PRINT ISSN 1119-8362
Electronic ISSN 1119-8362

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://ww.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 25 (6) 1047-1052 June 2021

Zooplankton Diversity, Dynamics and Correlation with Physicochemical Parameters at Ugbevwe Pond in Delta State, Nigeria

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ABSTRACT: Zooplankton are microscopic floating animals, which drift in water and whose swimming power if any, serve mainly to keep them afloat. A field study was conducted to determine the spatial and temporal variation in the zooplankton composition, dynamics and diversity at Ugbevwe Pond, Oghara, Delta State. Zooplankton samples were collected from three stations from August, 2014 to May, 2015 covering the wet and dry seasons. Zooplankton species were sorted and identified using appropriate identification keys. A total of six species of copepod belonging to two subfamilies and a total of five species of Cladocera belonging to three families were encountered. The spatial distribution of species of cladoera shows that of the five species encountered, three species namely *Alona eximia, Alona costata* and *Macrothrix* sp. occurred in all three stations. *Diaphanosoma sp* was restricted to station 1 while *Pleuroxus hematus* was restricted to station 3. The spatial distribution of species of copepod shows that of the six species encountered, *Thermocyclops neglectus, Tropocyclops prasinus, Microcyclops varicans Mesocyclops bodanicola* and *Eucyclops serrulatus* occurred in all three stations while *Cryptocyclops bicolor* was absent in station 1. Zooplankton was more abundant in the rainy season than the dry season. The relationship between zooplankton and the investigated physico-chemical parameters showed that all the zooplankton correlated positively with depth, lead and total hydrocarbon and negatively with colour, sodium, Calcium, Iron and Zinc.

DOI: https://dx.doi.org/10.4314/jasem.v25i6.24

Dates: Received: 20 March 2021; Revised: 27 April 2021; Accepted: 07 May 2021

Keywords: Zooplankton diversity, physicochemical parameters, pond.

Zooplankton are animals whose swimming appendages are too small to enable them swim effectively against water current hence, they drift along with water. Their characteristics, coupled with high sensitivity to changes in the environment have drawn the attention of several biologists worldwide, who had investigated their occurrence, composition, distribution and significant roles in the study of pollution. (Chigbu, 1984; Das et al., 1996; Davies, 2009; Ibrahim, 2009). Zooplankton occupies central position in the trophic link between primary producer and higher trophic level. (Iloba, 2002). Zooplankton are considered indicators of water quality, however the responses of zooplankton to water quality variation are ecosystem and species dependent and vary within and between lakes (Ravera, 1996; Dejen *et al*., 2004). Species richness peak in the dry season while abundance peak in the rainy season indicating an inverse relationship between species richness and abundance (Okechukwu, 2009). Species composition and abundance of zooplankton communities can be influenced by a number of physical, chemical and biological factors, in a general way, factors such as temperature (Amarasinghe et al., 1997) salinity (Egborge, 1994) pH (Sprules, 1975) and electrical conductivity can affect their community with regard to both composition and population density. The size of the water body (Patalas, 1971), their trophic state (Gannon and Stemberger, 1998) and the successional stage (Hutchinson, 1967) also greatly influence the species composition of zooplankton. In natural environments these factors act simultaneously and may also interact to difference degrees, modifying the zooplankton structure in different ways and because Ugbevwe pond, Oghara, Delta state, Nigeria is one of such water body facing environmental and seasonal fluctuations, therefore the objective of this paper is to report the zooplankton diversity, dynamics and correlation with physico-chemical parameters at ugbevwe pond in Delta State, Nigeria.

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MATERIALS AND METHODS

Study area: The study was carried out at Ugbevwe pond (fig. 1), close to Ogharaefe junction in Delta State, Nigeria. Samples were collected at monthly interval for 10 months from august, 2014 to May, 2015 covering raining and dry season. Sampling was done between the hours of 9am and 11:30am on each sampling day. Ugbevwe pond is located between latitudes 5º40'E and 5º42'E and longitudes 5º56'N and 5º58'N. Typically, the region has the characteristic feature of the humid tropical wet and dry climate governed primarily by the rainfall. The dry season is from November to February and the wet season is from March to October. (NEDECO, 1961; Egborge, 1987). Three sampling stations were established at the pond. Station 1 is very close to the Warri/Benin high way. It is subjected to human activities. Dominant plant there was *Ischaemum rugosum* under family Poaceae and also Algae (Chlorophyta). Station 2 is 29m away from station 1 and was o human activities. Dominant plant species include *Nymhaea lotus* (waterlily), *Ludwigia decurrens* (water primrose), *Musca paradisiacal* (Plantain) and Algae (Chlorophyta). Station 3 is 20m away from station 2. Dominant plant species are Fern, *Eleais guineesis* (Palm tree), Algae (Chlorophyta) and *Kyllinga erecta.* This part of the pond was seldom disturbed.

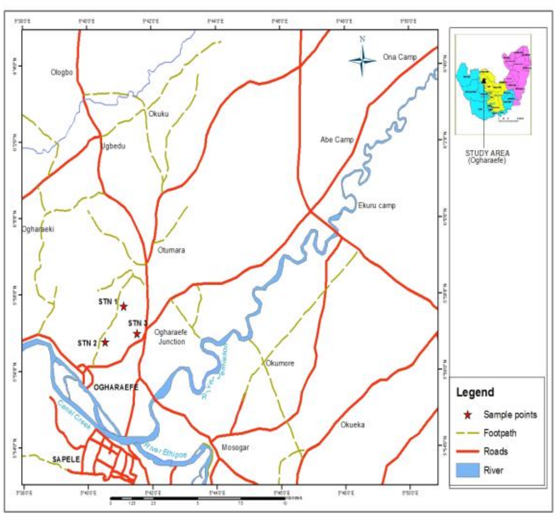

Fig. 1: Map of study area showing sampled stations.

Water sample collection and analysis: The methods according to Ogbeibu, 2001 were used. Water samples were collected with bottles made of polyethylene, previously washed, rinsed and dried in the laboratory. This was done by completely immersing the bottle few centimeters below the water surface and sealing it after filling while still immersed in the water, before bringing it out. Water samples for determination of dissolved oxygen were collected, using 250ml reagent bottles with glass stoppers and was immediately fixed according to (APHA, 1998). All the water samples were analyzed in the laboratory using standard methods (APHA, 1998) Data obtained from this study was statistically analyzed using the Statistical Package for Social Science (SPSS) version 16 to determine the correlation between zooplankton and water parameters. Zooplankton sampling was done by sweeping a hydro-bios plankton net of mesh size 55um randomly at each sampling station for 10 minutes, the residue were collected and preserved in a plankton bottle using 4% formalin. (UNESCO, 1974). A total of 30 samples were collected throughout the period of sampling. In the laboratory, zooplankton specimens were sorted under an optical microscope (model 570) at x4.0 magnification and counting was done using the gridded Petri dish under dissecting microscope. Specimen were viewed under the Olympus compound microscope with eye piece of x10 magnification and varying magnification of objective lens. Parts of the organism like the antenna, caudal rami, rostrum, post abdomen, antennules were closely examined and the distinguishing features on these parts were used to identify the organisms to species level or at least generic level using appropriate identification keys like Jeje and Fernando, 1986; Edmondson, 1959; and literatures like; Kieter 1932; 1934; Lang 1965, Onabamiro 1952a; 1952b; 1956; 1957. Basic statistical measurement of diversity indices and One-way Analysis of Variance (ANOVA) were used to describe the zooplankton community structure. The following characteristics were ascertained: taxa richness and Species diversity.

RESULTS AND DISCUSSIONS

The zooplankton community comprised of six species of copepods (Table 2) belonging to two subfamilies and five species of cladocera (Table 1) belonging to three families were encountered and with this number from this study, Ugbevwe pond is said to be fairly rich in crustacean zooplankton when compared with many other water bodies. Dodson, (1992) found an average of 4.5 cladoceran species for ponds and Keller & Conlon, (1994) found an average of 9 species for ponds with a depth of less than 2 m. The six species of copepod are represented by the cyclopoids and no calanoid was found. The cyclopoids comprises *Tropocyclops prasinus, Thermocyclops neglectus, Cryptocyclops bicolor, Mesocyclops bodanicola, Microcyclops varicans, Eucyclops serrulatus.* This result is similar with the findings of Burgis (1973), were the calanoid copepods were conspicuously absent in his study of the zooplankton of lake George, Uganda.The Cladocera community of Ugbevwe pond comprises of five species belonging to three families which include Chydoridae *(represented* by *Alona* *eximia, Alona costata, Pleuroxus hamatus*), Sididae (represented by *Diaphanosoma sp.),* and Macrothricidae (represented by *Macrothrix sp.).* Chydoridae are large sized Cladocera, therefore their presence may be because of the relative cool atmospheric and water temperature recorded in the study area and this is in accordance with Burgis, (1973) which reported that there is a tendency for animals in the geographical region of lower temperature to be bigger than animals in the region of higher temperatures.

The cyclopoids were the only dominant copepods while the chydorids was the most abundant cladocerans. Copepods are known to occur in plankton of most water bodies and have been ranked as one of the most abundant (Hemalatha et al, 2016). The cyclopoids dominated in this study (Fig. 3) and this agrees with the findings of Egborge, (1981), and Jeje and Fernando, (1986) where the 11 cyclopoid copepods were the dominant group in Lake Asejire and Kainji respectively.

Table 1: Spatial distribution and abundance of species of cladocera

Taxa	Stations			zooplankton abundance
	1	2	3	
Alona eximia	8	10	9	27
Alona costata	4	11	9	24
Pleuroxus hamatus	-	-	2	2
Diaphanosoma *sp*	5	-	-	5
Macrothrix sp	1	3	2	6
Total	18	24	22	

Table 2: Spatial distribution and abundance of species of Copepod

TAXA	STATIONS			zooplankton abundance
	1	2	3	
Thermocyclops neglectus	27	23	2	52
Tropocyclops prasinus	27	26	29	82
Cryptocyclops bicolor	4	0	1	5
Microcyclops varicans	4	5	4	13
Mesocyclops bodanicola	11	8	11	30
Eucyclops serrulatus	3	2	2	7
Total	76	64	49	

Table 3: Spatial and temporal distribution of species of cladocera

	Station 1	Station 2	Station 3	
August	Δ	Δ		Δ *Alona eximia*
September	*	*	Δ *	* *Alona costata*
October		*	Δ	*pleuroxus hamatus*
November	Δ⊘			⊘*Diaphanosona sp*
December	⊘	Δ +	Δ	+ *Macrothrix sp*
January				
February	Δ +	⩮		
March				
April	⊘	Δ	Δ@+	
May	Δ⊘	Δ +	Δ*@	

Table 4: Spatial and Temporal Distribution of Species of Copepod

	Station 1	Station 2	Station 3	-
August	T↔◙	TM	T↔	T *Thermocyclops prasinus*
September	T↔M	T	T↔M	↔ *Tropocyclops neglectus*
October	↔MΘ	T↔Θ	T ⩮	◙ *Cryptocyclops bicolor*
November	T◙Θ	T↔M	TMΘ	Θ *Microcyclops varicans*
December	T↔	TM	T	M Mesocyclops bodanicola
January		T↔		E Eucyclops serrulatus
February	T	T↔		
March	T↔M	↔	T↔	
April	T↔Θ	TΘE	TME	
May	T↔ME	T↔	T◙MΘ	

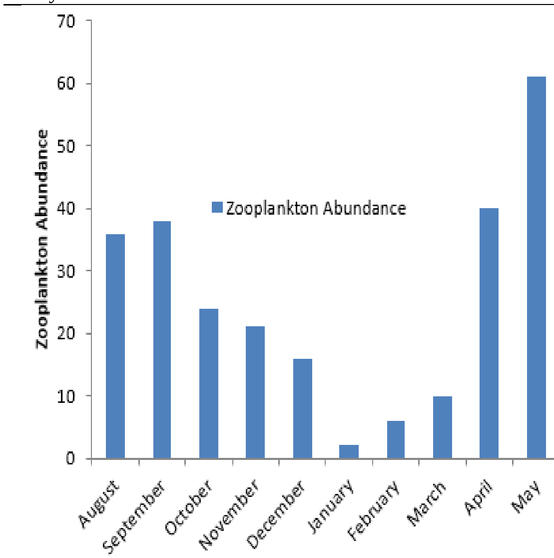

Fig. 2: Monthly abundance of zooplankton encountered

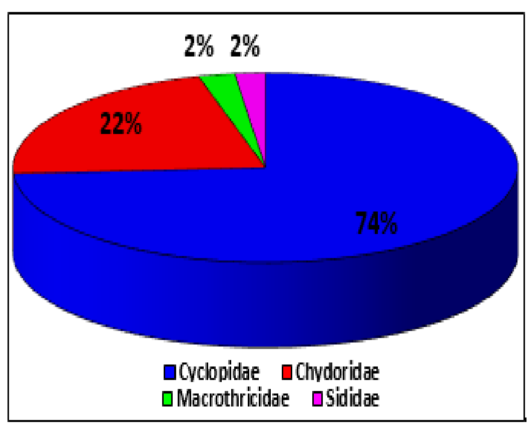

Fig. 3: Percentage of Zooplankton families

From the four families encountered in this study, the family cyclopidae was the most diverse with six species and it is also the most abundant with 189 individuals making 74% of organism found. (Fig. 3).

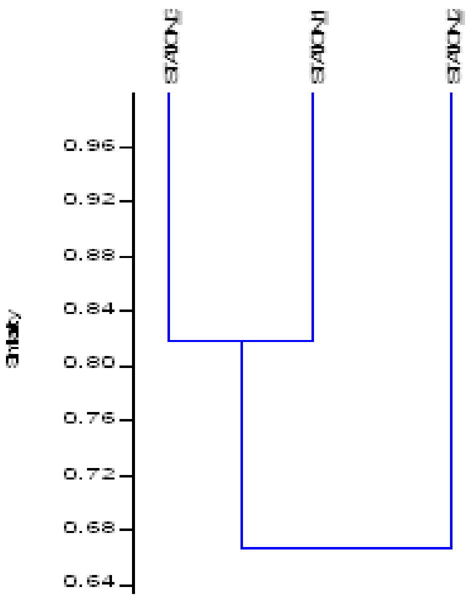

Fig. 4: Test of zooplankton similarity/diversity among stations using Jaccard

The family Sididae and Macrothricidae was the least diverse and was represented by 1 species with a number of individuals of 5 and 6 respectively. The calculated diversity indices using jaccard index (Fig. 4) revealed that the diversity of the three stations is almost the same with station 3 (1.915) slightly more diverse than station 2 while station 2 was slightly more diverse than station 1.

This study revealed that more cladocerans (Table 2) and copepods (Table 2) were encountered in the rainy season than in the dry season (Fig. 2) and this is in accordance with (Imoobe and Egborge, 1997) which recorded more crustacean zooplankton during the wet seeaon in Jamiesan River. The correlation between zooplankton abundance and the investigated physico-chemical parameters (Table 6) revealed that representatives of the family Chydoridae were found to exist in positive correlation with THC, Cr and Pb and they were negatively correlated with Fe, Zn and Ca. Cyclopidae correlated positively with depth and negatively with colour, Turb, Na, Ca, Fe and Zinc. Macrothricidae exist in positive correlation with only Pb while Sididae exist in negative correlation with phosphorus.

In general, all the zooplankton correlated positively with depth, lead and THC and negatively with colour, Na, Ca, Fe and Zn.

Table 6: Test of relationship between the investigated physical and chemical parameters and zooplankton in Ugbevwe Pond

	Chydoridae	Cyclopidae	Macrothricidae	Sididae	Total zooplankton
Air.temp	-0.111	0.054	-0.081	0.173	0.01
Water.temp	-0.111	-0.127	0.127	-0.027	-0.123
Depth	0.145	**0.48**	-0.135	0.175	**0.389**
conductivity	-0.235	-0.254	0.295	0.107	-0.23
pH	-0.109	-0.168	0.066	-0.112	-0.161
EC	-0.224	-0.244	0.33	0.124	-0.216
Sal	-0.263	-0.306	0.213	0.125	-0.284
Pt.Co	-0.266	**-0.494**	0.184	-0.295	**-0.447**
NTU	-0.129	**-0.385**	0.239	-0.283	-0.315
TSS	-0.108	-0.242	0.205	-0.196	-0.204
TDS	-0.21	-0.301	0.289	0.098	-0.257
DO	0.14	0.222	-0.187	-0.182	0.184
BOD5	0.134	0.077	-0.071	-0.114	0.088
COD	-0.034	0.033	0.015	-0.083	0.008
HCO3	-0.109	-0.195	0.265	-0.169	-0.162
Na	-0.318	**-0.46**	0.273	-0.01	**-0.416**
K	0.085	0.202	-0.179	-0.2	0.146
Ca	**-0.433**	**-0.409**	-0.003	-0.145	**-0.452**
Cl	-0.183	-0.165	0.127	-0.022	-0.17
P	-0.034	-0.065	-0.13	**-0.379**	-0.09
NH4N	-0.282	-0.253	0.099	0.037	-0.272
NO2	-0.23	-0.274	-0.018	0.039	-0.279
NO3	-0.027	-0.171	0.24	0.009	-0.108
SO4	-0.087	-0.072	0.077	-0.116	-0.08
Fe	**-0.501**	**-0.521**	-0.085	-0.073	**-0.562**
Mn	0.327	0.341	-0.036	-0.2	0.347
Zn	**-0.422**	**-0.496**	0.066	-0.045	**-0.5**
Cu	-0.293	-0.223	-0.143	-0.297	-0.293
Cr	**0.376**	0.263	0.331	0.125	0.356
Ni	-0.224	-0.22	0.078	-0.096	-0.233
Pb	**0.581**	0.332	**0.495**	0.166	**0.496**
V	-0.205	-0.222	0.204	-0.005	-0.212
THC	**0.41**	0.324	0.176	0.149	**0.402**

Note: All analysis was proved significant at 95% confidence level

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