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Assessment of Macro-invertebrates and Physico-chemical Parameters of the Lower Qua Iboe River, Akwa Ibom State, Nigeria

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ABSTRACT

Macro-invertebrates composition and physico-chemical properties of lower Qua lboe River, Etinan Local Government Area of Akwa Ibom State, Nigeria were investigated from July to October, 2013. Invertebrate samples were collected from four different locations using Van Veen Grab method. Three phyla of macro-invertebrates were encountered in the river. They were Arthropoda represented by eleven genera such as *Macromia* and *Crocothemis* (Odonata); *Similum* and *Tabanus* (Diptera); *Cybister* and *Hydrophilus* (Coleoptera); *Stenonema* and *Atractomorph* (Ephemenoptera); *Macrobrachium*, *Uca* and *Peneanus* (Crustacean): Annelida represented by three genera such as *Hirudo*, *Capitela* and *Glycera*: Mollusca represented by four genera of gastropods namely *Pachymelania*, *Pyenogonid*, *Pila* and *Neritina*. Arthropoda have the highest percentage composition (52.0%) by number followed by Annelids (30.0%), while Gastropoda was the least (18.0%) by number. Variations in distribution of these organisms could be as a result of differences in local environmental conditions. Parameters for in-situ water quality study along the four sampling locations were Water Velocity, pH, Temperature, Dissolved Oxygen (DO), Conductivity and Turbidity. The mean values and standard deviation of surface water parameters were as follows: Velocity 0.24±0.09(m/s), Temperature 0.24±0.09(0C), pH 7.30±0.07, DO 3.56±0.07(mg/l), Turbidity 12.83±0.61(FTU), Conductivity 11.54±0.20(s/m), Nitrites 0.05±0.03(mg/l), Nitrates 0.031±0.01(mg/l), Ammonium 0.20±0.01(mg/l), Phosphate 12.34±0.05(mg/l), Total Hardness 12.00±0.00(mg/l), Salinity 82±0.53(mg/l), TDS 5.78±0.09(mg/l), TSS 724.60±56.79(mg/l), BOD 0.95±0.14(mg/l) and COD 0.09±0.05(mg/l). The results showed that Lower Qua Iboe River is moderately polluted. All the macro-benthic invertebrates represented were pollution-tolerant and clean water species.

Keywords: *Macro-invertebrates, Assessment, physico-chemical, parameters, Qua Iboe River, Nigeria*

1. INTRODUCTION

Macro-invertebrates are a diverse array of animals without backbones operationally defined as those that can be retained by a sieve or mesh with pore size of 0.2 to 0.5mm, as used most frequently in stream sampling devices (Winterbourne, et al., 1981). They are biological quality elements required for the classification of biological status of water bodies. They live on or inside the deposit at the bottom of a water body (Barnes and Hughes, 1988). They constitute the link between the unavailable nutrients in detritus and useful protein materials in fish and shellfish. They also accelerate the breakdown of decaying organic matter into simpler inorganic forms such as phosphate and nitrate and in turn may become food for predators e.g. fish, and are commonly used for biological monitoring of freshwater ecology worldwide. Macro-invertebrates have generally limited mobility, are easily collected by well-established sampling techniques and there is a diversity of forms that ensures a wide range of sensitivities of changes in both water quality (of virtually any nature) and habitats (Hellawell, 1986; Abel,1989). Macro-invertebrates are useful bio-indicators providing a more accurate understanding of changing aquatic conditions than chemical and microbiological data which only gives short term fluctuations (Ravera, 2000; Ikomi, et al., 2005).

Rivers, Streams, wetlands and lakes are homes for macro-invertebrates, their composition, distribution and abundance are influenced by water quality and quantity. Macro-invertebrates are sensitive to different chemical and physical conditions. If there is a change in the water quality, perhaps because of a pollutant entering the water or a change in the flow downstream, then the macro-invertebrates community may also change. Therefore, the richness of macro-invertebrates community composition in a water body can be used to provide an estimate of water body health (Argerichet al., 2004).

Rivers and lakes in industrial and agricultural areas may be contaminated with industrial waste, pesticide and fertilizer, and the concentrations may vary with time and seasons. Some contaminants that enter aquatic systems are capable of influencing the population of macro-invertebrates. In different parts of Nigeria, rivers are used for disposal of refuse, human sewage, and waste waters from residential areas, and industries. Storm water runoffs and discharge of sewage into rivers are the two common sources of nutrients in aquatic ecosystem that results in their pollution. Rapid industrialization has direct and indirect adverse effects on our environment. This may lead to an increase in generation of industrial effluents which when discharge untreated, would result in water and sediment pollution. Many tropical soils have been leached of much of their soluble materials into river water.

This research is aimed at investigating macro-invertebrates and some physical and chemical characteristics of lower Qua-Iboe river in order to ascertain the level of contamination of the river. Considering increased anthropogenic activities which take place along the river banks, there is need to investigate and provide useful information on the physico-chemical parameters and macro-invertebrates of the Lower Qua

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Iboe River, AkwaIbom State, Nigeria. This will ensure environmental protection and preservation of biota.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study was carried out in the lower Qua-Iboe River which is a distributaries of the Great Qua-Iboe River located in the Eastern part of AkwaIbom State, Nigeria. The Lower Qua-Iboe River flows from EkpeneUkpa in Etinan through Ibawa in OrukAnam Local Government Area. The river is 26km from Uyo, the state capital. The river is located in the Central AkwaIbom with length of about 46km, bounded with NsitIbom Local Government Area (East), MkpatEnin Local Government Area (West), Onna Local Government Area (South), Uyo and Abak Local Government Area in the North. The river is a tidal river. It flows North-South direction at low tide and South-North direction at high tide. The study area lies between latitude 4^o 42’ and 4^o 46’ North and longitude 7^o 44’ and 7^o 45’ East.

2.2 Sampling Locations

Four sampling locations were used. The sampling locations were Ibawa (location 1), EkpeneUkpa (location 2), EkpeneUkpa Downstream (location 3) and Esuk Ndiya (location 4). The sampling locations were established based on ecological settings and human activities in the area. The locations were 1 kilometers apart from each other for easy collection of specimen. A total of 3km was covered from location one to location four.

2.2.1 Location 1

This is the first sampling location indicated as the upstream locations. It is located at Ibawa in OrukAnam local Government Area of AkwaIbom State at latitude 4^0 52’ 55.8’’ and longitude 7^0 46’ 40.8’’. Activities in this area are mainly fishing and boat making at the river bank. The water is clean at this location.

2.2.2 Location 2

Location 2 receives effluents from the slaughter house located along the EkpeneUkpa Village Road. Household from residential houses are also discharged into the river at this location. The main activities here are mining and loading of sand for commercial purposes. It is about 1 km away from station 1 and located at latitude $4^0$50’22.9’’ and longitude $7^0$49’13.8’’.

2.2.3 Location 3

This is located along EketEtinan Road still within EkpeneUkpa. Activities at this location include washing of cars, washing of motor bikes, washing of clothes and bathing. The vegetation here is bamboo trees. It is about 1km away from location 2 and located at latitude $4^0$48’23.2’’and longitude $7^0$50’40.2’’

2.2.4 Location 4

This is located at Ndiya in Etinan Local Government Area. The human activities here include fishing and mining of sand. Vegetation here is mainly mangrove. This area is turbid due to the discharge of much wastes, it is also very deep due to the mining activities. It is about 1km away from station 3.and located at latitude $4^0$46’43.5’’ and longitude $7^0$52’53.3’’.

Fig 1: Map of AkwaIbom State showing sampling locations

2.3 Determination of Macro-invertebrates:

Sampling of macro-invertebrates was carried out for four (4) months at monthly intervals between July and October 2013. During this period, sampling was done between 0700 and 1200 hours on each sampling day. Water depth was determined using a calibrated straight wooden pole fixed at a particular portion. Macro-invertebrates sampled were collected using a Van Veen grab. For each station, 4 hauls were made by sending the grab down into the bottom. The sediment collected were poured into polythene bags and taken to the laboratory for analysis.

The sediment were passed through 3 sieves of 2mm, 1mm and 0.5mm mesh sizes to collect the benthos. The macro-invertebrates were poured into a white enamel tray stained with rose Benger solution and were sorted using forceps. They were sorted out into different groups and preserved in 4% formalin. They were then identified under a compound microscope using the guide of environmental protection agency and counted.

2.4 Determination of Physico-Chemical Parameters

Surface water was collected with a clean sterile container of 1000ml by volume. Samples were collected 10m away from the bank of the river at each location. Temperature, pH, DO, Electrical Conductivity and Turbidity, were measured in situ with their appropriate battery operated meters. Velocity (flow rate) was measured by floatation method. TDS, TSS, TS, TH COD and BOD were measured with an Electrochemistry millimeter CS-C933T (Topac Instrument Inc.). Carbonate, Bicarbonate, Nitrates, Ammonia and Phosphate were measured titrimetrically and the results expressed as mg/l.

2.5 Data Analysis

The mean values of data were calculated and presented in tables and charts. Biological indices such as Margalef's index (d); Shannon-Weiner Index (H) and Evenness (E) were used in the calculation of taxa richness, diversity and evenness. Margalef's Index (D) is a measure of species richness and is expressed as;

$$D = \frac{S-1}{N} \quad \text{………… (1)}$$

Where;

S is the number of species in sample
N is the number of individuals in the sample

Shannon Weiner's Index (H'): is a species abundance and evenness and is expressed as;

$$H' = \frac{N \ln N - (ni \ln ni)}{N} \quad \text{………… (2)}$$

Where;
N is the total number of individuals in the sample,
n_i is the total number of individual species in the samples,
ln is natural logarithm.

Species Equitability or Evenness (E) were determined by the equation

$$E = \frac{H'}{\text{In } S} \quad \text{………… (3)}$$

W here;
H is the Shannon and wiener's index
S is the number of species in sample

3. RESULTS

3.1 Macro-Invertebrates Composition and Abundance

Summary of the relative abundance of the various macro-invertebrates taxa encountered at the different sampling locations is presented in Table 1 while the illustration in Figure 1 shows the percentage composition of macro-invertebrate phyla of lower Qua-Iboe River. Eighteen genera were identified belonging to four phyla from a total of 243 individuals collected from all the stations. Ibawa location (L1) accounted for the highest abundance (35.3%) by number follow by EkpeneUkpa (L3) Downstream location which accounted for (27.9%) by number and Ndiya (L4) location accounted for the lowest abundance (16.9%) by number. The highest number of taxa (11) was recorded in Ibawa(L1) location. Annelids have the highest percentage composition (30.0%) by number followed by Crustacean (29.0%), then Arthropoda (23.0%) while Gastropoda was the least (18.0%) by number.

Though percentage abundance of Annelids was high (2.05-25.6%), Arthropods had the highest number of taxa (8) and these fall into different orders; Odonata which includes Macromia species and Crocothemiserythrae; Diptera which includes Similum species and Tabanus larvae; Coleoptera which includes Cybister larvae and Hydrophilus species, Ephemenoptera which includes Stenonema species and Atratomorphacutipennis. Macromia species were encountered only in L1 while Crocothemiserythraewere encountered only in L3. Similum species and Tabanus larvae were encountered only in L1. Cybister larvae occured only in L3 while Hydrophilus species were encountered only in L2.Stenonema species and Atratomorphacutipennis occur only in L1.

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Table 1: Composition and Relative Abundance of Macro-invertebrates encountered in lower Qua-Iboe River during the Study Period (July-October, 2013)

Taxonomic Group	L1		L2		L3		L4		Total	
	No	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Arthropoda										
Insecta										
Odonata										
Macromia species	20	23.4	-		-	-	-	-	20	8.23
Crocothemiserythrae	-	-	-		10	14.7	-	-	10	4.12
Diptera										
Similum species	1	1.20	-		-	-	-	-	1	0.41
Tabanus larvae	4	4.65	-		-	-	-	-	4	1.65
Coleoptera										
Cybister larvae	-	-	-		1	1.47	-	-	1	0.41
Hydrophilus species	-	-	2	4.20	-	-	-	-	2	0.82
Ephemenoptera										
Stenonema species	1	1.20	-		-	-	-	-	1	0.41
Atractomorpha cutipennis	15	17.40	-		-	-	-	-	15	6.17
Crustaceans										
Macrobrachiumvollenhovenii	9	10.4	8	16.6	7	10.3	13	31.7	37	15.2
Ucatangeri	5	5.82	10	20.8	15	22.1	7	17.0	27	11.1
Penaeusnotialis	-	-	-		3	4.41	-	-	3	1.23
Annelida										
Clitellata										
Hirudomedicinalis	-	-	1	2.08	2	2.94	-	-	3	1.23
Polychaeta										
Capitella species	23	26.7	21	43.8	10	14.7	8	19.5	62	25.5
Glycera species	1	1.20	-		-	-	4	9.80	5	2.05
Mollusca										
Gastropoda										
Pachymelaniafusca	5	5.82	4	8.30	19	27.9	4	9.80	32	13.2
Pyenogonid species	2	2.33	-		-	-	-	-	2	0.82
Pila ovate	-	-	1	2.08	-	-	2	4.90	3	1.23
Neritinarubricata	-	-	1	2.08	1	1.47	3	7.30	5	2.05
Number of species	**11**	**100**	**8**	**100**	**9**	**100**	**7**	**100**	**18**	**100**
Number of Individuals	**86**	**35.3**	**48**	**19.8**	**68**	**27.9**	**41**	**16.9**	**243**	**100**

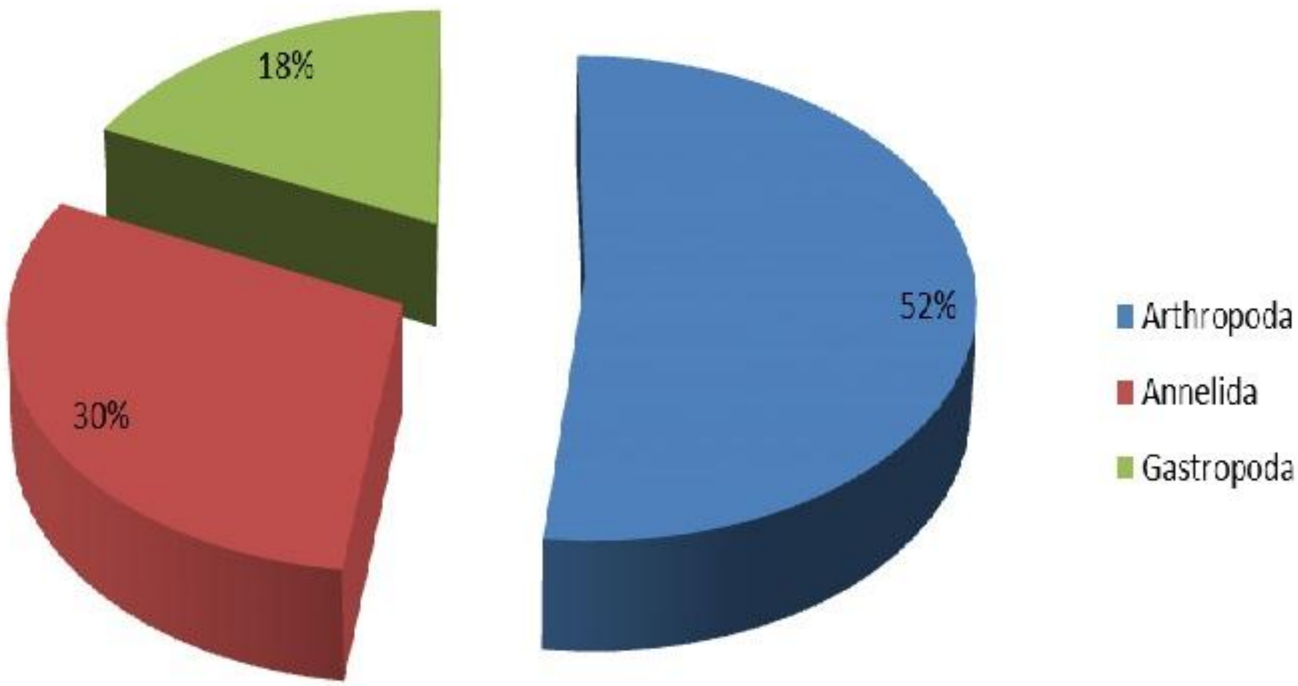

Fig 2: Percentage composition of macro-invertebrates of lower Qua-Iboe River

3.2 Diversity Indices of Benthic Macro-Invertebrates

A summary of the diversity and dominance indices calculated for the four stations is shown in Table 2. Taxa richness calculated as Margalef index (d) was least in L4 (1.620) followed by L2 which accounted for (1.810) while the L1 accounted for the highest diversity (2.250). The pattern was not similar for Shannon diversity index (H), L2 was least (0.681) followed by L4 Station which accounted for (0.781) while L3 Accounted for the highest diversity (1.743). Equitability was least in L2 (0.328) and highest in L3 (0.793). The four stations had more or less equal dominance and diversity levels with insignificantly different indices values.

Table 2: Diversity indices of Macro-invertebrate of lower Qua Iboe River (July to Oct., 2013)

STATIONS	L1	L2	L3	L4	Total
Margalef's Index (d)	2.250[a]	1.810[a]	1.890[a]	1.620[a]	3.090[a]
Shannon-Wiener Index(H′)	0.847[a]	0.681[a]	1.743[a]	0.781[a]	1.050[a]
Equitability Index (E)	0.353[a]	0.328[a]	0.793[a]	0.401[a]	0.364[a]

Similar superscript letters in a row indicates insignificant differences in the indices values ($P > 0.05$)

3.3 Physico-Chemical Parameters

The mean, standard deviation and range values of physico-chemical parameters of lower Qua-lboe river for all the four sampling locations during the study period are presented in tables 3 and 4. The Temperature of the river water during the period of study ranged between 22.80-23.20^{0}C with a mean value of 23.02 ± 0.06^{0}C. The highest mean Temperature of the Qua-lboe river was recorded in location 4 (23.20 ± 0.07^{0}C), while the lowest mean value was recorded in location 1 (22.80 ± 0.07^{0}C). Water Velocity ranged between 0.14 - 0.31 m/s with the mean value of 0.24 ± 0.09m/s. The highest mean Water Velocity was recorded in location 1 and 4 (0.31 ± 0.23 and 0.31 ± 0.18) respectively, while the lowest mean value was recorded in location 3 (0.14 ± 0.01) m/s. pH ranged between 7.12-7.45 with the mean value of 7.30 ± 0.07. The highest mean pH value was recorded in location 1 (7.45 ± 0.07) while the lowest mean value was recorded in location 4 (7.12 ± 0.17) respectively. Dissolved Oxygen ranged between 2.80 - 4.10mg/L with a mean value of 3.56 ± 0.07. The highest mean value of Dissolved Oxygen was recorded in location 1 (4.10 ± 0.16) while lowest mean value was recorded in location 5 (2.80 ± 0.16). Biochemical Oxygen Demand (BOD) ranged between (0.32-2.80) with a mean value of (0.95 + 0.14). The highest value was recorded in location 1 (2.80 ± 0.38) mg/L while lowest mean values were recorded in locations 2, 3 and 5 (0.32 ± 0.20, 0.32 ± 0.04 and 0.32 ± 0.06) mg/L respectively. Carbonates and Bicarbonates had negligible ranges because insignificant values were recorded in the samples analyzed. Total Dissolved Solids (TDS) ranged between 5.62 - 6.09mg/L with a mean value of 5.78 ± 0.09 mg/L. Highest mean of Total Dissolved Solid was recorded in location 1 (6.09 ± 0.01) mg/L. while the lowest mean value was recorded in location 3 (5.62 ± 0.21) mg/L. Conductivity ranged between 11.24 – 12.15µs/cm with a mean value of 11.54 ± 0.20µs/cm. Highest mean Conductivity was recorded in location 1 (12.15 ± 0.06 µs/cm) while the lowest mean values were recorded in location 2, 3, 4 and 5 (11.61 ± 0.50, 11.24 ± 0.20,11.37 ± 0.09 and 11.33 ± 0.21) µs/cm respectively. Nitrites ranged between 0.018 - 0.16mg/L with a mean value of 0.05 ± 0.03 mg/L. The highest mean Nitrate was recorded in location 1, 2 and 5 (0.026 ± 0.09, 0.026 ± 0.00 and 0.026 ± 0.000) mg/L respectively. While the lowest mean value was recorded in location 3 (0.16 ± 0.03) mg/L. Nitrates ranged between 0.022 - 0.35 mg/L with a mean value of 0.031 ± 0.01 mg/L. Highest mean Nitrate was recorded in location 1,2 and 5 (0.035 ± 0.00) mg/L for each of them respectively, while the lowest mean value was recorded in location 3 (0.022 ± 0.00) mg/L. Ammonium ranged between 0.11 - 0.36 mg/L with a mean value of 0.20 ± 0.01 mg/L. Highest mean Ammonium was recorded in location 5 (0.36 ± 0.01) mg/L, while lowest mean value was recorded in location 1 (0.11 ± 0.02) mg/L. Phosphates ranged between 9.20 - 16.40 mg/L with a mean value of 12.34 ± 0.05 mg/L. Highest mean Phosphate was recorded in location 5 (16.40 ± 0.08) mg/L, while lowest mean value was recorded in location 4 (9.20 ± 0.13) mg/L. Total Hardness ranged between 10.00 -15.00 mg/L with a mean value of 12.00 ± 0.00 mg/L. Highest mean Total Hardness was recorded in location 1 and 2 (15.00 ± 0.00 and 15.00 ± 0.01) mg/L respectively while the lowest mean value was recorded in location 3,4 and 5 (10.00 ± 0.00) mg/L for each location respectively. The Chemical Oxygen Demand had an insignificant range because the values for all locations were negligible, except for location 2 which had a mean value of 0.45 ±0.13 mg/L. Total Suspended Solid (TSS) was ranged between 652 - 800mg/L with a mean value of 724.60 ± 56.79 mg/L. Highest mean Total Suspended Solids was recorded in location 1 (800 ± 3.74) mg/L, while lowest mean value was recorded in location 5 (652 ± 208.38) mg/L. Turbidity ranged between 11.37 - 14.04 FTU with a mean value of 12.83 ± 0.61 FTU. Highest mean Turbidity was recorded in location 2 (14.04 ± 1.58 FTU) while lowest mean value was recorded in location 5 (12.52±2.21).

Table 3: Mean values of physico-chemical parameters of surface water from lower Qua-Iboe river

	Sampling Locations			
Parameter	**Location 1**	**Location 2**	**Location 3**	**Location 4**
Water velocity (m/s)	0.31±0.23	0.25±0.08	0.14±0.01	0.31±0.15
Temperature (^{0}C)	22.80±0.07	23.00±0.22	23.00±0.06	23.20±0.07
pH	7.45±0.07	7.42±0.17	7.33±0.07	7.12±0.17
DO (mg/l)	4.10±0.16	3.60±0.06	3.80±0.29	3.50±0.15
Turbidity (FTU)	13.33±2.66	14.04±1.58	12.87±1.02	12.52±2.21
Conductivity (µs/cm)	12.15±0.06	11.61±0.50	11.24±0.20	11.37±0.09
Carbonate (mg/l)	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
Bicarbonate (mg/l)	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
Nitrites (mg/l)	0.26±+0.09	0.26±0.00	0.16±0.03	0.18±0.00
Nitrates (mg/l)	O.35±0.00	0.35±0.00	0.22±0.00	0.28±0.00
Ammonium (mg/l)	0.11±0.02	0.15±0.00	0.16±0.01	0.22±0.02
Phosphates (mg/l)	12.70±0.2	12.70±0.17	10.70±0.22	9.20±0.13
Total Hardness (mg/l)	15.00±0.00	15.00±0.01	10.00±0.00	10.00±0.00
TDS (mg/l)	6.09±0.01	5.81±0.04	5.62±0.21	5.69±0.08
TSS (mg/l)	800±3.74	700±143.07	689±215.60	782 ± 81.42
BOD (mg/l)	2.80± 0.38	0.32±0.20	0.32±0.04	1.00 ± 0.01
COD (mg/l)	0.00±0.00	0.45±0.13	0.00±0.00	0.00 ± 0.00

Table 4: Range values of physico-chemical parameters of lower Qua-Iboe River and WHO standards for River Water

Parameter	Range value	WHO Standard
Velocity (m/s)	0.14-0.31	-
Temperature (^oC)	22.80-23.20	Ambient
pH	6.12-7.45	6.6 – 8.5
DO (mg/l)	2.80-4.10	7.5
Turbidity (FTU)	11.37-14.04	<5
Conductivity (µs/cm)	11.24-12.15	1000
Carbonate (mg/l)	0.00	100
Bicarbonate (mg/l)	0.00	100
Nitrites (mg/l)	0.018-0.16	0.2
Nitrates (mg/l)	0.022 - 0.035	50
Ammonium (mg/l)	0.11-0.36	0.4
Phosphate (mg/l)	9.20-16.40	3.5
Total Hardness (mg/l)	10.00-15.00	150
TDS (mg/l)	5.62-6.09	50
TSS (mg/l)	652 – 800	500
BOD (mg/l)	0.32-2.80	4 – 7.5
COD (mg/l)	0.00-0.45	1.5

4. DISCUSSION

The macro-invertebrate assemblages of the lower Qua Iboe River are striking in the fact that Polychaete, Capitella species dominated and was present in all stations in high numbers. Chukwu and Nwankwo (2003) investigated the impact of land-based pollution on the hydrochemistry and macro-benthic community of a tropical West African creek. The macro benthic fauna composition and abundance were low and the more dominant taxon was annelids. Macro-invertebrates similarities upstream were significantly different ($p < 0.01$) from locations downstream. The authors attributed the low faunal abundance and low diversity to stress imposed by effluents from land based sources as well as substrates instability. The reason for the high abundance of this organism could be that the River presented unique features that favored its survival and high abundance. Woke and Wokoma (2007) had earlier implicated the presence of polychaetes as indicator of pollution, since there are tolerant of pollution induced environmental changes.

In the present study, however, the lowest taxa number (18) was recorded In terms of overall taxa richness. Strict comparison could not be made owing to differences in sampling locations and duration of study. The number of macro-invertebrate taxa recorded in the locations could be ordered as 1>2>4<3>2, while the abundance pattern in these locations could be summarized as 1>2>3=4. The benthic invertebrate community composition, structure, density and diversity and horizontal distribution have been greatly affected by the presence of the River. Impoundment creates a more or less homogenous environment within the River, which reduces the number of colonizing taxa. The dominance of the Arthropods in terms of taxa representation is attributable to the freshness of the River in the study area. This conforms to Okoraforet al, (2012) in the Shore of Great Kwa River, Calabar, Nigeria. The presence of freshwater prawns, Macrobrachiumvollenhovenii as the predominant macro-invertebrate taxa as well as occurrence of various clean water indicator insect orders such as Odonata and Ephemenoptera as well as Gastropoda each represented by many species indicate relatively stress-free environmental condition in the study area. Marioghae, 1982; D'Abramoet al., 1995 and Aboweiet al., 2006 reported that Macrobrachium prawns are highly sensitive to deteriorated water quality condition, while Ogbogu and Olajide, 2002; Tyokumburet al., 2002 and Emere and Nasiru, 2007 listed Odonata, Plecopterans, Trichopterans, Hemipterans, Coleopterans and Ephemenopterans as well as some Gastropods as pollution sensitive macro-invertebrates.

The low Shannon-Weiner diversity value (1.0507) and a relatively high Margalef diversity level (3.090) recorded were due to the fact that the former incorporates evenness of distribution while the later only measures species richness. Thus, the low Shannon-Weiner diversity value was as a result of the much higher relative abundance of the Arthropods taxa than other macro-invertebrate taxa. The comparable number of macro-invertebrate taxa as well as insignificantly different macro-invertebrate abundance and diversity levels of upstream and downstream stations indicates uniform distribution of macro invertebrate fauna in the study area.

According to Brinkhurst (1965) the bigger the size of a lotic water body, the poorer the macro-invertebrates richness. The total of eighteen macro-invertebrate taxa encountered in this study is relatively high. Tyokumbur et al. (2002) and Emere and Nasiru, (2007) respectively recorded sixteen and twenty-seven macro-invertebrate taxa in smaller streams in Ibadan and Kaduna respectively, while fourteen taxa were encountered in the middle reaches of Imo River by (Sikoki and Zebbey, 2006). Generally, high biodiversity is expected in ecosystems devoid of significant anthropogenic impact (Ogbeibu and Egborge, 1995). The marked increase in macro-invertebrates abundance in the rainy season months of September and October could be attributed to the life history and population dynamics of the fresh water prawns and crabs that constituted the predominance macro-invertebrate taxa in this study. According to APHA/AWWA/WPCF (1985), although, the composition and density of macro-invertebrates in an unperturbed aquatic environment are reasonably stable, seasonal fluctuations associated with life cycle dynamics of individual species may cause extreme variation within any year. The life cycle of the prawn, Macrobrachiumvollenhovenii and crab, Ucatangeri entails migration of the planktonic larvae spawned in fresh water downstream to brackish water bodies, where further developmental stages are passed before a backward migration to the fresh water end where they live a more less a benthic life (D'Abramoet al., 1995). The large scale migration back to the fresh water is more pronounced in the rainy than dry season (Marioghae, 1990 and Aboweiet al., 2006). Abohweyereet al. (2008) identified the rainy season months of October- November as a major peak period for recruitment of young M. vollenhovenii population in the Lagos-Lekki Lagoon system. However, Umeozor (1995) and Sikoki and Zabbey (2006) recorded higher macro-invertebrate abundance in the dry than rainy season in New Calabar and the middle reaches of Imo Rivers respectively. These authors attributed this to unstable bottom sediments caused by rains, which leads to dislodgement of the benthic animals. In this present study, Arthropods (that constituted the dominant macro-invertebrate taxa) associated more with the river bank macrophytes than the bottom sediments. Perhaps, the growth of the river-bank macrophytes is much more pronounced during the rainy than dry season. Ogbogu (2001) reported a similar significantly higher abundance during rainy than dry season for various species in an intermittent reservoir outflow at Ile-Ife, western Nigeria. All the Gastropods organisms recorded in the River are indicative of polluted waters (Odiete, 1999). Variations in distribution of these organisms could be as a result of differences in local environmental conditions. The presence of Pyenogonid species in Ibawa location and Pilaovata in EkpeneUkpa and Ndiya locations across all months throughout the study period may be as a result of the nature of the substratum, a concrete channel with a muddy margin and presence of vegetation at one margin of the River.

The mean values of surface water temperature recorded in this study fall within the temperature range of river water (20-30^{0}C) stipulated for aquatic life in the tropical region. An increase in temperature will lead to an increase rate of chemical reactions and formation of toxic complexes which may have profound effect on aquatic organisms. The mean pH obtained in this study in all sampling locations fall within the recommended range 6.5-9 which is suitable for aquatic life (World Health Organization, WHO, 1984). The mean pH between the locations had no much difference, suggesting the uniform pH of the water body. Similar reports on slightly alkaline pH value were reported by And met al., (2012) in Ona River, Apata, Ibadan, Ogunwenmo and Osuala (2004) in an estuarine creek and artificial pond in Lagos, Ogidiakaet al., (2012) in Ogunpa River at Bodija, Ibadan, and Okoraforet al., (2013) in Calabar River. The total suspended solids were high in all Sampling locations. This could be attributed to the season of sampling. Sampling and analysis were done during the rainy season when rain carries non-dissolvable materials into the water body. Total solid (TS) is the sum total of the suspended solid particles and dissolved materials in water. TS values were low when compared to the maximum permissible limit of 2000 mg/L set by (FMENV, 1999). The levels of TS and TDS were generally low. This could be as a result of tidal influence of the river. Nitrate values during the study period were below 20 mg/L permissible limit by (FMENV, 1999). The source of Nitrate could be from oxidation of other forms of nitrogen compounds like ammonia and nitrite into nitrate. Phosphate values were lower than the maximum permissible level of <5mg/L by (FMENV, 1999). The level of phosphate in the water could relatively be due to the leaching of fertilizer residues from agricultural farms along the river.

Phosphate levels in the water are likely also from phosphate and containing compounds that are washed from the terrestrial environment into the river. Washing activities by residents and discharge of house hold effluents into the river can also result to input of Phosphate. Carbonate and Bicarbonate were below detectable limit. Conductivity is a measure of conducting ionic species in a sample solution. Low level of

Conductivity recorded during the study period could be attributed to the low levels of conducting species such as Chloride, Phosphate and heavy metals present in the stations. This affirms the study of Fakayode (2005) in Alaro stream, Ibadan. Dissolved oxygen (DO) concentration in natural waters depends on the physical, chemical and biochemical activities in the water body. DO values recorded during the study period were lower than FMENV permissible limit of 5.0mg/l. The depletion of DO at the lower stations could also be due to enormous amount of organic loads which required high levels of oxygen for chemical oxidation, decomposition or break down. Similar findings have been reported by some authors (Okoraforet al., 2012, Morenikeji and Raheem, 2008; Chukwuet al., 2008 and met al., 2012). Large depletion of Dissolved Oxygen is indicative of the presence of considerable amount of biodegradable organic matters in the river water. WHO recommended that Dissolved Oxygen concentration above 4mg/L is good while below 4mg/L is lethal to aquatic life. The Chemical Oxygen Demand (COD) during the study period was very low when compared to permissible limit of 80mg/L set by (FMENV, 1999). The mean turbidity value of 12.71 NTU exceeded the limit of >5 acceptable by FMENV and WHO. Turbidity is associated with suspended solid concentrations. The high turbidity content of this study was attributed to household and industrial waste inputs. This affects the general condition of the water and aquatic lives.

5. CONCLUSION

In the present study, information about macro-invertebrate community of Lower Qua Iboe River provides important baseline data which may be useful for assessing future environmental changes. The identification of a suite of environmental variables underlying the spatial variation in macro-invertebrate assemblages suggests that management should attempt to ensure minimal disturbance to their natural patterns of variation in environmental factors. The present study also showed that the ecological capacity of Lower Qua River has largely been diminished due to industrialization. The current study also clearly showed an alteration in macro-invertebrate assemblage in response to anthropogenic activities. In this regard, change in species composition of macro-invertebrate is suggested as a more reliable tool in determination of the status of alterations than the diversity indices alone. Also species diversity and spatial distribution between study locations could be attributed to strong preference for ecological niche.

The quality of an aquatic habitat as describable by physical and chemical properties of the water goes a long way to help assess the stress conditions and thus the survival potentials of organisms present in it. But early detection of unfavorable changes in water quality will allow for proper management of the water resource and the fauna living in it. The common practice of using natural water bodies as disposal media for wastes/effluents in Nigeria poses a serious threat to the aquatic ecosystems. In order to ensure sustainable management and conservation of aquatic environment and enhance biodiversity, there is a need to regulate and prevent untreated effluent discharged from industries into the natural water bodies. The following regulatory measures are therefore recommended: avoidance of indiscriminate dumping of refuse and sewage on the run-off that supplies the river during rainfall, carrying out public enlightenment campaigns to raise the level of awareness and reorienting the attitude of large and small scale industries as well as individuals with respect to environmental pollution problems which may result from discharge of untreated wastes/ effluents into the natural water bodies, punishing offenders of Environmental laws/legislations so that it will serve as a deterrent to others and reinforcing existing environmental laws.

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