INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 15, No. 6, p. 313-324, 2019

RESEARCH PAPER OPEN ACCESS

Effects of prevailing anthropogenic and environmental factors on fauna composition and distribution of zooplankton in Ethiope River, Delta State, Nigeria

Osaro Hilda Erhenhi*, Osasele Michael Omoigberale

Department of Animal and Environmental Biology, University of Benin, Benin city, Nigeria

Key words: Ehiope River, Fauna, Zooplankton.

http://dx.doi.org/10.12692/ijb/15.6.313-324 Article published on December 29, 2019

Abstract

This study was aimed at evaluating composition and distribution of zooplankton fauna of River Ethiope, Delta State, Nigeria. Sampling and survey of zooplankton was carried out for 24 (twenty four) months (January, 2016 to December, 2017) across the wet and dry seasons. Five designated stations were sampled with varying anthropogenic activities along the river stretch. The five stations included station1 (Umuaja) which is the main source of the river, station 2 (Umutu), station 3 (Ubiaruku), station 4 (Abraka) and Station 5(Eku). The zooplankton species recorded in the study comprised of one thousand six hundred and sixty two individuals. A total of 47 zooplankton taxa comprising 19 *Copepoda, 7 rotifers* and 21 Cladocera species were encountered during the study period. The *Copepoda* was the most abundant constituting (45%) followed by the*Cladocera* (40%) and *Rotifera* which accounted for 15%. Abundance was highest at stations 1 and 4. The dominant zooplankton was *Tropocyclops prasinus, Mesocyclops bodanicola, Metacyclops minutes and Thermocyclops neglectus*. The rotifers were dominated by *Platyias lelupui* and *Lecane ungulate*. The values of diversity (H), Evenness (E) and Dominance were highest at station 3, while species richness value (D) was highest at station 4. The similarity index (Bray Curtis) showed that stations 1 and 4, and stations 2 and 5 had the highest similarities. The results obtained showed variation in the composition and distribution in the stations.

*** Corresponding Author:** Osaro Hilda Erhenhi ✉ osarohilda@gmail.com

Introduction

Zooplankton fauna composition and distribution vary in different aquatic bodies ranging from fresh water to marine (Gurbuzer *et al.,* 2017). The fresh water ecosystem could be lotic or lentic. Their presence in the water bodies speaks volume of the physico-chemical status of the water. The fauna composition and distribution of zooplankton equally vary from one water body to another as result of difference in temporal and spatial pattern occasioned by the prevailing environmental factors such as natural, anthropogenic, nutrient enrichment, depth, sediment nature, seasonal variation and other environmental stress (Akbulut and Tavsanoglu, 2018). As researches increase, more of the significance of zooplankton are unfolding giving a wide new perspective into scientific, medical and other applications and utilizations of zooplankton to man hence breaking the barrier of limited information of the applications and utilizations of zooplankton.

Zooplanktons are sensitive to changes in an aquatic ecosystem, due to environmental disturbance which can be detected via changes in specie differentiation and abundance, size and distribution and can be used as a marker for variation in aquatic environment. A variation in physical and chemical characteristics of a water body correspondingly influences the relative abundance, distribution and composition of zooplankton in a water body (Ogbeibu, 1991; Imoobe and Akoma, 2009; Imoobe, 2011).

The abundance and composition of zooplankton are different in various water bodies. The zooplankton biomass production is of immense importance to monitor global warming, eutrophication, water pollution and quality and problems in the aquatic ecosystems for prolong period. Zooplankton abundance can also be changed by prevailing physical forces and hydrochemical parameters occasioned by spatio-temporal variations (Bianchi *et al.,* 2003).

Molinero *et al.* (2005) reported that change in climate as well in the ecosystems can be monitored using zooplankton which also played a major in the survival of herbivory fishes and other aquatic lives that feed on them. Xuelu *et al.* (2011) have also reported that there exists a direct high proportion of fish population concentrated in areas where there was high production of zooplankton. This may help to ensure sustainable management of fishery resources as well monitor anthropogenic impact on fisheries in the different aquatic ecosystems. This paper seeks to assess the zooplankton fauna composition and distribution in River Ethiope as a result of the prevailing environmental factors along the five designated stations along the river course.

Materials and methods

Description of study area

Sampling and survey of zooplankton was done in five designated stations in River Ethiope. The stations included station 1(Umuaja), station 2 (Umutu), station 3(Obiaruku), station 4 (Abraka) and station 5 (Eku).

Sampling stations

Five sampling stations were selected along the course of the river from upstream (Umuaja; station 1) to downstream (Eku; station 5).

Station 1 (Umuaja)

Station 1 which also serves as the reference site is the watershed of the Ethiope River (lat. 05° 56' 31.4 N and long. 06°13'58.7 E) with elevation of 30 m sited in Ukwuani Local Government Area, Delta State (Fig. 1)The substratum is covered by coarse sand and gravel. It has an average depth of 0.43 m and it is a swift-flowing (mean flow rate of 1.95 m/s).and a very low turbidity of 0.241 NTU.

The dominant vegetations are *Babusa vulgaris*, *Xylopia* species, floating macrophytes; *Lemna* sp, and submerged vegetation; *Salvinia* sp. The major human activities include ritual rites and bathing.

Station 2 (Umutu)

Station 2 which is located 7 km downstream of station 1 lies between latitude 05°54'53.1N and longitude 06° 13'09.5 E with elevation of 24 m (Fig. 1).

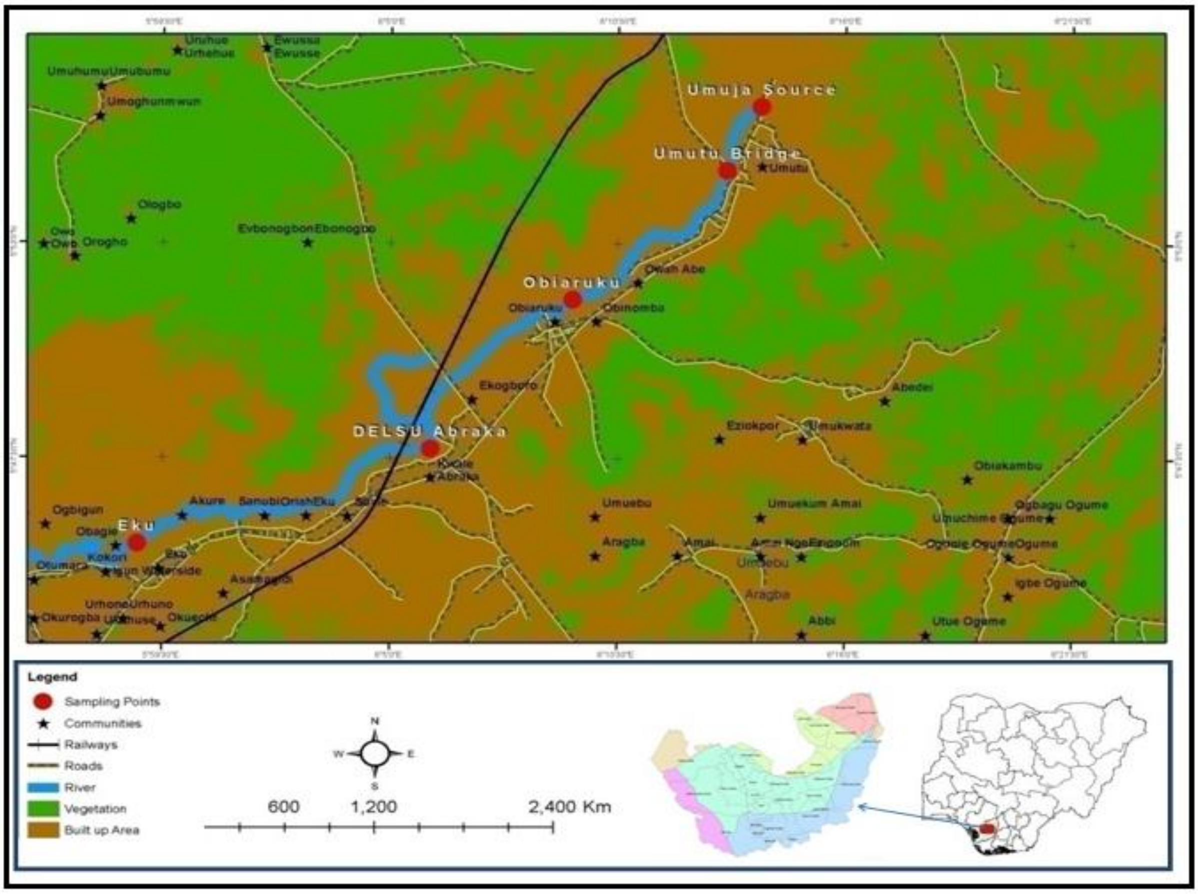

Fig. 1. River Ethiope showing sampling stations (Inset: Nigeria showing Delta State).

The substratum is covered with coarse sand and a mixture of course alluvial with an average depth of 0.34 m. The mean flow rate is 2.899 m/s. The station is characterized by meandering area and high current velocity.

The vegetation consists of *Xylopia* sp, *Oxystigma manni*, *Bambus vulgaris*. The floating macrophytes include *Lemna* sp, while the submerge vegetations were mainly *Ceratophyllum submersum* and *Pistia stratiotes*. Anthropogenic activities include agricultural activities, laundering and swimming.

Station 3 (Obiaruku)

Station 3 which lies within lat. 05°51'29.5 N and long. 06°09'30.9 E with an elevation of 12 m (Fig. 1). This station is about 12 km downstream of station 2with an average depth and mean flow rate of 0.32 m and 2.680 m/s respectively. The substratum is muddy sandy, whitish in the upper layer and reddish-brown at the subsurface. The dominant riparian vegetation are *Fussiaera repens, Bambusa vulgaris* and *Matrogyna* while the floating macrophytes include *Lemna minor,* submerged macrophyte *Salvinia* sp. Anthropogenic activities include washing of automobiles, recreational activities, laundering, bathing, and fishing.

Station 4 (Abraka):

Station 4 (Abraka) lies within lat. 05°47'44.6 N and long. 06° 05' 57.1 E with elevation of 6 m (Fig. 1). It is about 11 km downstream of station 3. The substratum is tropical ferruginous type of sandy and loamy soil, which is whitish at the upper layer and along the shore. It has an average depth of 0.31 m and a mean flow rate of 2.939 m/s. The dominant vegetations are *Symphoma globifena, Alstorila congests* and *Bambusa vulgaris.* The macrophytes include *Lemna* sp, *Nymphaea lotus, Salvinia* sp and *Ceratophyllum submersum.* There were high human activities such as laundering, bathing, artisanal fishing, irrigation of cassava farm, and discharge of petroleum by–

products.

Station 5 (Eku)

Station 5 **(**Eku) lies between lat. 05°45'19.2 N and long. 05°58'57.3 E with elevation of 15 m. This station is about 20 km downstream of station 4 (Fig. 1). It has an average depth of 1.63 m and a mean flow rate of 3.029 m/s. The substratum comprises a tropical ferruginous type of loamy soil which is brownish at the upper layer and along the shore. The vegetation of the catchment consists of secondary rainforest which has been greatly subjected to deforestation. The vegetation includes *Havea brasiliensis, Bambusa vulgaris*, *Elaeis guineensis,* while the macrophytes includes *Salvinia* sp. and *Ceratophyllum submersum*. Human activities include farming, fishing, logging and timber transportation, laundering, bathing and washing of automobiles.

Collection of zooplankton

Zooplankton samples were collected from undisturbed areas of the water, using both quantitative (estimating abundance) and qualitative (evaluating diversity) methods of sampling. For quantitative evaluation, 100 litres of water was filtered through 55µm hydro-bios plankton net at each station. Qualitative sampling was done with the aid of the 55µm hydro-bios plankton net towed by hand against water current for a period of 5 minutes at each station. The samples collected were preserved in 4% formalin solution in plankton bottles immediately after collection.

Sorting and identification of zooplankton

Zooplankton samples collected were sorted under an optical microscope (model 570) at x10 magnification. Zooplankton were concentrated by centrifugation and thereafter picked with the aid of micro pipette and carefully placed on a glass slide and covered with a cover slip prior to viewing under the microscope.

Specimens were viewed under the light microscope with eye and objective lens of X10 and the microphotographs taken with the aid of digital camera. Counting was done using the gridded counter under light microscope, while systematic or taxonomic identification of zooplankton specimen was done using standard identification keys of Dhanapathi (2000) and Durand and Leveque (1980).

Results

The results obtained from sampling shows variation across the stations. The checklist of the taxa composition, abundance and distribution of zooplankton in the study stations are presented in Table 1. Spatial variation in the number of taxa and individuals for zooplankton in the study area are reported in Fig. 2. The relative density of themajor zooplankton groups in the study stations are shown in Fig. 3.

Table 1. Checklist of the taxa composition, abundance and distribution of zooplankton in the study stations.

Phylum	Class	Order	Family	Species	Stations					Total
					1	2	3	4	5	
COPEPODA										
Arthropoda	Crustacea	Cyclopoida	Cyclopoidae	*Mesocyclops bodanicola*	18	32	27	22	35	134
				Mesocyclops ogunnus	13	18	7	-	9	47
				Mesocyclop albidus	-	-	-	1	-	1
				Thermocyclopsneglectus	36	22	21	37	16	132
				Thermocyclops crassus	1	-	3	6	1	11
				Metacyclops minutes	17	33	42	25	32	149
				Microcyclops varicans	18	18	9	10	11	66
				Paracyclops affinis	2	2	4	7	1	16
				Crytocyclopsbicolor	4	11	3	5	9	32
				Diacyclops sp.	-	7	6	-	5	18
				Larva of copepod	3	8	7	2	4	24
				Tropocyclops prasinus	37	33	27	36	40	173
				Eucyclops compactus	-	-	4	3	6	13

				Eucyclops serulatus	10	27	9	21	23	90
				Euclyclops agiloides	-	-	-	1	-	1
				Halicyclops troglodytes	14	8	6	9	3	40
				Halicyclops pondensis	3	3	5	4	2	17
				Thermodiaptomus galebi	7	2	3	4	2	18
				Tropodiaptomus sp.	1	-	6	-	-	7
ROTIFERA										
			Brachionidae	*Platyias* sp.	3	1	3	4	-	11
				Platyias lelupui	18	9	7	25	8	67
				Platyias quadriconis	2	6	4	3	15	30
				Platyias sp.	-	-	-	1	-	1
			Lecanidae	*Lecane ungulata*	12	7	13	12	11	55
				Lecane papuana	6	4	9	4	11	34
			Trichocercidae	*Trichocerca weberi*		4	2	1	1	8
CLADOCERA										
Arthropoda	Branchiopoda	Diplostraca	Moinidae	*Moina macrocopa*	1	1	2	2	4	10
	(crustacea)			*Moina reticulata*	3	5	5	1	6	20
				Echinisca sp.	-	1	-	1	4	6
	Branchipoda	Diplostraca	Macrothricidae	*Echinisca rosea*	7	7	16	6	16	52
		Cladocera		*Echinisca triseralis*	-	1	-	-	1	2
	Branchiodpoda	Ctenopoda	Sididae	*Diaphansoma* sp.	1	3	5	5	1	15
		Diplostraca		*Diaphanosoma excisum*	4	4	6	9	-	23
	Branchipoda	Cladocera (Cladocera)	Macrothriadae	*Macrothrix triserialis*	11	5	1	2	3	22
	Branchiopoda	Diplostraca	Bosminidae	*Bosmina longirostris*	-	3	1	3	-	7
	Branchiopoda (crustacea)	Diplostraca	Chydoridae	*Chydorus sphaericus*	10	4	5	7	2	28
				Camptocercus sp.	5	2	4	3	2	16
	Branchiopoda	Diplostraca	Chydoridae	*Pleuroxus hamutus-hamatus*	9	3	5	1	2	20
				Pleuroxus sp.	-	-	-	-	1	1
	Branchiopoda (Crustacea)			*Kurzia longirostris*	26	8	15	10	9	68
				Alona sp.	5	-	2	6	-	13
				Alona rectangula	2	1	-	2	-	5
				Alona monacantha	-	-	1	-	-	1
				Alonella excise excise	-	1	-	5	1	7
	Branchiopoda	Diplostraca	Chydoridae	*Alona quadrangularis*	14	13	22	15	8	72
				Alona cambouei	14	8	10	9	8	49
				Alona costata	-	4	-	4	-	8
				Alona karua	-	1	3	2	-	6
				TOTAL	333	325	324	331	309	1622

Relative Abundances and Species Composition of Zooplankton

The order Cyclopoida (Cyclopods) had the highest relative abundance (60.97%) followed by the Diplostraca (Cladocera) (26.82%) and the Plomia (Rotifers) (14.89%); while the species composition the Diplostraca (44.68%) followed by the Cyclopoida (40.20%) and the Plomia (14.89%). The percentage spatial distribution of zooplankton taxonomic species showed that were unevenly distributed across the studied sampled stations. Station 1 (Umuaja) recorded Copepoda 55.42%, Rotifera 12.65% and Cladocera 33.02%, Station 2 (Umutu) showed Copepoda 67.16%, Rotifera 8.33% and Cladocera 25.53%, station 3 (Obiaruku) obtained for Copepoda 56.92%, Rotifera 11.11% and Cladocera 30.50%, station 4 (Abraka) spatial variation Copepoda 58.13%, Rotifera 15.12% and Cladocera 27.93% and station 5 (Eku) Copepod 59.93%,

Rotifera 13.88% and Cladocera 20.31%.The distribution showed that for Copopoda recorded the highest percentage station 2, for Rotifera in station 4 and for Cladocera in station 1 (Fig. 4).

Table 2. Zooplankton Diversity Indices for the Study Stations.

	Station 1	Station 2	Station 3	Station 4	Station 5
Taxa_S	33	37	37	40	34
Individuals	332	324	324	332	310
Dominance_D	0.06	0.06	0.05	0.06	0.06
	(0.05-0.06)	(0.05-0.07)	(0.05-0.06)	(0.05-0.06)	(0.05-0.07)
Shannon_H	3.12	3.14	3.23	3.22	3.06
	(3.04-3.20)	(3.05-3.23)	(3.14-3.32)	(3.13-3.31)	(2.97-3.15)
Margalef	5.51	6.23	6.23	6.72	5.75
	(5.51-5.51)	(6.23-6.23)	(6.23-6.23)	(6.72-6.72)	(5.75-5.75)
Equitability_J	0.8916	0.8704	0.8936	0.8719	0.8666
	(0.87-0.91)	(0.85-0.90)	(0.87-0.92)	(0.85-0.90)	(0.84-0.89)

Zooplankton Diversity Indices for the Study Stations

Dominance (D)

The values of Dominance recorded were (0.06) in stations 1, 3, 4 and 5 while station 2 recorded (0.05) respectively during the period of study (Table 2).

Shannon Wiener Index (H)

Ethiope River recorded the highest diversity with value (3.23) in station 1 and the lowest diversity value (3.06) in station 5 (Table 2).

Margalef Index

Margalef index (species richness) the values of recorded for the species richness were (5.51) in station 1 (6.23) in stations 2 and 3, (6.72) in station 4 and (5.75) station 5 respectively.

The highest values were obtained in station 4 and the lowest values in station 1 (Table 2).

Equitability (J)

The complete evenness of the zooplankton species in Ethiope River recorded maximum values in station 3 and minimum values in station 5 in a scale of 0-1 in the studied duration though slight differences were observed in values across the study stations (Table 2).

Table 3. Pearson Correlation of Zooplankton Abundance with Water Quality Parameters.

Parameters	Zooplankton Pearson Correlation (r)	P-Value	Significance
Air Temperature	.046	.618	P>0.05
water temperature	.264**	.004	P<0.01
Flow rate	.044	.634	P>0.05
Depth	.040	.668	P>0.05
pH	-.085	.357	P>0.05
EC	.127	.167	P>0.05
Salinity	-.103	.263	P>0.05
Col.	-.047	.607	P>0.05
Turbidity	-.042	.649	P>0.05
TSS	.118	.200	P>0.05
TDS	.135	.142	P>0.05
DO	.332**	.000	P<0.01
BOD_5	.026	.776	P>0.05
COD	.132	.150	P>0.05
HCO_3	.178	.052	P<0.05
Na	.057	.538	P>0.05
K	-.108	.239	P>0.05
Ca	.091	.322	P>0.05

Mg	-.088	.341	P>0.05
CI	.302*	.001	P<0.01
P	.228*	.012	P<0.05
NH_4N	-.052	.570	P>0.05
NO_3	.027	.770	P>0.05
SO_4	.110	.232	P>0.05
Fe	.071	.441	P>0.05
Mn	.040	.666	P>0.05
Zn	.191*	.036	P<0.05
Cu	.294**	.001	P<0.01
Cr	.020	.827	P>0.05
Cd	.082	.373	P>0.05
Ni	.262**	.004	P<0.01
Pb	-.136	.138	P>0.05
V	-.008	.933	P>0.05
THC	-.207*	.024	P<0.05

** Correlation is significant at the level 0.01 level (2-tailed), * Correlation is significant at the 0.05 level (2-tailed).

Dominant Taxa for Zooplankton

Cyclopods

Order Cyclopoida subfamily Cyclopinae has a relative abundance as (38.38%) sub family Eycyclopinae (19.08%) and sub-family Halcyclopine (3.51%) respectively. Eycyclopinae represent the dominant the species *Tropocyclops Prasinus* was recorded the most dominant with a percentage of (10.66%) closely followed by the subfamily cyclopinae *Metacyclops minutes* (9.186%), *Mesocyclops bodanicola* (8.26%) and *Thermocyclops neglectus* (8.138%). and subfamily Diaptomide, order Clanoida (1.54%), is the rare species.

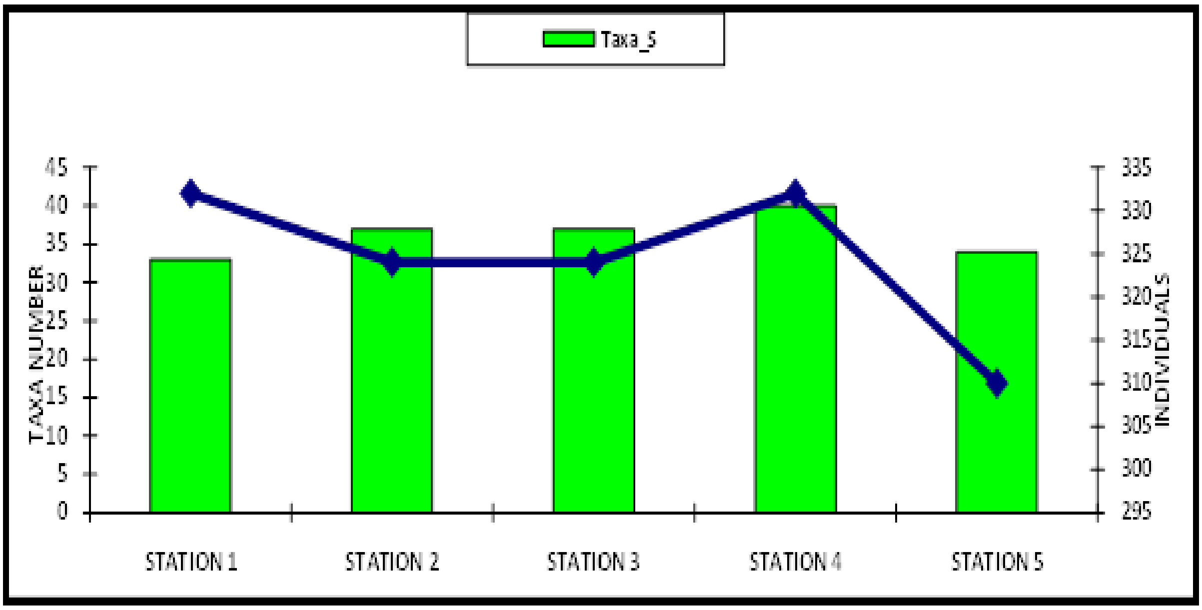

Fig. 2. Spatialvariation in the number of taxa and individuals for zooplankton in the study area.

Rotifers

Order Plomia, two families present Brachionidae and Lecanidae respectively. The Lecanidae in studied consist of *Lecane ungulate* (27.72%) and *Lecane papuana* (17.17%). Their high abundance were recorded across the sampled stations. The family Brachionidae consists of *playtias sp* (5.5%) *Platyias lelupui* (33.83%), *Platyias quadriconis (15.15%*) and *Playtias sp* type 2(0.5%). The most dominated is *Platyias lelupui* and rare *Playtias sp*.

Cladocerans

Order Diplostraca; five (5) families were obtained in this study; Moinidae, Macrothricidae, Sididae, Bosminidae and Chydoridae. Its relative abundance includes (1.85%, 5.06%, 2.342%, 0.431% and 16.83%).

The most dominant species ,*Alona quadrangularis* the family Chydoridae was the most occurred, with a percentage of (4.438%) followed by *Kurzia longirostris* (4.19%) and *Alona cambouei* (3.02%).

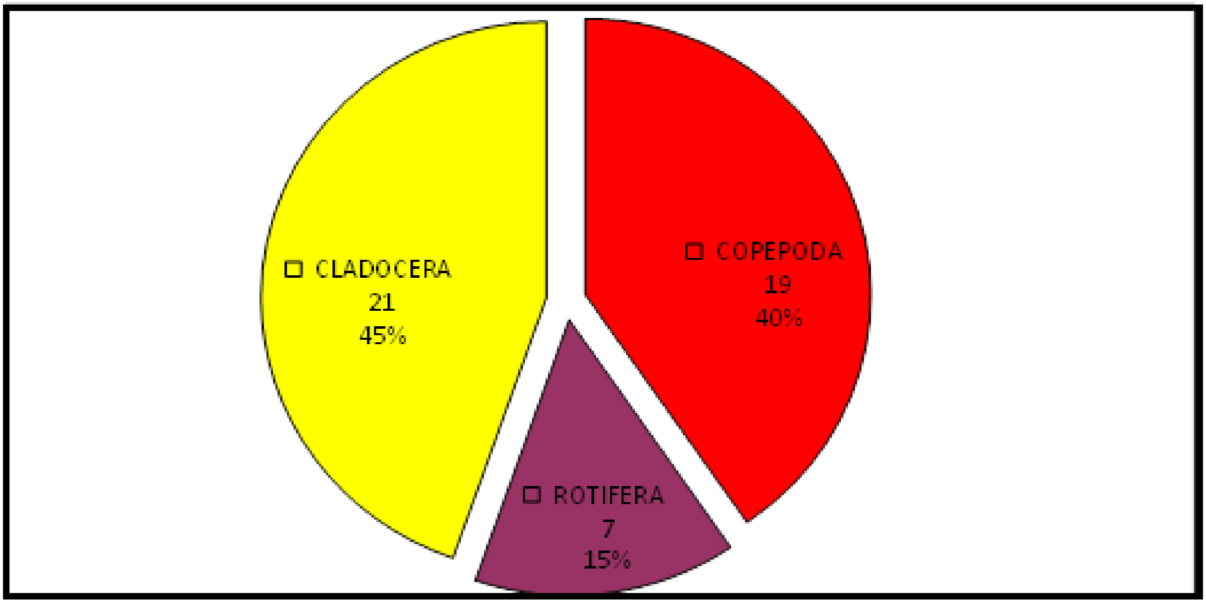

Fig. 3. Relative density of the major zooplankton groups in the study stations.

Canonical Correspondances Analysis for Zooplankton

The ordination of the zooplankton species by canonical correspondence analysis showed that the species variation patterns were significantly related to the environmental heterogeneity patterns observed in the river. The impacts of identified anthropogenic activities in the principal component analysis of water were the physico chemical parameters that significantly explained the principal variations in the species composition of the zooplankton community. Axis 1, which accounted for a total variance of 43.34% were positively correlated with depth, total hydrocarbon and negatively correlated with flow rate, magnesium and nitrate. Axis 2 showed 19.7% variation and were positively correlated with biochemical oxygen demand, chemical oxygen demand, chloride, bicarbonates, total dissolved solids and electrical conductivity but impacted negatively with total hydrocarbon. The canonical correspondence analysis triplot showed a good relationship between zooplankton species distribution and measured physico-chemical parameters. Halicyclopinae, Brachionidae, Eucyclopinae and macrothriadae were most influenced positively by electrical conductivity bicarbonates total dissolved solids and chloride but negatively influenced by total hydrocarbon; Chydoridae and Cyclopinanae were strongly, influenced by depth and total hydrocarbon but correlated negatively with magnesium (Fig. 5).

Pearson Correlation Coefficients between Zooplankton Abundance and Water Physicochemical Parameters during the Study Period

Correlation coefficients showed significant relationship between zooplankton abundance and water physicochemical parameters in Ethiope River in this study except for hydrogen ion concentration, flow rate, salinity, colour, turbidity, magnesium, ammonium nitrogen, lead and vanadium showed no significant influenced on the abundance zooplankton (Table 3).

Bray Curtis Similarity Index

Dendogram cluster analysis was also employed in this study to classify the stations with defined characteristics; notably smallest distance (greatest similarity) then combining distances shows greatest dissimilarity using the complete linkage method indicates (Fig. 6) stations 2 and 3; stations 4 and 5 were in greatest similarity while station 1 combining distances, hence were dissimilar as shown by Bray curtis similarity index.

Legend of zooplankton canonical correspondence analysis (CCA) ordination triplot: Cyc-cyclopinae; Hal-halicyclopinae; Euc-Eucyclopinae; Dia - Diaptomidae-;Lec-Lecanidae Tri-Trichocerca;Bra-Brachionidae; Moi-Moinidae; Macro Macrothriadae; Sid-Sididae; Bos-Bosminidae and Chy-Chydoridae. PC1 electrical conductivity, bicarbonates, total dissolved solids and chloride; PC2 total suspended solids colour and turbidity; PC3 flow rate; PC4 nitrate;, PC5 biochemical oxygen demand and chemical oxygen demand; PC6 chloride; PC7 magnesium; PC8 total hydrocarbon and total suspended solids; PC9 depth, total suspended solids and chloride; PC10 depth and total hydrocarbon; and PC11 total hydrocarbon.

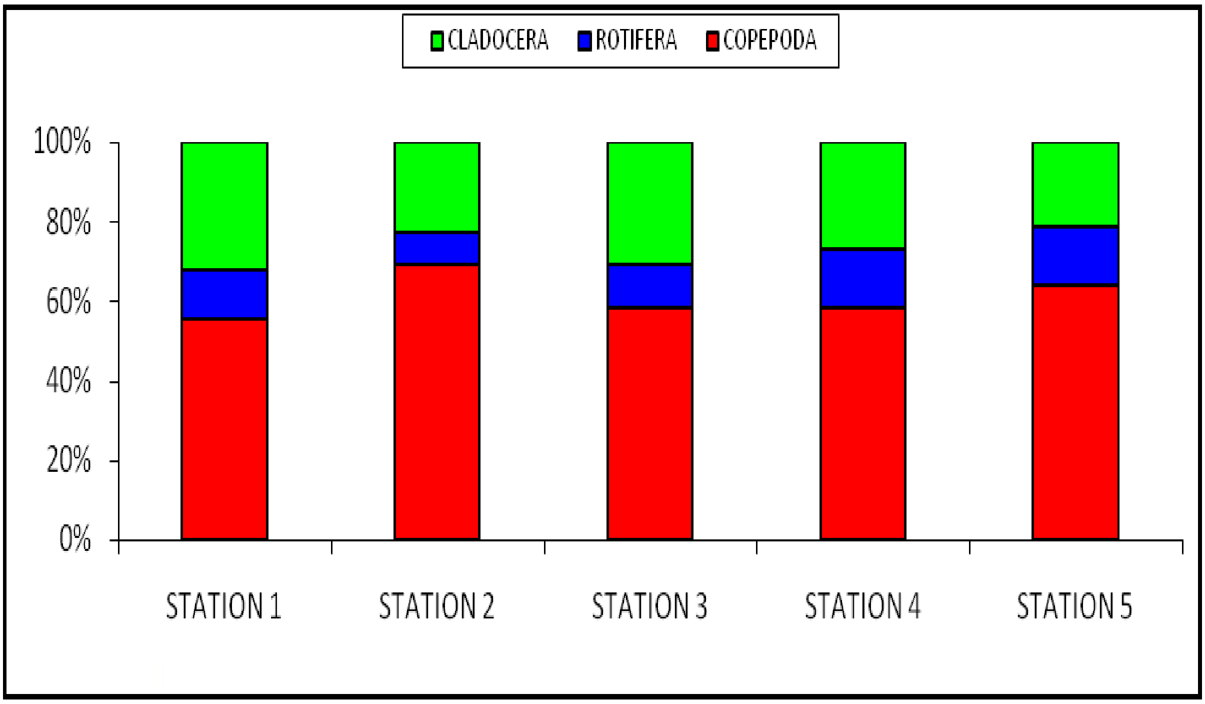

Fig. 4. Spatial variation in zooplankton taxonomic groups in the study stations.

Discussion

The results in this study showed some variations in the designated stations. This may be due to differences in prevailing factors inherent them. The anthropogenic activities, nutrient enrichment, depth, vegetation cover as well physico-chemical nature of both sediments and water. Similarly, Bianchi *et al.*(2003)reported that the abundance and composition of zooplankton are different in various water bodies. The zooplankton biomass production is of immense importance to monitor global warming, eutrophication, water pollution and quality and problems in the aquatic ecosystems for prolong period. Zooplankton abundance can also be changed by prevailing physical forces and hydrochemical parameters occasioned by spatio-temporal variations.

The zooplankton species recorded in the study comprised of one thousand six hundred and sixty two individuals. Furthermore the trend of the present study varied with other reports with regard to specific number of individuals and taxa of zooplankton collected during the 24 months sampling period. Copepod (*Tropocyclops prasinus*) was quantitatively dominant in the zooplankton fauna contrast with *Plomia* dominances .*Cladoceran* presence in comparable studies of Iloba and Ruejoma (2014). Although the Diplostraca dominated the fauna qualitatively, their quantitative contribution was much lower than that of the copepod. Station 2 recorded the highest abundance of copepod which could be attributed to sediments retention and suspension of high levels of nutrient, reduced flow from steeply gradient and shape of the river. More so phosphorus and turbidity negativity impacted Cladocerans abundances by positively affected copepod abundances at station 4. Iloba (2019) reported on zooplankton assemblage of which four (4) taxonomic groups were found; Copepoda, Rotifera, Cladocera and Protozoa in the Aghalokpe Wetland in Delta State, Nigeria.

The relativity low abundances of Rotifers may not be unconnected to the depth of sampled stations as well as the presence of predatory fish species making the rotifers unable to seek refuge in deeper depth were less visible to the fish and thus was included as indices for ecological assessment of water bodies (Jeppesen*et al.,* 2011).

The Pearson correlation analysis highlighted water temperature, dissolved oxygen, bicarbonates, chlorides, phosphorus, zinc, copper, nickel and total hydrocarbon as the parameters the influenced the abundance and diversity of zooplankton shown on axis 2 on the CCA ordination plot were the Cyclopinae, Chydoridae, Bosminidae, Moinidae, and Lecanidae, also buttressed in the principal components analysis in PC4, PC6 and PC8. Iloba and Ruejoma (2014) stated that phosphate, nitrate and dissolved oxygen influenced the composition of zooplankton in Ekpan River.

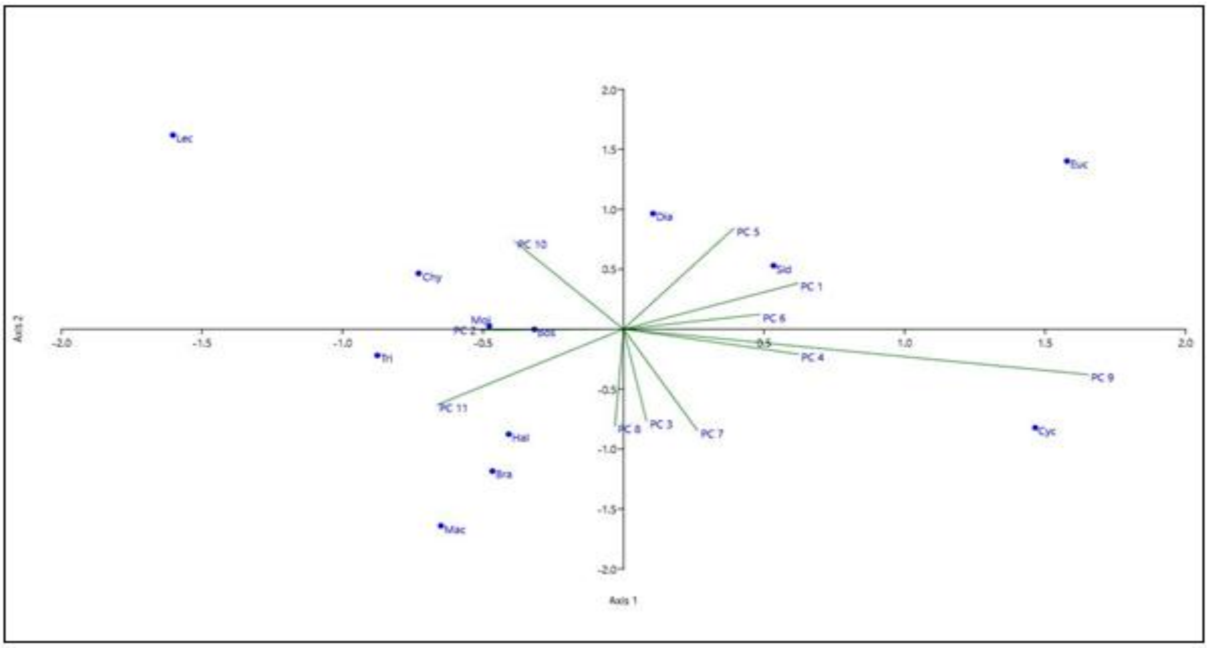

Fig. 5. Zooplankton CCA.

The low abundance of rotifers could be attributed to low turbidity and other unmeasured factors of the study such as competition and body size. *Cladoceras* species in the likes of *Bosmina*, *Moina* and *Macrothrix* are indicative of organic pollution status an aftermath of organic matter deposition status. The presences of cyclopoidae such as *Eucyclops* sp., *Thermocyclops crassus* and *Thermocyclops* sp suggest the themophlic in nature of Ethiope of River. *Trichocera sp* was encountered in stations 2, 3, 4 and 5 as an indication of impaired water qualiy possibly attributed to farm activities and runoff from Nitrogen-Phosphate based fertilizers. Submission made by Jakhar (2013) is that zooplankton species type, population and spatial distribution are distinctive attributes used for ascertaining physicochemical conditions of an aquatic habitat.

This implies that interaction between physiochemical indices is said to be either positive or negative to the sustenance of spatial and seasonal distributions of zooplankton (Khanna *et al.*, 2009). Zooplankton has been previously used as bio monitors for prevalent changes in aquatic environments and ecosystems (Abowei and Sikoki, 2005) the reason of which may be traced to their ease of identification over varied seasons, diversity and abundance, high sensitivity to slight change or moderation in environmental factors compared to aquatic invertebrates fauna.

The Pearson's correlation coefficient analysis of zooplankton abundance with water quality indicated several physiochemical parameters that lead to a considerable increased on the zooplankton abundance. The CCA is indicative of a clearly visible positive and negative correlation on zooplankton distribution which means that the relative abundance of any species was influenced by specific on the physiochemical attribute shown in the eleven principal component analysis of water component, thus explaining the observed variations in species composition of zooplankton community.

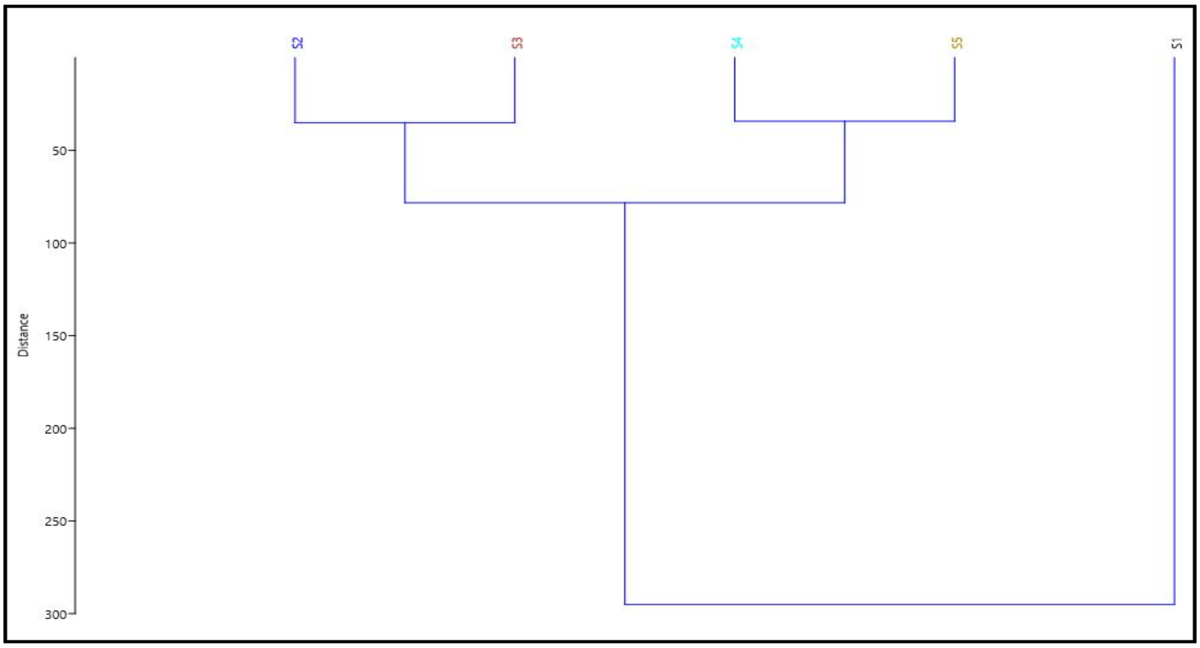

Fig. 6. Dendrogram cluters analysis for macrobenthic invertebrates.

Zooplankton community structure analysis using Shannon and Wiener diversity index, Margalef richness index and equitability evenness index revealed slight variation in the distribution of individuals among the study area. The high diversity index recorded in station 3 reflects the fact that variability in environmental conditions strongly affects zooplankton specie mobilization and distribution. Imoobe and Adeyinka (2009), submits that zooplanktonic organisms are special bio indicators of changes to environmental conditions as they provide early signals of environmental stress in aquatic ecosystems through their responses and behaviours in the presence of certain anthropogenic disturbance or natural distortions.

Conclusion

Although the fauna of zooplankton was studied in the same river, variation occurred in the composition and distribution in the five designated stations due to varying prevailing anthropogenic factors, nutrient enrichment, physico-chemical factors as well as seasonal fluctuations.

References

Abowei JFN, Sikoki FD. 2005. Water Pollution Management and Control. Double Trust Publications company Port Harcourt, p 236.

Akbulut NE, Tavşanoglu UN. 2018. Impacts of environmental factors on zooplankton taxonomic diversity in coastal lagoons in Turkey. Turkish Journal of Zoology**42,** 68-78.

Bianchi F, Acri F, Aubry FB, Berton A, Boldrin A, Camatti E, Cassin D, Comasch AI. 2003. Can plankton communities be considered as bioindicators of water quality in the lagoon of Venice**?** Marine Pollution Bulletin **46,** 964-971.

Dhanapathi MVS. 2000. Taxonomic Notes on the Rotifers from India (from 1889-2000). Indian Association of Aquatic Boilogists, Hyderabad, India. 178 pp.

Gurbuzer P, Buyurgan O, Tekatli C, Altindag A. 2017. Species diversity and community structure of zooplankton in three different types of water body within the Sakarya River Basin, Turkey. Turkish Journal of Zoology **41,** 848-859.

Iloba KI, Ruejoma M. 2014. Physico-chemical characteristics and zooplankton of Ekpan River, Delta State, Nigeria International Journal of Agriculture and Biology Research **6(1),** 8 – 30.

Iloba KI. 2019. Water properties and zooplankton diversity of Aghalokpe wetland in Delta State, Nigeria. Science World Journal **14(1),** 164-170.

Imoobe TOT, Akoma OC. 2009. Spatia variaions in the composition and abundance of zooplankton in the Bahir DarGulf of Lake Tan, Ethiopia. African Journal of Ecology **48,** 72-77.

Imoobe TOT. 2011. Characterization of the zooplankton community structure of polluted Eruvbi Stream Benin City, Nigeria. Nigerian Journal of Fisheries **8(1),** 197-207.

Imoobe TOT, Adeyinka ML. 2009. Zooplankton-based assessment of the trophic state of a tropical forest river.Archive of Biological Science **61(4),** 733-740.

Jakhar P. 2013. Role of phytoplankton and zooplankton as health indicators of aquatic ecosystem: A review. International Journal of Innovation Research Study **2(12),** 489-500.

Jeppesen E, Kronvang B, Olesen JE, Audet J. Sondergaard M, Hoffmann CC, Andersen HE, Lauridsen TL, Liboriussen L, Larsen SE, Beklioglu M, Meerhoff M, Ozen A, Ozkan K. 2011. Climate change effects on nitrogen loading from cultivated catchments in Europe: implications for nitrogen retention, ecological state of lakes and adaptation. Hydrobiologia **663,** 1–21.

Khanna DR, Bhutiani R, Gagan M, Ginh G, Kumar D, Ahraf J. 2009. A study of zooplankton with special reference to the concentration of River Ganga at Haridwar**.** Environmental Conservation Journal **10(3),** 15-20.

Molinero JC, Ibanez F, Nival P, Buecher IS, Souissi S. 2005.North Atlantic climate and north-western Mediterranean plankton variability Limnology and Oceanography **50,** 1213-1220.

Ogbeibu AE. 1991. Hydrobiological characteristics of water bodies in the Okomu forest reserve (sanctuary), Benin, Nigeria. Ph.D. Thesis. University of Benin, Nigeria.

Xuelu GAO, Jinming S, Xuegang L. 2011. Zooplankton spatial and diurnal variations in the Changjiang River estuary before operation of the Three Gorges Dam. China Journal of Oceanology and Limnology **29(3),** 591-602.