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Iloba KI
Department of Animal and Environmental Biology, Delta State University, Abraka

Correspondence
Iloba KI
Department of Animal and Environmental Biology, Delta State University, Abraka

Rotifers of River Ethiope, Delta State, Nigeria

Iloba KI

Abstract
The composition of rotifers with some physico-chemical parameters of River Ethiope, Delta State, Nigeria were assessed at five stations (Umuaja, Umutu, Abraka, Igun and Sapele) from February 2003 to January 2005 using standard methods. Fifteen species of rotifers identified represented a low rotifer composition dominated by Branchionidae constituting 28% species composition, Colurellidae (27%), Lecanidae 18%, Trichocercidae, Proalidae and Notomatidae had 9% each. Species richness was in this order; Station 3 >2>4>1=5 and abundance in Station 4 >3>2 = 4 > 1 order. High similarity index and Jacard coefficient were found between stations 4 and 5, 2 and 3, 2 and 5, 2 and 4 and lastly 3 and 5. The limnological parameters varied significantly within and among the stations except total dissolved solids, pH, dissolved oxygen and alkalinity (P<0.05). Higher Margalef, Shannon and evenness values in Stations 2 and 3 are indicative of ecologically stable environment than others.

Keywords: Rotifers, abundance, composition, distribution, physico-chemical parameters, diversity indices

1. Introduction
River Ethiope is one of the important water bodies in the Western Niger Delta of Nigeria and has not received extensive hydrobiological research from its source to the mouth. The few studies on the river system focused on the fish assemblages which include the works of Ikomi, [1]; Odum, [2]; Ikomi and Jessa [3] and Omo-Irabor and Olabaniyi, [4]; Kaizer and Osakwe, [5]. A detailed work on the hydrobiological work on the river system has not been previously done [6]). Information on the water quality status of such water bodies that offer employment, industry, agriculture, transportation, scientific or educational opportunities and domestic uses to the numerous communities along its course is of global importance [7, 8]. As part of documenting information on the ecological status of the river, this article presents the rotifers community richness, abundance and diversity as part of the basic platform for evaluating the water quality of the river.
These fascinating creatures are of great importance in understanding the ecological status of freshwater systems as variations in their species compositional structure, distribution and abundance over a range of timescales is a feature of Rotifera [9, 10]. Rotifers are therefore good biological indicators of richness and quality of a water body due to their sensitivity to changes in environmental factors and their short reproductive cycle [11]. Researchers have reported the use of the quantity and quality of rotifers as good water quality indicator [12-14] because these biological variables are affected by a variety of factors other than nutrient and food availability. In order words rotifers are known to perform unique functional roles different from other aquatic communities. Amongst these important roles is the transfer of bacterial production to higher trophic levels in the complex riverine food chain [12, 15] and their disturbance will upset the complexity of aquatic food relationships resulting in stressful ecosystem. The resultant effects of ecosystem instability are significant deviations from a random distribution within a given region disrupting the cosmopolitanism [10]. Limnological study of this system is therefore timely and undertaken to provide baseline information on the rotifers of this river system.

2. Materials and Methods
2.1 Study Area
River Ethiope lies within the Niger Delta basin in the southern part of Nigeria on the West African coast region and is bordered by the Atlantic Ocean [16].

It took its source from a watershed at Umuaja and flows westward for about 100km where it discharges into the Benin River at Sapele close to the African Timber and Plywood (ATP) Companies. The entire length of the River lies between latitude 6º31 and 6 º 30 N and longitude 500 - 600 E (Fig. 1).The River is tidally influenced partially from Sapele to Eku. Its width and depth range from less than 10m to 90m and 1m to 20m respectively [2]. The river flow is perennial with the highest level and discharges during the flood (July - November).

The common aquatic macrophytes are *Nymphaea lotus* Linnaeus, *Pistia stratiotes* Linnaeus, *Lemma* sp., *Azolla africana* Desv. *Ceratophyllum submersum* Linnaeus. The riverbank supports rich riparian vegetation, which includes *Raphia vinifera* P., Beauv, *Elaeis guineensis* Jacq. *Hevea brasiliensis* Muell. Arg. and *Cocos nucifera* Linnaeus. The substratum is mainly sand and pebbly units in the non-tidal zone and consisting of sand and silt and sandy clays in the tidal zone which are Sapele, Aghalokpe and Eku.

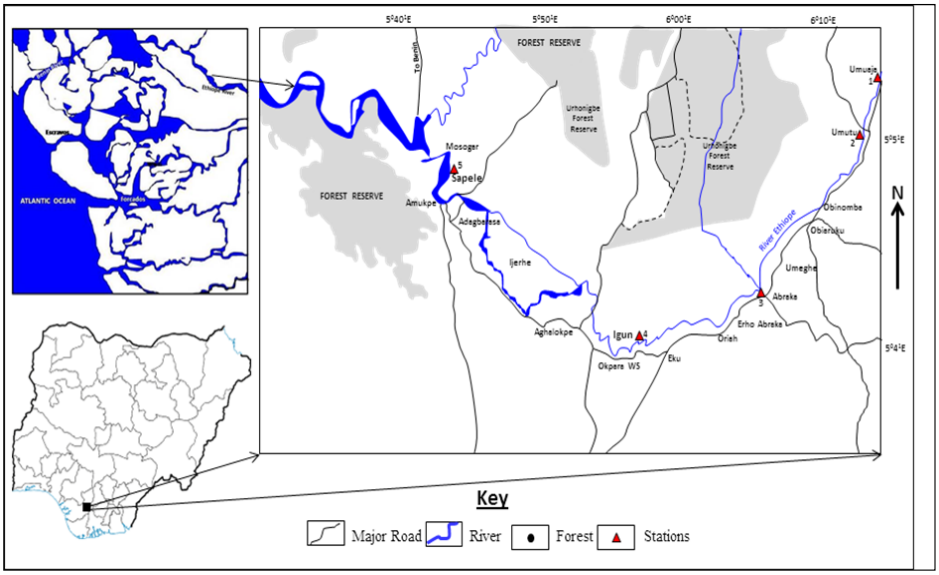

Fig 1: Map of River Ethiope showing sampling stations

There are lots of anthropogenic activities along the river channel. For instance at Umuaja, mined gravel are washed in the river, white sharp sands are also quarried along the river channel too.

2.2. Sample collection and Analysis

Monthly water and plankton samples were studied from five sampling stations; Umuja, station 1, Umutu (2), Abraka (3), Igun (4), Sapele (5) (Fig.1) for 24 months from February 2003 to January 2005 between the hours of 9.00 - 15.00.

Surface water samples were analyzed according to standard method [17] for physico-chemical parameters namely; Temperature, conductivity and pH were estimated on the spot using mercury in glass thermometer (0 – 110^{0}C), Hanna conductivity meter and pH meter (model H196107) respectively. Total solids by the use of a meter Flow velocity was determined by the drift method. The rest of the parameters were analyzed in the laboratory. Total alkalinity and chloride were determined using the titrimetric method. Dissolved oxygen was determined immediately after collection by the Azide modification method. Their values were recorded in mg/L. Estimation of phosphate and nitrate were carried out spectrophotometrically and values were expressed in mg/L.

The 5% buffered formalin preserved rotifer samples were viewed, identified and counted under a binocular microscope Olympus CK 40 in an ulthmol counting chambers. Pictures of the various rotifer species were taken with a Canon digital camera (model A 470). The taxonomic identification was made by reference to Onwudinjo, [18], Dussart and Defaye [19], Shiel [20] and Iloba, [9]. The rotifer abundance was expressed as the number of individuals per sample volume (Ind/ml). The abundant and dominant species were defined as those with the highest occurring number of species counted or encountered. The following Diversity indices were used to study the community structure of rotifers; Margalef, Shannor-Weiner index (H`), Simpson's diversity (D_s), Dominance index Evenness index (E). The Jaccard's coefficient (JC) and the Sorenson's index of significant (SIS) were used to compare the rotifers of the various stations in the river.

3. Results

Results of the hydrobiological parameters are listed in Table 1.

Table 1: The mean, coefficient of variations values of the physico - chemical parameters studied in River Ethiope at the various stations, with F and P values. (C.V.> 40.0%) - significant

Stations	1	2	3	4	5	F values	P values
Parameters							
Air temperature ºC	29.5 (4.7)	29.5(5.4)	31 (4.7)	31.1(5.3)	30.6 (5.6)	8.91	0.0000*
Water temperature ºC	27.2 (3.9)	27.3 (4.4)	28.8 (4.6)	27.9(2.8)	27.5 (3.8)	8.17	0.0000*
Transparency m	100%(0.000)	100%(0.000)	100%	5.1(27.2)	4.8(29.1).	2.27	0.0000*
Conductivity µS/cm	30.8(47.6)	23.9(45.2)	27.4 (28.5)	23.0(22.1)	20.9(30.6)	3.93	0.0000*

Hydrogen-ion concentration	6.3(9.5)	6.5(8.6)	6.3(8.9)	6.1(5.9)	6.2 (6.4)	2.06	0.0900
Total solids mg/$CaCO_3$	28.1(27)	21.6(14.3)	21.5(22.4)	28.4(19.3)	20(33.2)	1.55	0.1913
Total suspended solids mg/l	11.0(23.1)	11.1(24.5)	10.9 (24.2)	16.9(27.4)	12.4(20.0)	26.7	0.0000*
Total dissolved solids mg/l	17.0(43.7)	10,5(29.7)	10.3 (30.8)	9.8 (12.4)	11.2(30.7)	12.0	0.0000*
Dissolved oxygen mg/l	3.1 (141.7*)	2.1 (64.6)	3.4 (82.0*)	2.2(70.8*)	2.8(59.9*)	1.10	0.3581
Alkalinity mg/$CaCO_3$	46.7(612.1*)	29.8 (78.9)	23.4(90.6)	15.9(66.6)	18.3(59.5	2.43	0.0518
Chloride mg/l	2.2(46.5)	4.9 (32.1)	3.2(50.4)	3.0(14.7)	3.2(14.8)	17.2	0.0000*
Sulphate mg/l	2.1(117.1)	2.1(83.6)	2.2 (84.3)	3.7 (56.1)	3.0(47.5)	3.30	0.0134*
Phosphate mg/l	0.11(75.8)	0.08(67.4)	0.11(73.0)	0.17(62)	0.18(68)	5.35	0.0005*
Nitrate mg/l	1.1(80.4) 0.0 – 2.60	1.5 (51) 0.36 – 3.16	1.8 (61.6) 0.03 -4.01	1.3(45.1) 0.5 – 3.3	2.1(22.6) 1.4 – 3.0	6.25	0.0001*

*****Significant @ 0.005 level of significance.

The checklist of the rotifer species identified in this study is presented in Table 2. Table 2 also presents the spatial distribution of the rotifer species. The spatial distribution of the species shows that the species were not uniformly distributed but varies among the stations. Fifteen species of Phylum rotifera were identified (Table 2). Majority of these species were encountered in station 3 excluding three species *Cephalodella gibba, Floscularia sp, Floscularia sp.*

Station 3 recorded all species of rotifer listed in Station 2. Station 5 recorded only three species, *Lapadella cristata, Monostyla bulla and M. lunaris*. Station 1 and 4 had 4 species, *Monostyla lunaris* in common. *Monostyla lunaris* was encountered at all stations while *Monostyla bulla* was absent in station 1 only. *Anureaopsis sp* was absent from both stations 4 and 5, the lower reaches of the river. *Keratella sp., Lapadella cristata, Lapadella patella* and *Lecane decipiens* were restricted to the middle reaches of the river. They were absent in stations 1, 4, and 5. *Floscularia* sp, *Brachionus urceolaris* and *Paracolurella aladjensi* were recorded once in stations 1 and 3.

The family branchionidae had a higher percentage species composition, followed by the family Colurellidae (27%), Lecanidae 18% while the rest had 9% each

From the percentage species composition, the genera Monostyla and Lepadella were the most abundant forming about 15% each of the total rotifer species while the rest taxa had 7% each.

Rotifers abundance in Ethiope River was generally very low. In station 1, they were encountered thrice in the quantitative samples. Sporadic monthly distribution was observed.

Two species; *Trichocerca* and *Anuraeopsis* were encountered in Station 1. Trichocerca was recorded in October of both sampling year while *Anuraeopsis* was recorded once in April 2004. Stations 2 and 3 had no record of rotifer quantitatively. In station 4, *Monostylla bulla* in August 2003, *Lecane* in January 2004 were the rotifers encountered quantitatively.

Rotifers were low in species and also in numbers (Table 3). Station 3 was of highest species richness while station 5 was the lowest number of species. However, species abundance did not follow the species richness sequence. Station 4 was more populated while station 1 was the least populated.

Despite the differences in the Shannon diversity of the various stations, the t-test showed no significant difference between station 1 and others ($p>0.05$). Only stations 3 and 5 were found to be significantly different from 2. Station 3 was significantly different from 4 and 5 while no significant difference exists between 4 and 5.

Table 2: The checklist, spatial distribution of the species of the phylum Rotifera at the different Stations

Stations Genera/Species		**1**	**2**	**3**	**4**	**5**
Checklist						
Phylum Class	Rotifera Monogonota					
Order Genus & species	Flosculariacea *Floscularia sp*	x				
Order: Family	*Ploima* Brachionidae					
Anureaopsis sp		*X*	*X*	*X*		
Brachionus urceolaris				*X*		
Keratella sp			*X*	*X*		
Family		Colurellidae Bartos 1959				
Lapadella cristata Rouss			*X*	*X*	*X*	*X*
Lapadella patella Muller 1773			*X*	*X*		
Paracolurella aladjensis				*X*		
Family		Euchlanidae				
Beauchamppiella eudactylota Goose 1886					*X*	*X*
Family:		Lecanidae				
Lecane decipiens Murray, 1913			*X*	*X*	*X*	*X*
Monostyla bulla Goose 1886			*X*	*X*	*X*	*X*
Monostyla lunaris Ehrenberg 1826		*X*	*X*	*X*	*X*	*X*
Family		Notomatidae				
Cephalodella gibba		*x*				
*F*amily		Proalidae / Epiphanidae				
Proales sp 2		*X*		*X*		
Family		Trichocercidae				
Trichocera similes Wierzejaki, 1893		*X*		*X*	*X*	*X*

The stations with significant level of rotifers similarities had significant agreement also except between stations 3 and 5. A very high similarity index and Jacard's coefficient was found between stations 4 and 5, followed by stations 2 and 3, 2 and 5, 2 and 4 and lastly 3 and 5 which did not record any significant difference in agreement (Table 4).

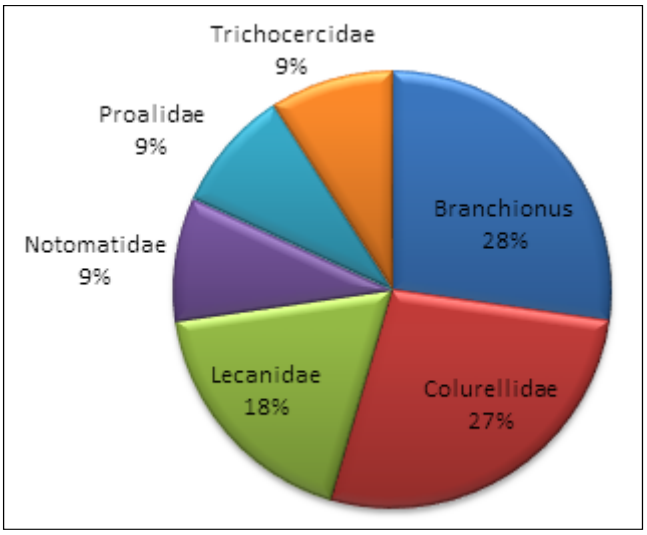

Fig 2: Percentage composition and abundance of the major taxa of rotifers at the different stations

Table 3: Diversity indices of the Phylum Rotifera at the five stations in River Ethiope

Stations Indices	1	2	3	4	5
Species richness	5	7	12	6	5
Total no individuals	6	7	12	17	7
Margalef	2.23	3.08	4.43	1.76	2.06
Menhinicks	2.04	2.65	3.46	1.46	1.89
Shannon	1.56	1.95	2.48	1.54	1.55
Evenness	0.97	1	1	0.86	0.96
Variance	0.078	0.21	0.017	0.023	0.097
Simpson	0.067	0	0	0.015	0.095

Table 4: Sorenson's Indices and Jaccard's coefficient (in bracket) of the Phylum Rotifera at the five stations in River Ethiope

Stations	1	2	3	4	5
1	-	33.3(0.29)	47.1(38.1)	36.4(0.31)	40(0.33)
2		-	73.7*(53.8*)	61.5*(0.51*)	66.7*(0.50*)
3			-	44.4(0.33)	58.8*(0.45)
4				-	90.9*(0.632*)

*Significant association.

4. Discussion

The high variability of the physical and chemical parameters in River Ethiope as revealed by variability coefficient of over 40% in all parameters except water and air temperature, pH, total solids (physical parameters) is an indication that the river is continually undergoing rapid changes which is typical of tropical rivers [21]. The variations in the different parameters at the different stations could be due to variations due to region, reflecting factors such as climate, geology, habitat and biota. The air temperature of River Ethiope during this study (26 - 34 ºC) with mean of 29.5 ºC conformed to the tropical climate of Nigeria which is generally greater than 24 ºC [22].

The air temperature ranges is comparable to those within the same geographical region Ezekiel *et al*. [23] on Sombreiro River (27.9 ºC to 29.2 ºC), Arimoro *et al*. [24] on Warri River recorded 26.3 and 30.3 °C. The water temperature range in River Ethiope during this study is comparable to Edokpayi and Gbugbemi [25] (Ibiekuma river), Oso and Fagbuaro [26], but different from Kaizer and Osakwe [5] (River Ethiope). Station 3 had relatively higher temperatures than stations 1 and 2 during this study. This could be due to the shallowness and the exposure of Station 3. The 100% transparency in stations 1, 2 and 3 is expected since these sections of the river are shallow allowing light penetration all through.

The relatively low conductivity range of River Ethiope (3.22 and 68 µmhos/cm) indicates that the River is low in chemical ions and then confirms the river's oligotrophic nature [22] however, the conductivity varied within the range recommended for aquatic organisms therefore can support good fisheries [23, 24].

The acidic range in this study has been recorded by other researchers in the same system [21, 25] and also similar to rivers within the same geographic location. The total organic loads of the river were low. This is further confirmed by the low transparency values recorded. River Ethiope is a tropical aquatic ecosystem evident from the dissolved oxygen concentration range value (0.3 – 23.5mg/l) recorded in this study as noted by Ahmed [26] and the river is well oxygenated for the survival of aquatic organisms. The alkalinity range (2.8 – 178mg/$CaCO_3$) recorded in River Ethiope is comparable to the suitable alkalinity range of 20 -300pm. This infers that the River is has a good buffering capacity [23]. The

chloride values of River Ethiope (0.3 and 7.01mg/l) is considered normal as against the suspect and problematic levels of 17-36mg/L. This is an indication that there was no cumulative addition of pollutants (runoff) into the River Ethiope. The low sulphate concentrations (0.00 – 9.00mg/l) in the river are comparable to sulphate concentrations in natural waters ranging from a few to several hundred milligrams per liter [27]. The low Phosphate concentrations (< 0.001 – 0.64mg/l) in River Ethiope are similar to those reported in natural unpolluted water with generally very low phosphate levels [27]. The low nutrients observed in this study also confirm that the Niger Delta soil and sediment are low in nitrate and phosphorus [28]. This could be another probable reason why River Ethiope is low in nutrients.

River Ethiope is not rich in rotifers. This could be due to the lotic nature of the river. Dumont [29] reported that lotic systems such as in river Ethiope are poor in rotifer abundance. The numbers of rotifers encountered were not in accordance with Nigerian waters with low conductivity to always record over 40 species of rotifers [30]. Green [31] reported 41 species rotifers in River Sokoto. The preponderance of rotifer species of the family Brachionidae was the general pattern for most Nigerian water bodies [1]. The abundance of Branchionidae suggests that it plays a substantial role in nutrient regeneration in the water column and it is favoured by the environmental factors.

The high species richness downstream could be probably due to their ability to grow rapidly enough to compensate for downstream loss [29]. The low rotifer abundance in River Ethiope may due to their inability to maintain high number as a result of the rapid flow of the river and as well as their sensitivity to a wide range of environmental factors [7].

The abundance of Branchionidae, Colurellidae and Lecanidae suggest that they play a substantial role in nutrient regeneration in the water body. In other words rotifers in River Ethiope play a significant role in the productivity of the system. The dominance of Branchionidae, Colurellidae and Lecanidae has been reported by several workers [1, 3, 30]. This could be attributed to the availability of similar food supply they share [32]. The seasonal variability of rotifers in the tropics could not be verified due to their paucity in this system.

Duggan *et al.* [32] opined that species composition, trophic state of lotic system as well as predators are consequential of the physical features such as catchments, zone and reaches. This could be possibly the reasons for the different species at various stations. Station 4 being the lower reaches of River Ethiope with reduced flow could be responsible for its relatively high rotifer abundance [29]. The range of Margalef indices in river Ethiope from 1.46 to 4.43 (Rotifera) is an indication that river Ethiope fluctuates and is unstable except in station 2 and 3 which indicate that these stations are ecologically good for rotifers [2].

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