the protozoa. Fish larva dominated the Chordata group and was found more abundantly in January. Gastropoda and Polychaeta were sparingly found in the study although their presence was noticed in February. In the rainy season, Copepoda species dominated the zooplankton community of Mbo River with *Cyclopoia copepod* and *Nauplii* still making the highest percentage contribution but in April. Rotifera taxa in the community had the largest contribution from *Euclanis sp* in June and least contribution from *Filinia longiseta*. In the Cladocera group, the dominant species was *Dapinia longispa*. Species of Cladocera were found in all the months in the rainy season. *Diffugia sp* (Protozoa) and *Polychaeta larva* (Polychaeta) were absent during the rainy season. Fish larva dominated the Chordata group in April and was found less abundant compared to the dry season occurrence. Gastropoda were sparingly found in the study although their presence was minimally noticed in April. This shows that there is a seasonal impact on the zooplankton density. The detail result of monthly distribution, species composition and percentage frequencies of each species, genera and class are recorded. Most Rotifera and Copepods fall into resident (1.0%), subdominant (2.1-5.0%) and dominant (5.1-10.0%) except *Cyclopoia copepod* (15.8%) and *Naupilli copepod* (14.4%) which are eudominant species (Table 3).



**Figure 3: Seasonal distribution and abundance of Zooplankton in Mbo River**



**Figure 4: Percentage seasonal variation of zooplankton taxa**

**Table 3: Seasonal variation and abundance of zooplankton (unit/L) in Mbo River**

	DRY SEASON						RAINY SEASON						Grand Total	t	p
	NOV, 2017	DEC	JAN, 2018	FEB	MAR	Total	APR	MAY	JUN	JUL	AUG	Total			
<b>ROTIFERA</b>	52	29	27	57	28	193 (12.5)	27	19	26	28	37	137 (8.9)	330 (21.4)	11.46	0.010**
<b>COPEPODA</b>	138	95	87	125	165	610 (39.6)	88	61	81	68	74	372(37.8)	982 (24.2)	5.012	0.056**
<b>GASTROPODA</b>	0	2	3	3	0	8 (0.5)	5	0	0	0	1	6 (0.4)	14 (0.9)	0.140	0.7188*
<b>POLYCHAETA</b>	3	0	2	0	0	5 (0.32)	0	0	0	0	0	0 (0.0)	5 (0.3)	36.00	0.000**
<b>CHORDATA</b>	17	17	21	18	19	92 (5.9)	10	8	4	3	7	32 (2.1)	124 (8.1)	2.327	0.166*
<b>PROTOZOA</b>	10	5	9	1	9	34 (2.2)	3	1	2	3	7	16 (1.0)	50 (3.2)	2.329	0.165*
<b>CLADOCERA</b>	4	0	1	2	3	10 (0.6)	6	1	1	11	5	24 (1.6)	34 (2.2)	2.667	0.141*
<b>Grand Total</b>	<b>224</b>	<b>148</b>	<b>150</b>	<b>206</b>	<b>224</b>	<b>952 (61.8)</b>	<b>139</b>	<b>90</b>	<b>114</b>	<b>113</b>	<b>131</b>	<b>587 (38.2)</b>	<b>1539 (100)</b>	8.160	

\*\* = Significant @ p < 0.05, \* = not significant @ p > 0.05, () = % composition



#### 4.0 Discussion

##### 4.1 Percentage composition, abundance and distribution of zooplankton in Mbo River

In this study, Copepoda was the most dominant taxon in terms of abundance and composition forming 63.9%, Rotifera 21.4%, Chordata 8.1%, Protozoa 3.2%, Cladocera 2.2% and Gastropods 0.9% of the total zooplankton in this study. This is different from the report of Wokoma (2016) that Rotifera were represented by 26 species (32.91%) to be the most prominent class, followed by Protozoa and Copepoda with 20 (25.32%) and 19 (24.05%) species respectively and finally Cladocera with 14 species (17.72%) in the Brackish water axis of Sombreiro River, Niger Delta and from the report of Iloba (2019) where Copepod was only (10 %) in Aghalokpe Wetland in Delta State, Nigeria.

The 16 species of copepod recorded in this study is different from the result of Iloba (2002) in Ikpoda Reservoir, Nigeria that recorded copepoda with only 2 species, followed by a single species each apportioned to cladoceran (*Diaphanosoma sp*) and Protozoa (*Arcella discoides*). Low abundance and six species of Protozoa recorded in this study was higher than the report of Wokoma (2016). The paucity of protozoa could be attributed to environmental stress.

The overwhelming contribution of Copepods to the zooplankton community is similar to the report of (Iloba 2019) that Copepoda contained > 50 % of the total zooplankton in Aghalokpe Wetland in Delta State, Nigeria but strikingly different from Arazu and Ogbeibu (2017) of River Niger at Onitsha stretch, Niger Delta. The study also observed the rarity of cladocera and protozoa and their inconsequential existence. This is similar to patterns reported by Iloba (2019). Again, the structured and populated dominance of Copepods over rotifera may not be farfetched from grazing effects of Copepoda on Rotifera. However, abundance of the Rotifera plankton biotype over some other group (protozoa, cladocera) probably is due to their ability to withstand and survive stressed conditions.

The study recorded 1539 zooplankton individuals made up of 7 taxa, 32 genera and 33 species. These values are closer to the six (6) zooplankton taxa and thirty-three 33 zooplankton species identified by Ali *et al.* (1985) but at variance from a total of 45 species of zooplankton in eight taxonomic groups collected in Mbo River (Essien-Ibok and Ekpo, 2015) and significantly lower than the 79 species of zooplankton observed by Wokoma (2016) in the Brackish water axis of Sombreiro River, Niger Delta. However, it is higher than the 17 species belonging to 6 classes reported by Ezekiel, *et al.* (2011) in the water axis of Sombreiro River. These differences may be attributed to tidal current, food

availability, wind direction and river discharge that govern the diversity of zooplankton in the estuarine environment. The low total of 32 genera of zooplankton encountered in this study is an indication that this environment has been further stressed resulting in reduction of organisms in the sediment of Mbo River.

*Keratella*, *Brachionus* and *Trichocerca* species recorded in this study indicated that zooplankton taxa are resident of lotic areas and are well-known indicators of eutrophic coastal water. The presence of *Paracalamus parvus* of Copepod indicates high salinities and conductivities of the study area while the dominance of Naupilli larva of Copepods in this investigation is suggestive of ambient conditions suitable for the development of these endemic and migratory benthic species. According to Kasprzak and Niedbata (1981), dominance classes are classified as  $\leq 1.0\%$  sub-resident, 1.0% resident, 2.1-5.0% subdominant, 5.1-10.0% dominant, > 10.0% eudominant species. Thus, dominance classes of Cladocera, Polychaeta, Gastropoda, Protozoa, Chordata species are all sub-resident because the percentage dominance are < 1.0 except for *Arcella vigaris* (1.4%) of Protozoa and Fish larva (6.88%) of Chordata group. Most Rotifera and Copepods fall into resident (1.0%), subdominant (2.1-5.0%) and dominant (5.1-10.0%) except Cyclopoia copepod (15.8%) and Naupilli copepod (14.4%) which fall under eudominant.

The highest species diversity and density were observed in Station 1 (upstream). This was in contrast to the observation of Ekpo (2013) in which highest density was obtained downstream. Order of dominance of zooplankton groups showed Copepoda > Rotifera > Cladocera > Protozoa > Chordata > Gastropoda > Polychaeta. This is similar to the report of Ahmed *et al.* 2003 in River Meghna, Bangladesh that zooplankton population was mainly dominated by the members of the group Copepoda (51.2%) and the report of Osore, *et al.* 2004 where the order Copepoda was the most abundant taxon in Mida Creek, Kenya. Also, similar to the report of Davis (2009) who recorded the dominance of copepods (43.4%) in Woiye River, Port Harcourt, Niger Delta. Similar order of Copepoda > Rotifera > Cladocera > Protozoa was also observed by Iloba (2019) in Aghalokpe Wetland in Delta State, Nigeria.

However, this is different from the report of Dimowo (2013) who recorded the dominance of Cladocera in Ogun River and also different from the report of Kushwaha and Agrahari (2014) in River Rapti at Gorakhpur, India that protozoa population was the most abundant. The numerical dominance of copepods observed in this study is strikingly different from Ogbuagu and Ayoade (2012) from Imo River,

Iloba and Ruejoma (2014) in Ekpan River, Delta State, Arazu and Ogbeibu, 2017 of River Niger at Onitsha stretch, all in Niger Delta, who noted cladocera as prominent in their studies. Surprisingly, the dominance of copepods and rotifera did not show faunistic similarity of Mbo River because earlier report by Essien-Ibok and Ekpo (2015) in Mbo River showed the dominance of crustaceans. Further contradictions to this study was seen in the result of Wokoma (2016) that Rotifera had the highest number of species (26), followed by Protozoa with 20 species and Copepoda and Cladocera with 19 and 14 species respectively in the Brackish water axis of Sombreiro River, Niger Delta.

Also, the low density of cladocera observed in this study is similar to the report of Abowei and Ezekiel (2013) who observed low dominant of cladocera in Koluama Area, Niger Delta Area, Nigeria and attributed the decline composition to frequent human influence, constant industrial disturbance of the surface water column. These activities may reduce water quality directly or indirectly by encouraging the growth of nuisance algae (i.e. Cyanobacteria). However, the preponderance of rotifera has been indicted as pollution indices (Kar & Kar, 2016). So, twenty-one (21%) of rotifera in this study area may express the present of pollution.

The composition and abundance of zooplankton in any aquatic ecosystem are crucial in water quality monitoring. Extensive research on the zooplankton of this wetland is paramount to develop quality control engineering tool for sustainable fisheries development and its future preservation. The differences in the abundance and dominance of zooplankton in respect to location could be attributed to species dominance, community structure, seasonality, nutrient status and other location factors of the water in different water bodies across the globe which speak expressly about the specificity and variations of water bodies in space, status and time. This explanation agrees with several reports that supported this position. For instance, the composition and distribution of zooplankton vary from place to place and year to year due to the dynamic nature of the aquatic systems (FAO,2006). Wokoma (2016) posits that variations in zooplankton diversity and abundance are contingent upon the place and time of sampling. Arazu and Ogbeibu (2017) confirmed that habitats size of the river and climate of the area in which the water body is situated are most common factors that affect species number, diversity and richness.

Above 85 % dominance of copepods and rotifera was recorded in this study. This high abundance and outburst of these groups may be

attributed to the ability of these phylum to overcome stiff environment and selective grazing strategy by higher energy gainers. The copepods are free-living filter feeder zooplankton and are used in bio-monitoring of pollution. However, this superfluity of juvenile copepodites and rotifera suggest their overwhelming contributory power to food chain / trophic status functions of Mbo River. The low number of cladocera and gastropods could not be tagged absent or disappearance since infinitesimal information exists on these groups in Mbo River. This inconsequential presence of cladoceran and gastropods could be indicator of a turbulent and unstable coastal ecosystem. However, these groups could exist for their ability to survive varieties of water temperature, habitat molestation and trophic harassment.

#### 4.2 Seasonal Variation of zooplankton Community

In general, zooplankton species flourished at different seasons of the year and thrived best during the dry season with a peak in February. This result contradicts previous report. For instance, Davies (2009) in his study of species composition of Zooplankton of Woji-okpoka Creek, Port Harcourt recorded higher dominance of zooplankton in the wet than in the dry season. Essien-Ibok and Ekpo (2015) also recorded higher percentage composition of zooplankton in wet season than in the dry season in Mbo River. Davies (2009); Essien-Ibok and Ekpo (2015) attributed the wet season dominance to the seasonal variations of some physical and chemical factors such as pH and nutrient loads. However, this study observed higher volume of rainfall in the rainy season than the dry season. This can influence the quality of surface runoff which can in turn fluctuates the quantity and distribution of zooplankton species in the rainy season. Seasonally, dry season recorded maximum value while rainy season recorded lower values. This means that seasonal differences strongly influence the distribution pattern and composition of zooplankton community in Mbo River.

#### 5.0 Conclusion

Conclusively, Copepoda was the most dominant taxon in terms of abundance and composition forming 63.9%, Rotifera 21.4%, Chordata 8.1%, Protozoa 3.2%, Cladocera 2.2% and Gastropods 0.9% of the total zooplankton during the study. The study recorded 1539 zooplankton individuals made up of 7 taxa, 32 genera and 33 species. *Keratella*, *Brachionus* and *Trichocerca* species recorded in this study indicated that zooplankton taxa are resident of lotic areas and are well-known indicators of eutrophic coastal water. The presence of *Paracalamus parvus* of Copepod

indicates high salinities and conductivities of the study area while the dominance of Naupilli larva of Copepods in this investigation indicates the presence of conducive conditions for the development of endemic and migratory benthic (zooplankton) species. The differences in the abundance and dominance of zooplankton in respect to location could be attributed to species dominance, community structure, seasonality, nutrient status and other location factors of the water in different water bodies across the globe which speak expressly about the specificity and variations of water bodies in space, status and time. The composition and abundance of zooplankton in any aquatic ecosystem are crucial in water quality monitoring. Extensive research on the zooplankton of this wetland is paramount to develop quality control engineering tool for sustainable fisheries development and its future preservation.

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4/25/2021