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Pre-impoundment Macroinvertebrate Composition of Elemi River, Ado-Ekiti, Ekiti State, Nigeria

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Abstract: Benthic organisms are generally considered to be good indicators of environmental conditions of aquatic ecosystem. The present study was undertaken to study the pre-impoundment composition, abundance, distribution and diversity of the macroinvertebrate fauna of Elemi River, Ado-Ekiti, while using these organisms as water-quality bioindicators. Physicochemical, metals and benthic samples were collected biweekly at four stations between April –July, 2015, using standard methods of APHA (1998). The mean values of triplicate samples of physicochemical parameters include pH (6.82±0.06), temperature (27.05°C ± 4.35), TDS (0.07 ± 0.0001), DO (11.15 ± 1.88), BOD (5.8 ± 0.71), NO_3 (57.08 ± 6.48), SO_4 (76.14 ± 10.4). For the metals, the mean values are Pb (0.01 ± 0.0001), Cr (0.21 ± 0.04), Cu (0.07 ± 0.003), Mg (152.68 ± 79.5), Zn (2.05 ± 5.19), and Fe (1.98 ± 0.21). When compared with the WHO permissible standards for freshwaters, DO, BOD and NO_3 had mean values that were significantly higher than the WHO standards for drinking and agricultural purposes. Also, metals including Cr, Mg, Zn, and Fe had mean values significantly higher than the WHO standards. Seven families of macroinvertebrates representing five orders of Mollusca (66.6%), Coleoptera (14.6%), Plecoptera (12.7%), Hemiptera (4.3%), and Tricoptera (1.8%) were recorded during the period of study. Of the total collected macroinvertebrates, insects comprised only 33.4%, but they are more diverse compared with the gastropods which made up the highest (66.6%) percentage, but are less diverse. Their high abundance coupled with high concentrations of some physicochemical parameters indicates high impact of anthropogenic activities and may result into high organic pollution of the river. Elemi River thus experiences degradation as it flows downstream and benthic macroinvertebrates can serve as a good biological indicator to monitor the river health.

Keywords: Elemi River, Physicochemical Parameters, Macroinvertebrates, Pre-impoundment, Organic Pollution

1. Introduction

Dams are constructed to provide water for domestic use, irrigation and hydroelectric power generation, however the communities within the water body are of great importance. Man-made lakes during their early stages of existence are studied because the new community undergoes series of ecological changes immediately after the construction before it gradually approaches a relatively stable state [1, 2, and 3]. The dynamics and structures of reservoirs present a pattern of organization midway between those of rivers and lakes [4]. The ecological processes in these ecosystems are much more complex and variable than those found in natural lakes. Dams or reservoirs are subject to distinguishable influences of the physical, chemical, and biological components of their tributaries [5], as well as those caused by the principal land uses in the drainage basins.

Benthic macroinvertebrates are common inhabitants of lakes and streams where they are important in moving energy through food webs. The term "benthic" means "bottom-living", so these organisms usually inhabit bottom substrates for at least part of their life cycle; the prefix "macro" indicates that these organisms are retained by mesh sizes of ~200-500 mm [6]. The most diverse group of freshwater benthic macroinvertebrates is the aquatic insects, which account for ~70% of known species of major groups of aquatic macroinvertebrates. Thus, as a highly diverse group, benthic macroinvertebrates are excellent candidates for studies of changes in biodiversity, especially after disruption of the pristine nature of aquatic ecosystems. They are also the most preferred group in biomonitoring studies of fresh waters. This preference is due to their limited habitat and less motility, consequently, they cannot change their habitats quickly. Their life cycles are also long enough to understand what the differences are in their habitats before and after the disturbance. All these reasons make the benthic macroinvertebrates most favourable as biomonitors among the other groups [6]. Biomonitoring is a tool for assessing environmental quality because biological communities integrate the effects of different stressors and, thus, provide a broad measure of their aggregate impact [7, 8, and 9].

There are three major categories of environmental stress to the aquatic environment: the natural stresses (e.g. droughts and floods), imposed stresses (e.g. sewage pollution, toxic waste and pesticides) and environmental manipulation by man (e.g. reservoir construction, channel modification and the transfer of water between catchments [10]. The macroinvertebrate fauna could be affected by each one of these stresses, and the fauna at any given site may be the result of more than one category of stress [11]. Presently, very few studies have been conducted on the general benthic fauna of streams and rivers in Ekiti State. Yet, this area lies within the tropical rainforest expected to have a high diversity of aquatic organisms. This present study is designed to provide some baseline information on the pre-impoundment composition, abundance and distribution of the benthic fauna of an aspect of Elemi River, Ekiti State University Campus, Ado-Ekiti, Nigeria.

2. Material and Methods

2.1. Study Area

The study was carried out in River Elemi also known as Odo-Ayo which is located along the Ekiti State University, Ado – Ekiti road in Ekiti State, Nigeria. It lies between latitude 7o45'N and 5o20'E of the equator. Ado – Ekiti is the capital town of Ekiti State in the Southwestern Nigeria. River Elemi is a tributary of the main River, Elemi in Igede – Ekiti which itself was said to take its source from the popular Osun River in Osogbo, Osun State. River Elemi is located on a plane area and is surrounded by a dense stretch of vegetation and Agricultural farm. The river runs across the major road leading to Iworoko-Ekiti along which the University is situated.

2.2. Sampling Sites & Collection of Samples

Four sampling sites were selected for this study and designated as A, B, C and D as shown in fig. 1.

Different kinds of activities were seen taking place at the various sampling points on this river.

Points 1 – The kind of activities done at this point is bathing and laundry activities, people living in this area do come and take their bath inside the river even with soap and sponge.

Points 2 – People living in this area do defecate at the river bank and assorted household wastes litters this area. A block-making factory is also located close to the river bank.

Point 3 – At this point, a lot of activities are carried out, there Mechanic workshops and a Horticultural garden, also alongside the river banks are human faeces and household wastes.

Point 4 – At this point, there is another Mechanic workshop, Car wash, human faeces and a farm.

Figure 1. *Showing the sampling site A.*

Figure 2. *Showing the sampling site B.*

Surface water samples were collected from each sampling points with two litres plastic bottles for chemical analysis. Water samples were collected during April to July, 2015 between 7.00a.m and 10a.m in the morning bimonthly. Laboratory investigations were carried out at the Department of Chemistry, School of Science, Federal University of Technology, Akure, Ondo State.

2.3. Laboratory Analysis

Water samples collected were analysed to determine pH, temperature, total dissolved solids, dissolved oxygen (DO), biological oxygen demand (BOD), Nitrate, Sulphate, and metals including lead, chromium, copper, magnesium, zinc and iron. All physico-chemical analysis were carried out using standard methods according to [12]. The concentration of heavy metals was determined by Atomic Absorption Spectrophotometry.

Figure 3. *Showing the sampling site C.*

Figure 4. *Showing sampling site D.*

2.4. Macro-Invertebrate Sampling

Macro-invertebrate samples from the bankroot biotope of each station were collected using kick sampling method. A hand net of 154µm mesh size was used in sampling $1m^2$ of the agitated substratum in each sampling point. Collected samples were preserved with 10% formaldehyde in plastic containers. Identification of the benthic macroinvertebrates collected in the study was based mainly on the keys provided by [13], [14], [15], [16], [17], and [18]. Animals that could not be easily identified will be closely examined under a stereomicroscope. Description of specimens of taxa will be based on scale drawings, photographs and/or microphotography of parts.

2.5. Data Analysis

Data obtained from the physical and chemical parameters were analyzed using descriptive statistics and the composition, distribution and percentage abundance of macroinvertebrtaes was also calculated. Pearson correlation coefficient was used to determine the level of variance among the physicochemical parameters and also the relationship between the physicochemical parameters and the associated macroinvertebrates, using the statistical package (SPSS) and was tested at $p<0.05$ for significance. The mean values of the physicochemical parameters were compared with the water quality criteria of the World Health Organisation (WHO) and the Nigerian Federal Environmental Protection Agency (FEPA) to determine the suitability of River Elemi water for drinking and agricultural purposes.

3. Results

3.1. Composition and Distribution of Macroinvertebrates

The macro-invertebrate organisms recorded in all the sampling points during the period of study were made up of 5 orders which belong to 7 families of Physidae, Planorbidae, Gyrinidae, Noteridae, Perlodidae, Belostomatidae and Hydropsychidae, which falls into 2 phyla of Mollusca and Arthropoda.

Family Physidae and phylum Mollusca were the most abundant macro-invertebrates constituting 60.8% of the total macro-invertebrate encountered during the period of study. Planorbidae is the second family in the order hydrophila and had 5.8% of the total macroinvertebrate abundance. Among the two phyla recorded in the study period, mollusca have the highest percentage composition of 66.6%.

The second phylum recorded during the period of study was arthropoda which has 5 families. The largest group of this order is perlodidae making up 12.7% of the total macroinvertebratte abundance. Gyrinidae was the second largest arthropod with 12.6% and belongs to the order coleopteran. The least abundant arthropods are the hydropsychidae with 1.8% of the total macro-invertebrates (Table 1).

Table 1. *Percentage Spatial Distribution of Macro-invertebrates composition of Elemi River before Impoundment.*

Taxa list	Site A	%	Site B	%	Site C	%	Site D	%	Overall	%
Order: Hygrophila										
Physidae	130	65.32	13	30.95	60	45.80	164	70.69	367	60.76
Planorbidae	28	14.07	0	0	7	5.34	0	0	35	5.79
Total										
Order: Coleoptera										
Gyrinidae	16	8.04	17	40.48	0	0	43	18.54	76	12.58
Noteridae	3	1.51	0	0	9	6.87	0	0	12	1.99
Total										
Order: Plecoptera										
Perlodidae	0	0	12	28.57	55	41.99	10	4.31	77	12.75
Total										
Order: Hemiptera										
Belostomatidae	22	11.06	0	0	0	0	4	1.72	26	4.31
Total										
Order: Tricoptera										
Hydropsychidae	0	0	0	0	0	0	11	4.74	11	1.82
Total	199	100	42	100	131	100	232	100	604	100

Table 2. *Monthly variation in percentage distribution of macro-invertebrates of Elemi River.*

Taxalist	April	%	May	%	June	%	July	%	Overall	%
Order: Hygrophila										
Physidae	34	43.59	220	72.37	68	61.26	45	40.54	367	60.76
Plarnobidae	21	26.92	6	1.97	5	4.50	3	2.70	35	5.80
Total	55	70.51	226	74.34	73	65.76	48	43.24	402	66.56
0rder: Coleoptera										
Gyrinidae	23	29.49	32	10.53	11	9.91	10	9.01	76	12.58
Noteridae	0	0.0	0	0.0	0	0	12	10.81	12	1.99
Total	23	29.49	32	10.53	11	9.91	22	19.82	88	14.57
Order: Plecoptera										
Perlodidae	0	0.0	15	4.93	21	18.92	41	36.94	77	12.75
Total	0	0.0	15	4.93	21	18.92	41	36.94	77	12.75
Order: Hemiptera										
Belostimatidae	0	0.0	26	8.55	0	0	0	0	26	4.30
Total	0	0.0	26	8.55	0	0	0	0	26	4.30
Order: Trociptera										
Hydropsychidae	0	0.0	5	1.65	6	5.41	0	0	11	1.82
Total	0	0.0	5	1.65	6	5.41	0	0	11	1.82

Table 3. *Pearson correlation coefficient of macro-invertebrates.*

	Physidae	Planorbidae	Gyrinidae	Perlodidae	Hemiptera	Trichoptera	Coleoptera
Physidae	1.000						
Planorbidae	0.673*	1.000					
Gyrinidae	0,249	0.635*	1.000				
Perlodidae	0.889	0.155	0.360	1.000			
Hemiptera	0.013	0.718*	0.174	0.833*	1.000		
Trichoptera	0.401	0.543*	0.831*	0.934*	0.532*	1.000	
Coleoptera	0.640*	0.536*	0.428	0.146	0.667*	0.427	1.000

Note: This asterisk indicates the level of significance at $p<0.05$.

Table 4. Correlation coefficients of physicochemical parameters with macroinvertebrates.

	Physidae	Planorbidae	Gyrinidae	Perlodidae	Hemiptera	Trichoptera	Coleopteran
Temp	0.590*	0.005	0.727*	0.178	0.686*	0.542*	0.551*
pH	0.475	0.419	0.500	0.302	0.360	0.868*	0.533*
DO	0.682*	0.226	0.135	0.162	0.564*	0.793*	0.446
BOD	0.845*	0.312	0.296	0.459	0.689*	0.424	0.886*
TDS	0.535*	0.341	0.067	0.222	0.423	0.877*	0.458
NO_3	0.727*	0.054	0.575*	0.295	0.867*	0.343	0.767*
SO_4	0.699*	0.300	0.168	0.329	0.558*	0.615*	0.682*
Pb	0.612*	0.259	0.105	0.125	0.510*	0.924*	0.347
Cr	0.554*	0.327	0.075	0.219	0.440	0.858*	0.465
Cu	0.850*	0.219	0.258	0.319	0.702*	0.506*	0.724*
Mg	0.815*	0.141	0.213	0.120	0.696*	0.737*	0.433
Zn	0.598*	0.291	0.152	0.051	0.535*	0.843*	0.157
Fe	0.628*	0.250	0.139	0.062	0.548*	0.953*	0.225

Note:- asterisk values indicates those with p<0.005 level of significance.

From Table 4 it can be observed that correlation between the physicochemical parameters and macroinvertebrates exhibited a positive relationship at 5% level of probability all through. Physidae had a significant correlation with all the parameters except for pH. Hemipterans also had a significant relationship with almost all the parameters except for pH, TDS, and chromium. Trichopterans also exhibited a significant correlation with all the parameters except BOD and NO_3. Gyrinidae had a significant correlation with only temperature and NO_3. While the Coleopterans showed a significant relationship with temperature, pH, BOD, NO_3 and copper.

3.2. Physicochemical Parameters of River Elemi Surface Waters

The mean water temperature was 27.05°C ± 4.35 and ranged between 25.1°C and 30.3°C. The highest temperature, 30.3°C ± 0.02 was recorded at site B in the month of April 2015 and the least 25.1°C ± 0.02 at site A in the month of July. The range of the temperature falls below the WHO and FEPA limit of 30 – 32°C. The mean pH value recorded during the sampling period was 6.82 ± 0.06 and ranged from 6.4 – 7.1. The highest pH value recorded during the sampling period was 7.1±0.5 at sites A, C and D in the month of May and the lowest value recorded was 6.35±0.05 at site A in the month of June. The range of pH values observed in this study falls within the FEPA limit of 6.0 – 9.0.

Dissolved oxygen value of the river water ranged between 8.20mgO$_2$/L – 13.9mgO$_2$/L with a mean value of 11.15mgO$_2$/L ± 1.88. The highest dissolved oxygen value (13.9mgO$_2$/L) was recorded at site B in the month of July and lowest (8.20mgO$_2$/L) was observed at site C in the month of April. This range of dissolved oxygen was greater than the standard limit set by WHO and FEPA. Biochemical Oxygen demand of the river water ranged between 4.95 – 6.90mgO$_2$/L with the mean value of 5.82mgO$_2$/L ± 0.71. The lowest BOD value (4.95mgO$_2$/L) was recorded at site B and the highest value (6.90mgO$_2$/L) was recorded at site D in the month of June. This range of BOD was lower than the FEPA 50mgO$_2$/L. Total dissolved solids in the analysed water sample ranged between 0.03mg/L and 0.10mg/L. The highest (0.10mg/L) TDS mean value was recorded at site D in June and the lowest (0.03mg/L) at site B in July. This range falls below the WHO and the FEPA limit which is 250 and 500 respectively.

Table 5. Spatial means and range of physico-chemical parameters of River Elemi.

	Site A	Site B	Site C	Site D	WHO (2008)	FEPA (1991)
Parameters	Mean ±STD (Range)	Mean ±STD (Range)	Mean ±STD (Range)	Mean ±STD (Range)		
Temp	26.7±4.85 (25.1-29.9)	27.15±4.66 (25.4-30.3)	27.18±4.13 (25.9-30.2)	27.19±4.07 (26.0-30.2)-	30 -32	30 - 32
pH	6.8±0.14 (6.35-7.1)	6.73±0.05 (6.5-6.93)	6.88±0.05 (6.65-7.1)	6.9±0.03 (6.75-7.1)	6.5 – 8.5	6.0 – 9.0
DO	10.8±0.32 (10.00 -11.20)	11.8±3.35 (9.90 -13.90)	10.25±2.64 (8.20 -11.70)	11.71±3.38 (9.80 -13.80)	4. 00	≥ 4
BOD	5.4±0.58 (4.70 -6.20)	6.11±1.28 (4.50 -7.05)	5.5±1.10 (4.50 -6.95)	6.21±1.58 (4.90 -7.80)	3. 00	50
TDS	0.07±0.0001 (0.055-0.075)	0.065±0.001 (0.03-0.10)	0.058±0.0001 (0.05-0.07)	0.08±0.0002 (0.065-0.10)	250.00	500
NO_3	52.29±398.97 (25.5-73.45)	58.7±1003.8 (11.5-77.53)	48.06±894.65 (6.35-73.75)	69.27±569.0 (38.93-94.5)	50. 00	20

	Site A	Site B	Site C	Site D	WHO (2008)	FEPA (1991)
SO_4	75.99±19.68 (71.38-81.0)	78.2±420.59 (54.85-97.23)	66.17±186.67 (51.84-82.0)	88.18±27.04 (86.33-95.8)	200	
Pb	0.006±0.000 (0.00-0.01)	0.009±0.000 (0.0-0.02)	0.006±0.000 (0.00-0.015)	0.02±0.0003 (0.01-0.025)	0.05	0.05
Cr	0.13±0.009 (0.04-0.23)	0.10±0.006 (0.005-0.17)	0.074±0.005 (0.01-0.145)	0.54±0.32 (0.03-1.08)	0.01	0.01
Cu	0.03±0.0001 (0.005-0.06)	0.04±0.001 (0.00-0.05)	0.05±0.002 (0.00-0.09)	0.15±0.02 (0.005 – 35.00)	0.05	0.05
Mg	172.6±1037.4 (125-195.66)	140.4±1831.42 (80.2-180.6)	139.45±1230.66 (99.9-170.4)	158.34±1793.3 (96.5-192.56)	0.10	0.10
Zn	1.69±3.77 (0.01-4.06)	2.65±9.17 (0.005-6.64)	1.15±1.78 (0.00-2.93)	2.71±7.88 (0.02-6.09)	5.00	5.00
Fe	1.81±3.22 (0.04-3.43)	1.83±3.69 (0.05-4.55)	1.49±2.08 (0.14-3.09)	2.78±2.99 (1.0-4.48)	0.30	0.30

Table 6. *Monthly means and range of physico-chemical parameters of River Elemi.*

	April	May	June	July	WHO (2008)	FEPA (1991)
Parameters	Mean ±STD (Range)	Mean ±STD (Range)	Mean ±STD (Range)	Mean ±STD (Range)		
Temp	30.15 ± 0.03 (29.9-30.3)	26.1 ± 0.14 (25.6-36.5)	26.33 ± 0.06 (25.95-26.50)	25.63 ± 0.21 (25.1-26.1)	30 -32	30 – 32
pH	7.0 ± 0.005 (6.93-7.01)	7.05 ± 0.01 (6.9-7.1)	6.58 ± 0.04 (6.35-6.80)	6.65 ± 0.01 (6.55-6.75)	6.5-8.5	6.0–9.0
DO	9.7 ± 1.25 (8.2-10.9)	10.25 ± 0.23 (4.8-6.2)	12.35 ± 1.32 (11.2-13.8)	12.29 ± 1.57 (11.2-13.9)	4. 00	≥ 4
BOD	4.95 ± 0.44 (4.5-5.9)	5.4 ± 0.39 (9.7-10.7)	6.9 ± 0.45 (6.2-0.45)	5.95 ± 1.11 (4.7-7.05)	3. 00	50
TDS	0.06± 0.001 (0.03-0.075)	0.06± 4.17 (0.05-0.065)	0.08± 0.0002 (0.07-0.10)	0.08± 0.0004 (0.06-0.10)	250.00	500
NO_3	20.58±215.11 (6.35-38.95)	62.16±229.39 (47.25-80.10)	79.61±100.73 (73.45-94.50)	65.97±68.59 (57.9-77.53)	50. 00	20
SO_4	64.5±313.12 (51.8-86.33)	71.32±140.61 (58.25-86.50)	87.4±73.25 (78.3-95.8)	81.32±145.20 (71.38-97.23)	200	
Pb	0.005 ±0.000 (0.00-0.02)	0.006 ±0.000 (0.00-0.005)	0.014 ±7.29 (0.005-0.025)	0.02 ±0.00003 (0.01-0.02)	0.05	0.05
Cr	0.03±0.0007 (0.005-0.06)	0.04±0.0003 (0.045-0.06)	0.40±0.21 (0.145-1.08)	0.37±0.16 (0.12-0.97)	0.01	0.01
Cu	0.003±0.000 (0.00-0.005)	0.004±0.0007 (0.01-0.07)	0.135±0.02 (0.04-0.35)	0.09±0.03 (0.05-0.16)	0.05	0.05
Mg	119±1533.29 (80.2-170.9)	139.79±1604.52 (96.2-187.45)	175.26±558.5 (145.25-195.6)	176.68±32.38 (170.4-182.3)	0.10	0.10
Zn	0.009±0.000 (0.00-0.02)	0.46±0.08 (0.20-0.82)	2.81±1.20 (1.41-3.90)	0.009±0.0001 (2.93-6.64)	5.00	5.00
Fe	0.37±0.203 (0.04-1.00)	0.86±0.45 (0.14-1.62)	2.78±1.20 (1.52-4.03)	3.89±0.55 (3.09-4.55)	0.30	0.30

Table 7. *The Summary of the four months for the physicochemical parameters*

Parameters	Mean ± Std	Range	WHO (2008)	FEPA(1991)
Temp	27.05 ± 4.35	25.63– 30.15	30 -32	30 – 32
pH	6.82 ± 0.06	6.58 – 7.05	6.5 – 8.5	6.0 – 9.0
DO	11.15 ± 1.88	9.7 – 12.35	5. 0	≥ 5.0
BOD	5.8 ± 0.71	4.95 – 6.90	3. 00	50
TDS	0.07± 0.0001	0.06 – 0.08	250.00	500
NO_3	57.08± 48.23	20.58– 79.61	50. 00	20
SO_4	76.14 ± 10.4	64.50–87.40	200	
Pb	0.011 ±0.0001	0.005 – 0.02	0.05	0.05
Cr	0.21±0.04	0.03 – 0.40	0.01	0.01
Cu	0.07±0.003	0.003– 0.133	0.05	0.05
Mg	152.68 ± 79.5	119.0 -176.68	0.10	0.10
Zn	2.05±5.19	0.009 – 4.93	5.00	5.00
Fe	1.98±0.21	0.37 – 3.89	0.30	0.30

Table 8. *Pearson correlation coefficients of the physicochemical parameters.*

	Temp	pH	DO	BOD	TDS	NO_3	SO_4	Pb	Cr	Cu	Mg	Zn	Fe
Temp	1.000												
pH	0.506*	1.000											
DO	0.294	0.037	1,000										
BOD	0.383	0.114	0.110	1.000									
TDS	0.421	0.007	0.014	0.125	1.000								
NO_3	0.080	0.325	0.184	0.139	0.279	1.000							
SO_4	0.378	0.036	0.036	0.026	0.039	0.174	1.000						
Pb	0.327	0.043	0.009	0.177	0.015	0.250	0.074	1.000					
Cr	0.406	0.009	0.011	0.117	0.000	0.264	0.034	0.015	1.000				
Cu	0.286	0.085	0.051	0.016	0.078	0.099	0.012	0.102	0.070	1.000			
Mg	0.198	0.086	0.011	0.126	0.049	0.124	0.061	0.024	0.043	0.098	1.000		
Zn	0.344	0.145	0.085	0.371	0.096	0.373	0.222	0.042	0.098	0.256	0.090	1.000	
Fe	0.307	0.102	0.044	0.284	0.059	0.300	0.155	0.016	0.059	0.182	0.049	0.007	1.000

Note: Asterisk value indicate $p<0.05$ level of significance.

Nitrate values ranged between 20.58mg/L and 79.61mg/L with a mean value of 57.08mg/L ± 48.23. The highest mean value was recorded at site D in the month of June and the lowest at site C in the month of April. The range of nitrate in the analysis was above the WHO and the FEPA limits 50mg/L and 20mg/L. Sulphate value in this analysis ranged between 64.5mg/L – 87.4mg/L and had a mean value of 76.14mg/L ± 10.4. The highest sulphate mean value was recorded at site B in the month of July while the lowest mean value was recorded at site C in the month of April. Compared with the WHO and FEPA limits, the range of sulphate in this analysis fell below the 200mg/L recommended limit for drinking water.

Lead value in this analysis was very low and ranged between 0.005mg/L and 0.025mg/L with a mean value of 0.011mg/L ± 0.0001. The highest value was recorded at site D in the month June and the lowest value were recorded at sites A, B, C in the month of April. The standard limit set by WHO and FEPA is 0.05mg/L and is higher than the values recorded during this sampling period. Chromium values ranged between 0.005mg/L and 1.08mg/L and had a mean value of 0.21mg/L ± 0.04. The highest mean value recorded was 0.40mg/L at site 4 in the month of June and the lowest value recorded was 0.03mg/L at site B in the month of April. This range fell above the standard limit of 0.05mg/L set by the WHO and FEPA. Copper was not detected in some months of the study period and when found had the highest value of 0.35mg/L at site D in the month of June. The range of copper in this analysis was above the standard set limit of 0.05mg/L by WHO and FEPA.

The range of magnesium in this analysis was between 119.0mg/L and 176.68mg/L and a mean value of 152.68mg/L ± 79.5. The highest mean value was recorded in the month of June at site A and the lowest was recorded in the month of April at site B. This range and the mean value were far above the WHO and FEPA standard limit set for drinking water. Zinc value ranged between 0.009mg/L and 4.93mg/L with a mean value of 2.05mg/L ± 5.19. The highest mean value of 4.93mg/L was recorded at site B in the month of July and the lowest value recorded was 0.00±0.00 at site C in the month of April. This range was below the limit of 5.00mg/L set by WHO and FEPA. Iron had a mean value of 1.98mg/L ± 0.21 and ranged from 0.37mg/L to 3.89mg/L. The highest value of iron was recorded at site B in the month of July and the lowest mean value was recorded at site A in the month of April. This range is higher above the standard limit of 0.30mg/L set by WHO and FEPA.

4. Discussion

Clean water is essential to life and any adverse changes to the water quality of the steam can impact bodies of water downstream, lakes or even the ocean. River Elemi runs across the major road leading to Ekiti State University and Iworoko – Ekiti. The river has witnessed a great deal of anthropogenic activities in the recent times as a result of rapid urbanization after creation of the state.

The analysis of adverse effect of anthropogenic activities on the communities of aquatic organisms was among the first environmental assessment methods popularly adopted. Organisms found in streams and water bodies which are expected to be polluted as a result of human activities can be categorized as pollution-tolerant and clean water indicators. Macroinvertebrates are biological quality element required for the classification of biological status of the water bodies and are also useful bioindicators providing a more accurate understanding of changing aquatic conditions than physical and chemical data, which only gives a short - term fluctuation.

The macro – invertebrate taxa recorded in this study was characterized by low taxa number. This is not unusual in tropical waters, for instance [19], [20] and [21] also reported low taxa number in some tropical southwestern Nigeria streams and rivers. They ascribed this low species diversity to some physicochemical conditions of water like fast flow, high pH, low dissolved oxygen and conductivity. These factors probably caused disruption of life cycle, reproductive cycle, food chain and migrations or imposed physiological stress on even the tolerant macroinvertebrates [22]. The family of molluscs identified in this study especially physidae was pollution tolerant. The low pH observed in this study may have contributed to the abundance of molluscs in the river.

Arthropods were the second phylum in the macroinvertebrates recorded in the study period. Among the orders recorded in this phylum was coleopteran. Coleopteran were the dominant group with gyrinidae been the second preponderant species. It has been reported that this family is found mostly in clean waters [23] the presence of coleopteran in an aquatic system along with other less tolerant species such as Ephemeroptera, Plecoptera, Trichoptera and Odonata have been observed to reflect clean water conditions [24] and [22]. These species of clean water organisms are very sensitive to reductions in dissolved oxygen and are not found in areas where oxygen levels are consistently low and this coleopteran is found mostly at site D and makes it cleanwater due to the presence of these arthropods in the river and low oxygen level.

Most of the physico – chemical parameters measured in the surface water during this present study falls within WHO standard limit for drinking water. For instance, pH while temperature, Biochemical oxygen demand, Total dissolved solids, sulphate of the samples falls below the [25] and [26] standard for drinking water. The temperatures were found below the range of the WHO standard of 32°C. The reduction or low in temperature can be due to the shield covering by the trees alongside the sampling point preventing direct sun hitting the river and thereby increasing the temperature. The pH value recorded during the sampling falls within the FEPA limit which also varied from slightly acidic to Alkaline. pH levels between 6.0 and 9.0 are the recommended limits for aquatic organisms although they may not tolerate sudden change above this range [25]. The pH indicated the presence of metals such as zinc, the source of which may arise from improper disposal of used cans of aerosols and other disinfectant deposited in the rivers as waste. After exposure to air and water chemicals oxidized from these wastes may have found their ways to the river through seepage to give the slightly acidic nature of the water.

Dissolved oxygen value recorded during the sampling was above the 5.0Mg/L of FEPA and WHO standards. The high mean value of dissolved oxygen in all the water samples analysed may be as the results of slow breakdown of the organic matter by micro – organisms because of the rapid movement of the water. Dissolved oxygen is very crucial for the survival of aquatic life and it is also used to elevate the degree of freshness of river. Biochemical oxygen demand value recorded during the sampling has a greater value than the WHO standard set for drinking water and this recorded value is below the FEPA limit of 50Mg/L. The total dissolved solids value recorded during this period of analysis is low compared to the FEPA permissible limit of 500g/L and this could be as a result of tidal influences of the river.

Nitrates value recorded are far above the FEPA permissible limit. Nitrates are a major ingredient in farm fertilizer and necessary for crop production. Nitrate levels are usually higher in rainy season, this is in accordance with findings of [27] and [28]. The high level of Nitrate can be attributed to washing of varying quantities of nitrate from farm land into nearby water ways and also infiltration, and seepage of effluents. Nitrates are hazardous to infants causing the blue baby syndrome. Hence, the presence of nitrate in the sampled water may be as a result of the discharge of farm products in the water and the washing of farm tools in the river and the presence of human faeces all around the river banks that may become into the river. This can also be a factor that increases sulphate concentration. The sulphate value recorded were lower than the WHO permissible limit and this may be as a result of the laundry and farming activities that were carried out in all the sampling points and majorly the discharge of house hold effluence into the river.

The presence of heavy metals in a river indicates the presence of toxic waste perhaps from disposal of battery cells, used aerosol cans and other material with certain degree of toxicity. For lead, the WHO permissible limit set for lead is 0.5 and is greater than the recorded value during the study period. This may be as a result of discharged been deposited in the river by mechanic workshops beside the river. The presence of iron in water is a clean manifestation of the presence of toxic waste in the river. The maximum permissible limits of iron contents in drinking water is 0.30Mg/L above which the water is unsafe and unfit for consumption due to an objectionable and sour taste. It was remarked that the formation of goiter in adult was the result of consumption of water with quantity of iron above the specified values [29], [30]. The presence of zinc in the river may be as a result of wastes containing zinc metals which are dumped beside the river, got decomposed and its effluence found their way into the river. High level of zinc can be recorded due to the waste generated by all the mechanic, block making industry and furniture workshops in the vicinity of the river.

Chromium value obtained in the analysis is higher than the WHO permissible limits and the water is unsafe for consumption. This may be due to the discharge of metals containing substances released into the river. Magnesium and Copper value obtained are higher than the WHO permissible limit set and it may be due to the discharge of effluence containing these metals in the water.

5. Conclusion

The study revealed that the concentration of the detergents and discharged released in the river has an impact on the physic-chemical parameters of the river. The quality of an aquatic habitat as describable by physical and chemical properties of the water goes a long to help assess the stress conditions and thus the survival potential of organisms presents in it. But early detection of unfavourable changes in water quality will allow living in it. The common practice of using natural water bodies as disposal media for waste/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 need to regulate, and prevent untreated effluent discharged from house hold or from industries or workshops in to the natural water bodies. In view of this;

- Government should help in public enlightenment campaign to raise the level of awareness and re-orienting 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.
- Offenders of environmental laws should be duly punished so that it will serve as a deterrent to others.
- Existing environmental laws should be reinforced.

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