THE ZOOPLANKTON OF RIVER ADOFI IN DELTA STATE OF NIGERIA

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ABSTRACT

Some physico- chemical parameters were investigated alongside with the zooplankton of Adofi River between June and November 2009. The nutrient levels detected were significantly very high. Two taxonomic groups were identified; the rotifera and the Cladocera. The rotifers were the most occurring species (15) constituting about 98.7% of the total zooplankton species while the Cladocera recorded only two species with 1.3%. Of the phylum rotifera, the family Brachionidae recorded six species constituting 40% of the total number of species while the other three families Lecanidae, Proalidae and Trichocercidae had three species(20 %) each. Despite the equal species composition of the three families, the family Proalidae(39%) was almost of equal abundant composition with the family Brachionidae(39.4%} while the families Lecanidae and Trichocercidae contributed 12.9%, and 7.1% respectively. The two species of Cladocera recorded were *Ceriodaphnia audragula* contributing 1% abundance and *Diaphanosoma leuchen* having 0.5% abundance. No significant difference was found between the physico – chemical parameters. However, significant difference was found between the physico- chemical parameters and the zooplankton abundance ($P<0.01$).

Keywords: zooplankton, composition, abundance, diversity, River Adofi

INTRODUCTION

The zooplankton species composition in a water body is the result of the interactions between the abiotic and biotic factors. In order words zooplanktonic composition responds to the interannual variability in the aquatic ecosystem, thereby, affecting the production of the lower trophic level plankton. The population size or standing stock is therefore of great importance in any aquatic ecosystem since these organisms constitute an important source of food for many nektonic species particularly the juvenile fishes (Guy, 1992). Zooplankton are also globally recognized as pollution indicator organisms in any aquatic environment. This is as a result of their sensitivity and fast response to wide range of environmental changes such as water temperature, ph, conductivity, and nutrients (Yakubu *et al.,* 2000). The presence, abundance, composition and diversity of zooplankton in any aquatic ecosystem could be threatened or impacted on. The productivity of any water body is dependent on the amount of plankton in that water body (Guy, 1992). Physico-chemical parameters of the water also affect plankton distribution, sequential occurrence and species diversity (Raymond, 1983) which include the various protozoa, rotifers, crustacean, cladocera, copepod, ostracoda

Adofi river plays an important role in the lives of the surrounding inhabitants and hence this project work is to provide information on the zooplanktonic organisms represented in the River.

STUDY AREA

River Adofi is located in Utagba-uno, Ndokwa -West Local Government Area of Delta State ($5^0 45^0$, $6^0 00^0$N – $6^0 15^0$, $6^0 30^0$E). It lies within the dense and thick tropical rainforest flowing through Ossissa, Iselegu to Warri. The vege-

tation here consists of floating plants such as *Pistia Spp., Azolla Africana and Nymphacea lotus;* The totally submerged plants *include Vossia cuspidate, Ludioigia Spp., Salvinia nymphelluda, Hydroles glabra and Pyereus lanceotus.* Fishes found in this river include *Tillapia Spp., Malopterurus electricus*, e.t.c. Anthropogenic activities include fishing, washing of clothes, bathing, fermentation of cassava, lumbering, e.t.c.

DESCRIPTION OF STUDY STATION

STATION 1: This is the pool or relatively stagnant part of the river. Where activities such as the fermentation of cassava, anchorage for canoe, fetching of water for drinking and also swimming take place. The station was characterized by emergent, submerged as well as floating vegetations. There is also the occurrence of the bloom of filamentous algae.

STATION 2: This is the open, fast flowing part of the river. The station has both emergent and submerged vegetation but no floating vegetation. It is deeper than the pool region (station 1).

STATION 3: This is the deepest of the three stations and it is located further down along the path of the river from station two. This station receives water from both station 1 and 2. Also present here are submerged and emergent vegetations. Like station 2, there are no blooms of filamentous algae.

Sampling Procedure

The stations were visited at monthly intervals from June to November 2009 between 9.00am – 12pm. Water samples for physiochemical analysis were collected from below the surface in 2L plastic containers. The Zooplankton samples were collected using a 55mm hydrobios plankton tow net attached to a rope, by towing the plankton net across the water body. Samples were then transferred into properly labelled sample bottles and preserved immediately with 4% formaldehyde.

Water and air temperature were determined using mercury-in-glass thermometer. In the laboratory, the dissolved oxygen was determined, using the Winkler's method while biochemical the oxygen demand was determined after 5 days using Winkler's method too. Hydrogen ion concentration was determined by the use of a pH meter (model 9793/2) **.**Alkalinity was determined using titrimetric method. Sulphate was determined the use of the spectrophotometeric method. Phosphate – phosphorus was determined using the Auto-analyzer II while Nitrate was determined using the Brucine colorimetric method.

1 or 2 drops of zooplankton sub-sample were placed on a slide, covered with a cover slip and were examined microscopically. The zooplankton organisms were identified using keys provided by Jeje and Fernando (1986), Cooperative Research Centre for Freshwater Ecology (1995), Iloba and Egborge (2002). Counting was done using a counting chamber. The number of organisms counted was expressed in terms of organisms per ml.

The community structure of the river was analysed using the Margalef Index, Shannon-Weiner general diversity (H) and Evenness indices (Krebs, 1978).

RESULTS

A summary of the result of physico-chemical parameters obtained for the different stations in Adofi-river are shown below.

Table 1: Mean ± Standard Error value of some physical and chemical conditions of the study stations. (minimum and maximum in Parenthesis)

PARAMETER	STATION 1	STATION 2	STATION 3	F-ANOVA MONTHS	F-ANOVA STATIONS	P-MONTHS	P-STATION
Air temperature (°C)	27.5±1.23 (23.0-31.0)	27.83±1.25 (24.0-32.0)	28.0±0.86 (26.0-31.0)	14.15	0.10	(P<0.05)	(P>0.05)
Water temperature (°C)	26.50±1.23 (22.0-30.0)	27.08±1.40 (23.0-32.0)	27,25±0.75 (25.5-30.0)	21.22	0.93	P<0.05	P>0.05
pH	6.20±0.34 (5.00-7.10)	6.58±0.11 (0.28-6.92)	6.81±0.08 (6.5-7.11)	0.17	0.58	P>0.05	P>0.05
Dissolved oxygen (mg/L)	3.37±0.16 (3.00-4.00)	4.27±0.44 (3.2-6.00)	3.02±0.12 (2.6-3.4)	0.75	2.4	P>0.05	P<0.05
Biochemical oxygen demand (mg/L)	1.49±0.11 (1.2-1.94)	2.04±0.28 (1.05-3.00)	1.38±0.13 (1.05-1.9)	0.19	0.75	P>0.05	P>0.05
Alkalinity mg/$CaCO_3$	0.74±0.03 (0.66-0.81)	0.84±0.041 (0.73-1.00)	0.49±0.029 (0.41-0.6)	0.017	0.19	P<0.05	P<0.05
Nitrate (mg/L)	6.87±0.93 (3.00-9.23)	6.59±0.43 (4.5-7.25)	6.05±0.47 (4.6-7.65	5.78	1.05	P<0.05	P>0.05
Phosphate (mg/L)	0.027±0.005 (0.014-0.053)	0.24±0.02 (0.19-0.30)	0.03±0.0005 (0.026-0.029)	0.0006	0.09	P>0.05	P<0.05
Sulphate (mg/L)	3.28±0.011 (3.25-3.32)	9.68±0.52 (8.00-11.31)	2.09±0.03 (2.00-2.16)	0.59	100.08	P>0.05	P<0.05

P<0.05 = statistically significant different (Reject the null hypothesis: (H_0), P>0.05 = not statistically significant (accept the null hypothesis: (H_0)

The air temperature ranged between 23^0C and 32^0C. The water temperature recorded for the entire sampling period ranged between 22^0C and 32^0C. There was no significant difference in the water temperature in the three stations (p>0.05). The highest value for Biochemical Oxygen Demand was recorded as 3.00mgL^{-1} in the month of September for station 2 while the lowest values were recorded for station 2 as 1.05mgL^{-1}. 1.05mgL^{-1} was also recorded for the months of August and September in station 3. No significant was recorded in the station (p > 0.05)

The pH values ranged between 5.00 and 7.11. The pH varied from slightly acidic to slightly alkaline as shown in the range of values. There was no significant difference in the pH value of the three stations (p > 0.05). The alkalinity concentrations were generally low with a range of 0.41 -1.00 mg/$CaCO_3$ being records for stations 3 and 2 respectively. Alkalinity concentration was relatively higher in station 2, followed by station 1 and station 3. The differences in the alkalinity values were statistically different from one another (p < 0.05)(Table 1). The study revealed that the nutrients were highly variable in all stations investigated (p <0.005).The Nitrate level was high in all the stations. The highest value was 9.23mg/l recorded in Station 1 in the month of July and lowest was also in station 1 in the month of June with a value of 3.00mg/l. There was a significant difference among the stations (p > 0.05). The phosphate level in the river was generally high. The values were higher in Station 2. The phosphate level in the water body ranged from 0.023mg/l in Station 1 and Station 3 to 0.297mg/l in Station 2. The highest and lowest values were recorded for the months of July and June respectively. No significant difference was recorded in the stations (p < 0.05). The highest sulphate value was recorded in Station 2 as 11.31mgL^{-1} and the lowest was 2.00mgL^{-1} in Station 3 in the months of June and July respectively. The sulphate level in Station 2 was generally higher while station 3 was generally lower. Significant difference was noted among the stations (p < 0.05).

ZOOPLANKTON

Tables 2 – 3 show the list of zooplankton identified in River Adofi. Two taxonomic group of zooplankton only were identified during the study period. These groups were *Rotifera* and *Cladocera*. The *Rotifera* contributed the most abundant number of individuals throughout the sampling period with a total of 241 individuals representing 98 77% while *cladocera* was found only in Station 1,

with only three (3) individuals to give only 1.23%. Among the rotifers, the most abundant species was the family Brachionidae which contributed a total of six (6) species.

Table 2: Zooplankton species identified in River Adofi and their relative abundance in station 1.

Taxonomic groups in station 1	June	July	Aug.	Sept.	Oct.	Nov.	Total no. of individuals per litre	%
ROTIFERA								
BRACHIONIDAE								
Brachionus calyciflorus	10	8	3	6	-	4	31	15.5
Brachionus leydigi	12	6	10	2	1	-	31	15.5
Brachionus falcatus	5	2	-	-	3	-	10	5
Colurella uncinata	2	-	-	-	-	-	2	1
Lepadella ovalis	2	-	-	1	-	-	3	1.5
Notholca acuminata	1	-	-	-	-	-	1	0.5
TRICHOCERCHIDAE								
Trichocerca cylundrica	3	1	-	-	1	-	5	2.5
Trichocerca obtusteins	1	-	-	-	-	-	1	0.5
Trichocerca iarnis	5	2	-	-	3	1	11	5.5
LECANIDAE								
Lecane papauna	6	-	-	4	-	-	10	5
Lecane curvicornis	2	2	-	-	-	-	4	2
Lecane luna	4	4	-	1	1	-	10	5
PROALIDAE								
Proales Species 1	10	4	-	15	5	6	40	20
Proales Species 2	6	8	2	4	-	-	20	10
Proales Species 3	4	-	4	1	3	6	18	9
CLADOCERA								
Ceriodaphnia audragula	2	-	-	-	-	-	2	1
Diaphanosoma leuchen	1	-	-	-	-	-	1	0.5

In station 1, *Proales sp.1* dominated the zooplankton population during the study with 40 individuals . The least abundant species were *Trichocerca obtustiens* and *Diaphanosma leuchen* recording (1) one individual each.

Table 3: Zooplankton species identified in River Adofi and their relative abundance in station 2.

Taxonomic groups in station 2	June	July	Aug.	Sept.	Oct.	Nov.	Total no. of individuals per litre	%
ROTIFIERA								
BRACHIONIDAE								
Brachionus leydigi	2	-	3	1	-	-	6	35.3
Brachionus falcatus	4	2	-	2	-	-	8	47.1
LECANIDAE								
Lecene luna	2	1	-	-	-	-	3	17.7

Station 2 recorded only three species of rotifers *Brachionus leydigi* , *Brachionus falcatus*, *Lecene luna* during this period belonging to families *Brachionidae* and *lecanidae.* Their spatial appearances were sporadic. The family Proalidae and class Cladocera were completely absent from this station.

Table 4: Zooplankton species identified in River Adofi and their relative abundance in station 3

Taxonomic groups in station 3	June	July	Aug.	Sept.	Oct.	Nov.	Total no. of individuals per litre	%
ROTIFERA								
BRACHIONIDAE								
Brachionus Lleydiyi	2	-	-	1	-	-	3	11.11
LECANIDAE								
Lecane luna	2	2	-	-	-	-	4	14.82
PROALIDAE								
Proales species 1	6	1	-	-	1	1	9	33.33
Proales species 2	2	-	4	-	-	-	6	22.22

Station 3 recorded four rotifer species belonging to three families: *Proalidae*, *Brachiomidae* and *Lecamidae*. The family *Proalidae* was the most dominant and abundant, with three (3) species and 20 individuals/ml constituting 74.07% of the total zooplankton population.

Figure 2 presents the monthly variations in the total zooplankton biomass in the different sampling months.

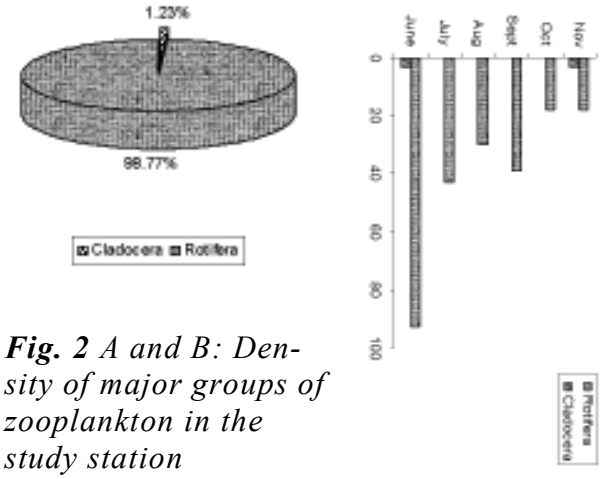

***Fig. 2** A and B: Density of major groups of zooplankton in the study station*

Cladocerans were obviously scarce in the system and occurred as single individuals only with a percentage of 0.5 and 1 as shown in the Figures 2 A and B.

Table 5 summarizes the diversity indices of the zooplankton composition during this study.

Table 5 : Diversity indices of zooplankton in the study area

	Station 1	Station 2	Station 3
No. of Individuals	200	17	27
No. of Taxa	17	3	5
Margalef's Index (d) (Taxa Richness)	3.019	0.7059	1.2136
Shannon-Wiener (H)	1.0252	0.4457	0.6688
Evenness Index (E)	0.8332	0.9341	0.9584
Simpson's Dominance Index (C)	0.5404	0.3407	0.1995
Simpson's Index (D^1)	1.8504	2.9345	5.0125

Based on the diversity, equitability dominance indices it was obvious that the zooplankton composition River Adofi were not diverse and rich in species. Simpson's Dominance Index (C) revealed that station I had

DISCUSSION

The air temperature of Adofi River during this study (23^0C and 32^0C) conformed to the tropical climate of tropical climate of Nigeria which is generally greater than 24^0C (Adesalu, 2010). The surface water temperature of the river followed closely the air temperature. This aquatic characteristics was also noted by Iloba and Egborge (2002) in the Ikpoba river system. The temperature variation recorded during the study was optimal for normal growth and survival of aquatic organisms as noted by Mustapha and Omotosho (2005). The difference between air and water temperature may be attributed to efficiency in rapid heat transfer from one medium to the other (Iloba, 2002).

The low dissolved oxygen in Adofi-river could be attributed to the cumulative effect of human activities such as cassava fermentation; sewage disposal which led consequently to the use of oxygen in decomposing these organic matter results thereby resulting in low oxygen concentration. No correlation was observed between temperature and dissolved oxygen as noted by Oladipo and Williams (2003). The optimal temperature observed in this study did not impact on the oxygen content of the River. The visible algal bloom in Station 1 was a resultant effect of the process of anthropogenic activities and eutrophication which was very prominent in this station and evident in the high nutrient elements recorded in this station as noted by Mustapha and Omotosho (2005).

The pH values recorded in this study were slightly acidic with values between 5.00 and 7.11. This is in line with Tropical waters as recorded by Mustapha (2009), the pH value of River Adofi suggests the preponderance of carbonates and bicarbonates in the River which could have been impacted by decay of organic matters and the respiration of micro-organisms(Iloba 2002; Mustapha 2009).

The pH of the River was normal as it still fell within the recommended range of 6.5 – 7 for the support of aquatic life (Boyd, 1979).

The Biochemical oxygen demand values were relatively high and ranged between 1.05 and 3.00 (mgl^{-1}). This is similar to the findings of Rai, (1974), who measured the biochemical oxygen demand of a river in Ivory Coast. The biochemical oxygen demand and other microbial activity generally increased by decomposition and eutrophication (Mustapha and Omotosho, 2005). Biochemical oxygen demand is frequently used to monitor waste loading in water bodies. Therefore, the biochemical oxygen demand values observed in this study revealed high loading of effluent/waste materials into the river.

The alkalinity values in this study are very low ranging from 0.41 to 1.00 mg/ $CaCO_3$. Similar values have been reported by Imoobe and Ogbeibu (1996) for Jamieson River with values of between 0.82 – 0.95 mg/ $CaCO_3$. .Alkalinity of many surface water is primarily a function of hydroxide, carbonate and bicarbonate concentration (Talling, 1957). Generally, the nutrient levels phosphate (PO_4), sulphate (SO_4) and nitrate (NO_3) were high. High nutrient values have been reported by Mustapha and Omotosho (2005), Mustapha (2009), Chindah and Braide (2004) and Davies ad Otene (2009). The increased nutrients level in the study resulted to the visible effect of eutrophication i.e. algal bloom. Ambasht and Ambasht (2005) reported that Nitrate and phosphate were limiting nutrients whose concentrations in water influences phytoplankton growth and division. Chindah (2004) reported that nutrients released into most tropical waters either from surroundings, sediments and or contagious groundwater sources, are used up by organisms such that the dissolved nutrients in water column is consistently small but the high nutrients levels could have resulted from domestic and industrial wastes being released into the stream from the surrounding.

The high nutrients level in the study area could be said to be from such activities as cassava fermentation, run-offs of nitrophosphate fertilizers from nearby farm lands into the river. Other sources includes fish landing, fish descaling and canoe repairs as well as lumbering activities.

Total Zooplankton count showed the most dominant taxa were the rotifers which contributed 98.77% to the population. It is not unexpected; that rotifers were the numerically dominant zooplankton group. The dominance of rotifers in Nigeria waters waters have been reported by several authors (Oriola, 2002, Jeje and Fernando, 1992). Iloba (2002) also characterised tropical freshwater as being dominated by rotifers.Cladocerans contributed just 1.23%. The low species spectra of cladocera recorded in this study was observed by Jeje and Fernando (1992) in the Niger- Sokoto River. This record was also similar to the findings of Davies and Otene (2009) in Michinda stream in Rivers State.

Zooplanktons were more dominant and abundant in station 1. A total of 197 individuals were recorded as against the 17 and 27 in stations 2 and 3 respectively. This could be attributed to the presence of food and stagnant nature of station 1. Mustapha and Omotosho (2005) reported that the absence of high velocity is likely to concentrate aquatic organisms in that site particularly littoral species as was the case in this present study. Burnes (2006) also noted that another factor that could possibly aid in rotifer dominance is the composition of the fish community in the water body. This probable reason could not be expatiated since the fish faunal of the system was not investigated. Further studies could be carried out to buttress this point.

From the physiochemical parameters viewpoint, the river is productive and will support diverse number of organisms as reported by Iloba and Akawo (In press) in the investigation of the Phytoplankton of this same River which they found diverse and favourable for the growth fish and other aquatic organisms. The only threat to its productivity was the case of cultural eutrophication which was observed in the river.

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