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COMPOSITION, ABUNDANCE AND DIVERSITY OF MACRO-BENTHIC FAUNA AND AQUATIC INSECTS OF ERELU RESERVOIR AND ITS PHYSICAL PROPERTIES

Amusat, A. I[1]., Popoola, K.O. K[2]., Adedokun, M. A[3]., and Rafiu, R. A[3].

1. Department of Science Laboratory Technology Oyo State College of Agriculture, Igboora.
2. Department of Zoology, University of Ibadan, Ibadan, Oyo State.
3. Department of Fisheries Technology, Oyo State College of Agriculture, Igboora.

E-mail: Wumiamusat@gmail.com

ABSTRACT

Erelu Reservoir was studied between July 2012 and June 2013, to assess the composition, abundance and diversity of macro-benthic fauna, aquatic insects and its physical parameters. The water, benthic and aquatic insects were collected once every month from three stations. Highest mean value of transparency was 94.42± 5.49cm, Temperature 29.08 ± 0.38°C and Hydrogen ion concentration (pH) 7.27 ± 0.15mg/l. The range for transparency was (70-130)cm, (6.40-7.8) Mg/l for pH and (26-32°C) for temperature. Seven families of benthic macro-fauna; Ampullaridae, Viviparidae, Chironomidae, Lymneaidae, Planorbidae, Thiaridae and Margaritiferidae as well as eight families of aquatic insects; Gyrinidae, Notonectidae, Gerridae, Veliidae, Nepidae, Aeshnidae, Coenagrionidae and Libellulidae were recorded. A total number of 4,632 benthic individuals and 8,648 insects were recorded. *Melanoides tuberculata* dominated the benthic fauna with a total relative abundance of 90.71% while Planorbidae (*Biomphalaria pfeifferi*) were the least abundant (0.11%) by number in the reservoir. Notonectidae (*Notonecta sp.*) dominated the aquatic insects with abundance of 92.43% while Nepidae (*Lacotrephes japonensis*) was the least abundant (0.01%). Margalef's index (H) in stations 1-3 was (0.60-1.14), Shannon Index (D) was (0.23-0.60), Evenness (E) was (0.41-0.90) for the benthic fauna while H= (0.35-0.50), D= (0.21-0.87) and E= (0.50-2.60) for the aquatic insects. The Margalef's index recorded across the stations for both benthic and aquatic insects showed that the reservoir was moderately polluted.

Key words: Benthic fauna, Aquatic insects, Erelu Reservoir, Physical parameters

INTRODUCTION

Benthic organisms are those organisms which live on or inside the deposit of the bottom of water body (Odum, 1971, Davide, *et al.*, 2010). They are generally classified according to size: Micro-benthos (>1.0) and sometimes mega-benthos (>10.0mm), (Castelli, *et al.*, 2004). They can also be differentiated by the position they occupy on or in bottom sediment, in-fauna for those that live in sediment and epi-fauna for those that live on the surface of bottom sediment (Davide and Marcosigovini, 2010).

Among the mainfactor responsible for numerical and structural fluctuation of Benthos are temperature (Beukemia, 1984), hydrodynamics and nutrient input (Beukemia, 1991). They play a vital role in circulation and recirculation of nutrients in aquatic environment. They constitute the link between the unavailable nutrients in detritus and useful protein materials in fish. Most benthic organisms feed on debris at the bottom of the water and in turn serve as food for a wide range of fishes (Adebisi, 1989; Oke, 1990). They also accelerate the breakdown of decaying organic matter into simpler inorganic forms. Benthos plays important roles in the ecology of aquatic ecosystem (Idowu and Ugwumba, 2005).

Aquatic insects are groups of arthropods which live or spend part of their life cycle in water bodies (Pennak, 1978). They are of great importance to water bodies where they are found and their presence in water serves various purposes; some as food for fishes and other invertebrates, others as vectors through which disease pathogens are transmitted to both human and animals (Foil, 1998; Chae, *et al.*, 2000).

Benthic and aquatic insect faunas are considered important indicator of water quality and are used in a variety of ways to assess and monitor overall health of the aquatic environmental disturbances tolerant levels (Simboura *et al.*, 1995; Arimoro and Ikomi, 2008). Benthic and aquatic insect communities provide some advantages over other biological assemblages, such as having limited mobility, often easily collectible, inexpensive to identify and found in all aquatic environment.

Most organisms depend on water temperature and hydrogen ion concentration (pH) for their metabolic activities. In warm waters, respiration rate increases leading to increased oxygen consumption and increased decomposition of organic matter, hence lower pH values can occur in such water high in organic content (Fakayode, 2005) and some sensitive species will be absent in water with pH value below six (6).

Several studies on aquatic ecosystem have been reported in Nigeria (Ajao, 1990; Oben; 2000; Ogbogu, 2001; Tyokumbur *et al.*, 2002; Atobatele *et al.*, 2005; Idowu and Ugwumba, 2005; Fakayode, 2005, Otalekor, 2009), but none covered Erelu reservoir in Oyo, Oyo State Nigeria. In this regard, the purpose of this study is to investigate the composition, diversity and distribution of benthic and aquatic insect fauna of Erelu reservoir and its physical parameters.

STUDYAREA

Erelu, one of the south western reservoir is located in Oyo town, in the North of Ibadan, capital of Oyo state and lies between latitude $7^{0}.8'33'$ and $7^{0}9'33'N$ and longitude $3^{0}8'67'E$ and $4^{0}0'00'E$ (Ufoegbune *et al.*, 2011).

The reservoir was built in 1961 on Aawon River along Oyo |Iseyin road. This reservoir is on latitude $7^{0}52^{1}$ O"N and longitude $3^{0}55^{1}$ O"E. The impoundment of the dam is 161.07ha, and the catchment area is 243.36km. It is about 6.4km from the heart of Oyo town and it supplies portable water and fishing activities to the people in the town. An output of 7.5million litres of water is released per day, from a reservoir with a capacity of $10cm^{3}$ (Akintola and Adeniyi, 1997).

Vegetation of the reservoir is evergreen and interspersed with grasses and trees.Predominant trees around the reservoir are *Anacardiumoccidentale*, *Cocos nucifera*, *Parkia biglobosa*, *Mangifera indica*, *Psidium guajava*,

The dominant aquatic plants that are found along the banks of the reservoir are *Pistia stratiotes, Eichorrnia crassipes, Persicaria senegalensis, Commelina benghalensis, Ceratophylum demersum, Ipomoea aquatic*. The floating plants include *Lemna minor*and *Nymphaea species*. Notable herbs along the banks are *Talinum triangulare, Amaranthus spinosus and Vernonia, amydgalina*.Aquatic birds such as Eagles, Heron, Eagrets and Ducks visit the reservoir on daily basis. Fish fauna found in the reservoir include *Tillapia zilli, Chrysichthysnigrodigitatus, Hepsetus odoe, Oreochromis, niloticus*, and *Momyrusrube* etc.

MATERIALS AND METHODS

Determination of Physical parameters

The physical parameters of water determined were temperature, Hydrogen ion concentration and transparency. Physical parameters in water were determined in situ once every month from each sampling station. The sampling period spanned July,2012 to June,2013. Sampling was carried out usually between the hours of 8am-12 noon. Surface water temperature was measured with a mercury-in–glass thermometer according to the method of Ademoroti (1996). A white with black painted 20cm radius Secchi disc was used to measure the transparency of the water as described by Angelo (1885) and Egborge (1979). The pH was measured using Ec500 Extech multimeter kit according to the method described by William (1997).

Benthic Macro-fauna collection

A Vanveen Grab with a surface area of 66.6m^2 was used to collect sediments. The collected sediment were emptied into pre-labelled polythene bags and taken to laboratory for washing. The washed samples were sieved separately through a sieve with mesh size of 0.5mm to eliminate the excess sediments. Organisms contained were sorted from the detritus and stored in 70% alcohol. Subsequently the collected macro-benthic fauna were identified with the aid of 0.90mm hand lense and compound microscopes while the unidentified organisms were taken to the museum in the Zoology Department, University of Ibadan, Nigeria for identification.

Aquatic insect sampling and identification

At each sampling point, adult insects were collected from water surface using a dip-net with Nytex(R) netting of 500µm mesh size. Adult insects and their nymphs were also collected from the vegetation around the reservoir using a sweep net with a mesh size of 250µm. The sweep net was passed over the area for at least two minutes. The contents collected were put in a sorting bucket and the net was properly checked for insects clinging to the mesh. Other several insects were handpicked from specific micro-habitats throughout the reservoir. Insects collected were later preserved in 70% alcohol in plastic bottles labeled according to sample point description and collection date. All samples collected were taken to the laboratory for identification by an Entomologist in the Department of Zoology University of Ibadan, Nigeria. Aquatic taxonomic keys (Heckman, 2002, Needham *et al.*, 2000; Merritt & Cummins, 1996; Phyllis*et al.*, 1970; Pennak,1978; Fred, 2004) were used by the researcher to identify the collected specimens to species, or at least to the genus level.

Data Processing

The monthly numerical abundance and percentages of macro-benthos and aquatic insects were calculated, while the mean and standard deviation of each physical parameters were determined

Diversity of the macro benthic and aquatic insects was determined using Shannon-Weinner index, Species richness was calculated using Margalef's Diversity index. Evenness (E) or Equitability (J) was used to examine the evenness of the species distribution to the maximum.

Diversity index (D) is a measure of species richness and was expressed as;

$$D = \frac{S-1}{\text{Ln } N}$$

Where S = no of Species

N = Total no of organisms

Shannon-Weinner Index (H) was expressed as

$$H = \frac{N \log N - \sum f_i \log f_i}{N}$$

Evenness index (E) is a measure of how evenly the species are distributed in the sample community and it is expressed as:

$$\frac{H}{\text{Log}S}$$

Table1: **Summary of Mean, Standard deviation and Range of Physical Parameters of Erelu Reservoir.**

Physical Parameters	Station 1	Station 2	Station 3	Range
Transparency (Cm)	94.42±5.49	92.50 ±4.75	90.00±5.64	70 130
Temperature (0C)	29.30± 0.05	29.08±0.38	29.00±0.35	26 32
Hydrogen ion Concentration in (Mg/l)	7.27±0.15	7.24±0.09	7.20± 0.12	6.40 7.8

Table 2: Composition and Distribution of Macrobenthic fauna encountered during Sampling in Erelu Reservoir, Oyo.

		Station 1		Station 2		Station 3		Total	
Order	**Family**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Architaeniglossa									
	Ampullaridae	06	0.26	24	1.37	-	-	30	0.65
	Viviparidae	28	1.29	50	2.84	01	0.19	79	1.71
Diptera									
	Chironomidae	78	3.50	137	7.79	79	12.25	294	6. 35
Hygrophila									
	Lymneaidae	04	0.18	25	1.42	03	0.57	32	0.70
Pulmonata									
	Planorbidae	04	0.18	-	-	01	0.19	05	0.11
Sorbeoconcha									
	Thiaridae	2,065	92.73	1,484	84.32	527	81.71	4,076	88.00
Unionidea									
	Margariferidae	42	1.89	40	2.28	34	5.27	116	2.50
Total		**2,227**		**1,760**		**645**		**4,632**	

Table 3: Composition and Distribution of Aquatic insects encountered during Sampling in Erelu Reservoir, Oyo.

Ord	Family	Station 1		Station 2		Station 3		Total	
		No	%	No	%	No	%	No	%
Coleoptera									
	Gyrinidae	-	-	-		51	1.97	51	0.59
Hemiptera									
	Notonectidae	2,700	94.60	2,900	90.65	2,393	92.22	7,993	92.43
	Gerridae	99	3.47	176	5.50	100	3.85	375	4.34
	Veliidae	50	1.75	104	3.25	50	1.93	204	2.36
Heteroptera									
	Nepidae	01	0.04	-	-	-	-	01	0.01
Odonata									
	Aeshnidae	01	0.04	03	0.09	-	-	04	0.05
	Coenagrionidae	02	0.07	12	0.38	01	0.04	15	0.17
	Libellulidae	01	0.04	04	0.13	-	-	05	0.06
Total		**2,854**		**3,199**		**2,595**		**8,648**	

Table 4: Diversity and other indices of Benthic and Aquatic insect fauna in the study stations of Erelu Reservoir

	Benthic fauna			Aquatic insects		
	Station 1	Station2	Station 3	Station 1	Station 2	Station 3
No of taxa	7	6	6	7	6	5
No of individual	2,178	1,758	529	2,854	3,199	2,595
Margalef s(D) richness	1.14	0.73	0.60	0.47	0.35	0.50
Shannon-Weiner (H)	0.23	0.60	0.30	0.21	0.81	0.23
Evenness (E)	0.41	0.90	0.60	0.54	2.60	0.50

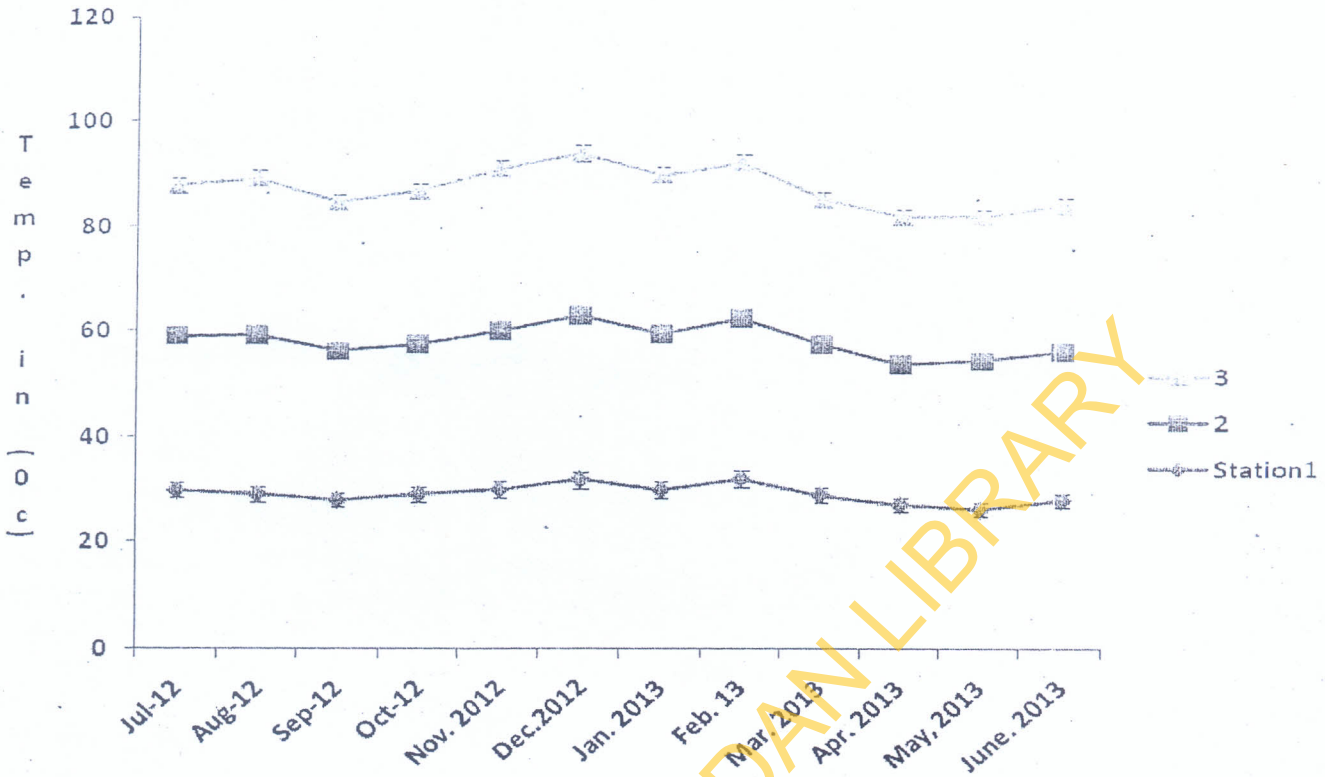

Fig1: Monthly variations of Temperature in Erelu Reservoir

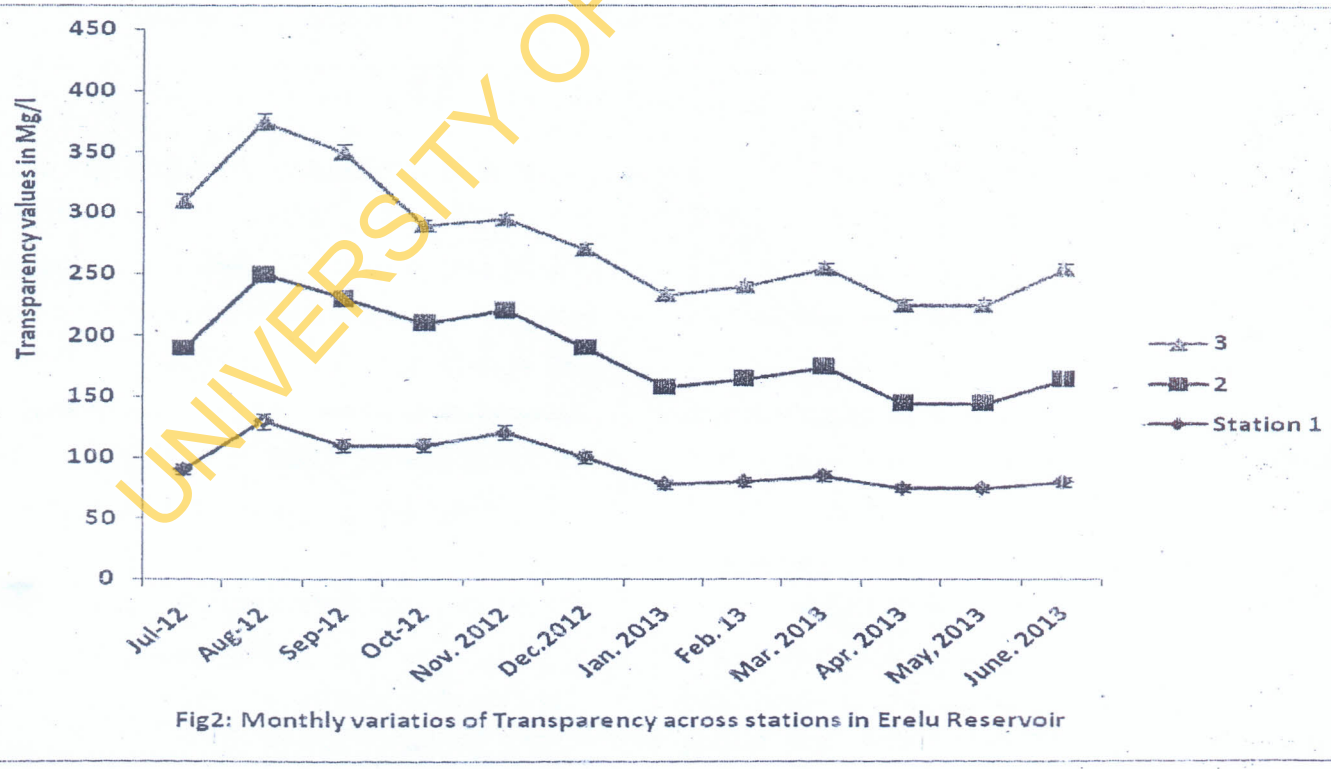

Fig2: Monthly variatios of Transparency across stations in Erelu Reservoir

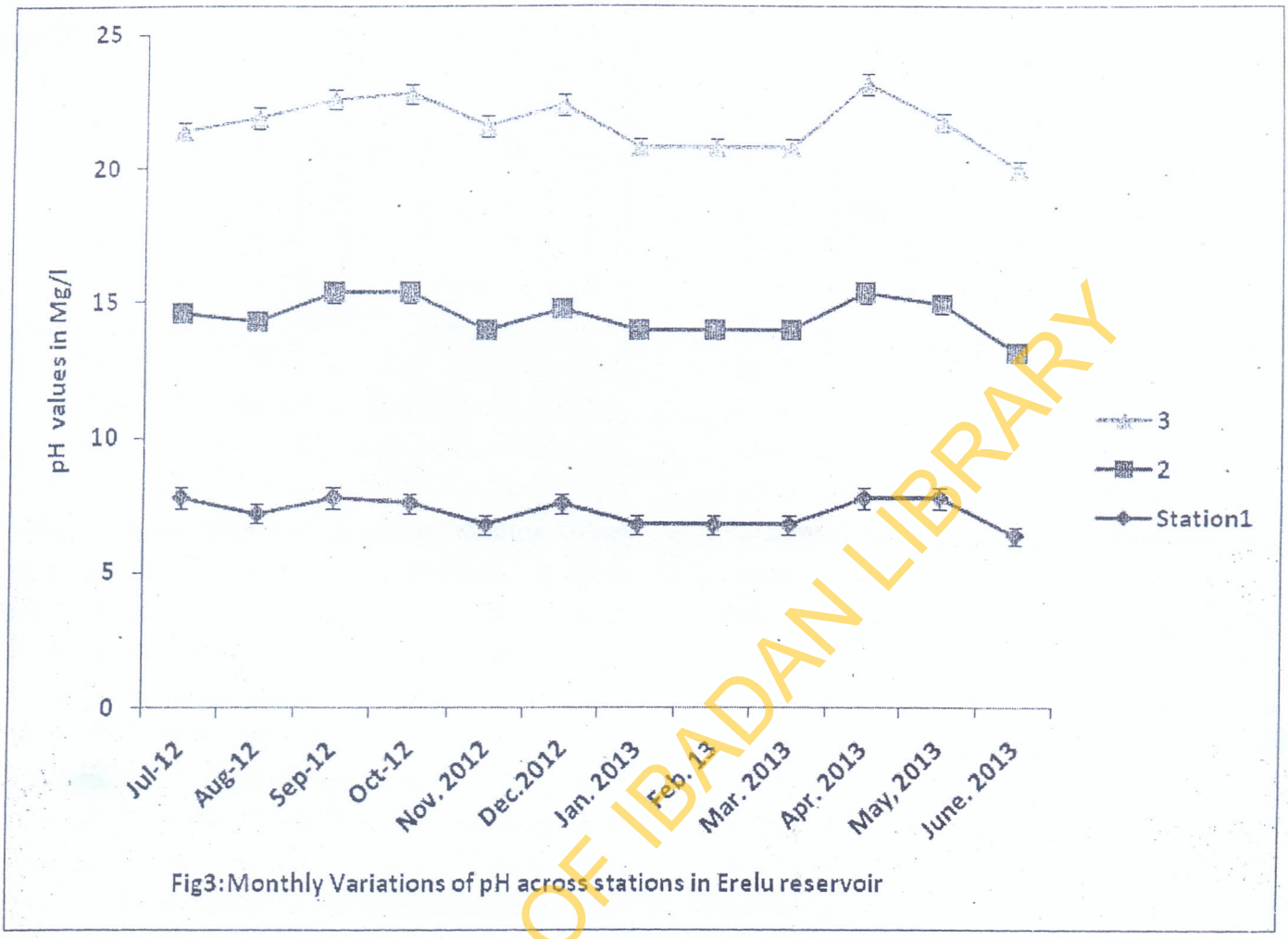

Fig3: Monthly Variations of pH across stations in Erelu reservoir

RESULTS

The mean, standard deviation and range of physical parameters of the reservoir during the study period were presented in Table1. The transparency of the reservoir in all stations was almost the same ranging from 70.00 – 130.00cm. The temperature of surfacewater in all the stations was almost the same ranging from 26.00 – 32.00°C. pH was acidic to neutral across the stations ranging from 6.40 – 7.80.

Composition and Relative Abundance of Macro benthos and Aquatic insects.

Six orders and seven families of benthic fauna were recorded in the reservoir. Family Thiaridae, which included *Melanoides tuberculata* and *Potadoma moerchii* was the most abundant in station 1 (92.73%), station 2 (84.32%) and station 3 (81.71%). This is followed by Chironomidae with 3.50%, 7.79% and 12.25% abundance respectively. The Viviparidae, Margaritiferidae, Lymneaidae and Plarnorbidae had the least abundance across the stations (Table 2). The aquatic insects were represented by four Orders and ten families. The Notonectidae (Back swimmers) had highest abundance of 92 .43% across the stations, followed by Gerridae (4.34%) while other families were low in abundance (Table 3). The result from table 4, shows species richness, diversity and evenness of benthic and aquatic insects. Margalef's index values ranged from 0.60 - 1.14 across stations, while Evenness ranged from 0.50 – 2.60 across the stations.

Monthly Variation of benthic fauna is shown in Table 5. Generally, the highest number of benthos was recorded in the rainy months with the exception of *Pomaceabridgesii, Lymnaenatalensis*, and *Margaritiferamargaritifera* which had the lowest number during both the rainy and dry months. The highest abundance was recorded for *Chironomid sp. Melanoides sp.* and *Potadoma sp.* during the dry and rainy months. Table 6 showed the variation of aquatic insects. *Notonecta sp.* was highly abundant with 5,531 in the rainy and 2,462 in the dry months. This was followed by *Gerris sp.* with 216 and 122 in the rainy and dry months. *Gyrinus sp.* had 47 and 04 abundance for both rainy and dry months. Other species were low in abundance.Figures 1-3 show the pattern of Monthly Variations in the physical parameters. The transparency in each station increased in the dry months than in the rainy months particularly November 2012 and March 2013 across stations (Fig 2). The temperature in each station increased in the December and February and dropped in the January and March – June 2013 (Fig1). The pattern of variation shows that pH was highest in September, October, December and April but finally dropped in May and June 2013 (fig 3).

DISCUSSION

The high transparency which was almost the same in all the stations of the reservoir might have favouredhigh photosynthesis (primary productivity) (Mason,1990). Moreover, the high transparency during the dry season and low value during the rainy season could be attributed to the rate of influx or turbid flood from the rivers and runoffs into the lakes which decreased light penetration. Similar observation was reported by Hassan (1974) in Awba reservoir, Adebisi (1981) in upper Ogun river, Ikomi*etal.*,2005) in river Adofi, Idowu and Ugwumba (2005) in Eleyele reservoir and Ayoade, *etal.*, (2006) in Asejire and Oyan lakes.

The uniform temperature across the stations may be because the sampled water was not deep(less than 1m depth). Uniform temperature owing to shallow water has been reported by Ajao (1990). The lower water temperature recorded in rainy month could be due to the thicker cloud cover which had a reducing effect on the solar radiation(Ayoade, *etal.*, 2006; Idowu and Ugwumba, 2005). The pH of Erelu reservoir ranged between 6.4 to 7.8 mg/l respectively. Thus, these values are neutral and fall within the suitable range (6-9mg/l) reported for most Animals (Abohweyere, 1990). Gastropoda, especially *Melanoidestuberculata* and *Potadomamoerchii were* the dominant benthic macro invertebratesencountered in the reservoir followed by the *Chironomidsp.Margaritifera sp.* and *Viviparus sp.* This result is in line with the finding of Adebayo (2009) in Eleyele reservoir, Fagbola (1989) in Opa reservoir, Oke(1990) in Owena reservoir and Edward and ugwumba (2011) in Ekiti reservoir. The present study recorded the highest number of macro invertebrates in both rain and dry seasons. This result however contrast the report of Zabbey (2006) who reported highest abundance of macro invertebrates in the dry season alone.

The Erelu reservoir has benthic fauna dominated by molluscs. This is contrary to the finding of Situ (1983), Tyokumbur, *etal.*, (2002) in Awba reservoir, Ogbeibu and Oribhabor (2002) in Ikpoba river and Ndaruga, *et al.*, (2004) who reported Chironomid larvae as the dominant benthic fauna in their studied reservoirs. The highest abundance of *Notonecta sp. Gerrissp. and Velia sp.* was recorded across the stations. This could be attributed to slightly acidic to neutral pH and temperature which falls within the normal range of freshwater organisms to survive i.e (21-32^{0}C) as reported by Ayodele and Ajani (1999) and Beukemia, 1984. Otalekor (2009) reported the

sp., Damselflies in some stations of Awba reservoir because they were slightly affected by acidification. *Gyrinus sp.* was abundant in station 3, which may be due to slow movement of water body. The high Margalef's value in station 1, 2 &3 and the Equitability values in stations 2 & 3 indicate high species richness in the stations though with low dominance (even distribution of organisms) in station 2. The low Shannon-weinner value in station 1&3 and the low equitability value in stations indicate low species diversity and equitability of species. High margalef's value in stations 1&3 indicate high species richness. Highest equitability value in station 2 shows even distribution of organisms in the station. It is likely that substrate differences has effect on the diversity of species by changing the frequencies at which various kinds of organisms settle on the substratum Wolff (1974) reported that many factors could affect the diversity of macro benthos, such as position of the trophic gradient, possibility of food source and benthos to concentrate in the unsampled area of the reservoir.

The highest abundance of *M. tuberculata, and Potadomamoerchii* during the rainy and dry months could be attributed to the moderately polluted nature of the reservoir and that the high abundance result observed were probably as a result of transparency, pH and temperature which fell within the limits for freshwater organisms to survive. This result agrees with that of Adebayo (2009) in Eleyele reservoir, who reported the highest abundance of *M. tuberculata* being the fairly tolerant group of benthic organisms. *Viviparus sp.* was abundant in the rainy season alone, while *Chironomid sp.* was more during the rainy and dry months. This could be attributed to their adaptation to anoxic condition. Similar results were reported in Eleyele (Adebayo, 2009) and in new Calabar by Zabbey and Hart, 2006).

The highest abundance of water bug (*Notonecta sp.) and Gyrinus sp.* recorded both in the rainy and dry months could be attributed to the highest transparency in all stations of the reservoir which leads to greater productivity as a result of light penetration. This aids photosynthesis and inturn leads to increased dissolved oxygen which was not examined in this study. This result corresponds with Idowu and Ugwumba (2005) and Ayoade, *etal.*, (2006).

CONCLUSION

The results showed that temperature, pH and transparency had the strongest influence on the diversity, abundance and composition of macro benthic fauna and aquatic insect community of Erelu reservoir. The temperature and pH of Erelu reservoir which fall within the recommended limits promoted high abundance and diversity of benthic and aquatic insects in the reservoir. The high abundance and distribution of fairly tolerant species of benthic and sensitive aquatic insects indicate moderate pollution of the reservoir. With special reference to Margalef's water quality index, values greater than 3 indicate clean conditions, values less than one (1) indicate heavy pollution of the reservoir while values between (1-3) indicate moderately polluted conditions (Lenat, *etal.*, 1980). Margalef's index for benthic in station 1 was (1.14), station 2 (0.73), station 3 (0.60) and that of insects was (0.47, 0.358 & 0.50) respectively. These are indicative of the moderately polluted nature of the reservoir. Hence, conservative measure of non-point source of pollution could be monitored to improve the quality and health status of the reservoir.

REFERENCES

Abohweyere, P.O.,(1990). Study of Limnological Parameters and Potential fish yield in Kigera Reservoir (Extensive System) in Kainji, New Bussa, *NigeriaJournal ofaquatic Science* 5: 53-58.

Adebayo, T., (2009). The Dynamics of the Macro Benthic invertebrates fauna of Eleyele and Awba reservoir. An unpublished M.sc thesis submitted to the Department of Zoology. Pp. 23-50.

Adebisi, A.A., (1981). The physico chemical hydrology of tropical seasonal river-Upper Ogun River *Hydrobiologia* 79: 157-165.

Adebisi, A.A., (1989). Planktonic and Benthic Organisms in some ponds on the Olupona Fish Farm, Olupona, Oyo state, Nigeria. A report prepared for Agro Team S.R.I. Ibadan Nigeria.

Ademoroti, C.M.A., (1996). Standard Method for Water and Effluents Analysis. Pp 44-76.

Ajao, E.A, (1990).The influence of Domestic and industrial Effluents on the population of sessile Benthic organisms in Lagos Lagoon. Ph.D Thesis submitted to the Department of Zoology, University of Ibadan, Ibadan Nigeria. 411PP.

Akintola. F.O. and Adeniyi, G., (1997). Land-use changes and water quality in impounded water supply dams in Southwest Nigeria. Freshwater contamination (*proceeding of Rabat symposium* S_4) AHS publ. No. 243, pp313-319.

Arimoro, F.O. and Ikomi, R.B., (2008). Ecological Integrity of upper Warri River, Niger Delta using Aquatic insects as bioindicators. *Ecological indicators*. Vol. 395: 1-7.

Atobatele, O.E, Morenikeji, O.A. and Ugwumba O.A. (2005). Spatial variation in physical and chemical parameters and benthic macro-invertebrate fauna of River Ogunpa,Ibadan. *The zoologist* vol. 3: 58-67.

Atobatele, O.E. and Ugwumba O.A., (2008).Seasonal variation in the physic chemistry of a small tropical reservoir (Aiba Reservoir, Iwo, Nigeria).*African Journal ofBiotechnology* Vol (12),1962-1971.

Ayoade, A.A. Fagade, S.O. and Adebisi, A.A., (2006). Dynamics of limnological features of man-made lakes in relation to fish production.*African Journal of Biotechnology*, Vol 5 (10),1013-1021.

Ayodele, I.A. and Ajani, E.K., (1999). Essentials of Fish Farming (Aquaculture). Odufuwa Press, Ibadan. Pp. 46

Beukemia, J.J., (1984). Zoobenthos survival during severe winters at high and low tidal flats in the Dutch Wadden Sea. In. J.S.Gray and M.E. Christiansen (eds.); Marine biology of polar regions and effects of stress on marine organisms. John Wiley, Chichester: 351-361./

Beukemia, J.J., (1991). Changes in composition of bottom fauna of a tidal-flat area during a period of eutrophication.*Marine Biology* 111: 293-301.

Boyd C.E., (1979). Water quality(1982).Water quality management for pond fishcultureElsevier science publishers B.V. pp.318.in warm water fish ponds. Craft master, printersinc. Auburn, Alabama, U.S.A, 353PP.

Castelli, A., Lardicci and Tagliapietra, D., (2004). Soft-bottom Macro-benthos, chapter four in M.C. Gambi and M. Dappiano (Eds.).Meditteranean marine Benthos. Amanual of methods for its sampling and study, *Biologia marine meditteranean* (SIBM-PATICRAM), 11 (suppl.1), 99-131.

Chae, S.J.N. Purstela, E. Dedrock, S.P. Lawler and Madigan, J.E., (2000). Infection of aquatic insects with trematodemetacercaria carrying*Ehrilichiaristicii*, the case of the Potomac house fever.*Journal of Medical Entomol.*, 37: 619-625.

Davide, T. and Marcosigovini, (2010). Benthic fauna: collection and identification of macrobenthic invertebrates instituto di scienze

marine consiglioNationatedellerRicerche (NR-ISMAR)Riva settemarturi 1364/a 30122, Venice Italy. Near Curricum in National Environmental Science, Terret Environmental, vol 88, Pp 253-261..

Fakayode, S.O., (2005). Impact assessment of the effect of industrial effluents on the receiving Alaro stream, Ibadan, Nigeria.*Journal of Aquatic sciences*, Vol. 12, No1:7-14.

Fagbola,, M.S., (1989). A survey of freshwater snails in Ile-Ife for Helminth parasites. M.sc project submitted to the Department of Zoology, University of Ibadan, Oyo state.

Foil, L.D., (1998). Tabanids as vectors of disease agents in Parasitol, Today, 5: 88-96.

Fred, G.T., (2004). An identification Manual for the freshwater snails of Florida. Pp1-96.

Hassan, A.T., (1974). Studies on the Ecology, Behaviour and Life History of Libelluline Dragonflies.University of Ibadan, Ph.D thesis of Zoology Dept. 51-58pp.

Heckman, C.W., (2002). Encyclopedia of the South American aquatic insects: Ephemeroptera. Kluwa Academic publishers, Norwell, MA. 419PP.
Idowu, E.O. and Ugwumba, A.A.A., (2005). Physical, Chemical and Benthic Faunal Characteristics of a Southern Nigeria Reservoir.*The Zoologist* Vol. 3: 15-25.

Ikomi, R.B., Arimoro, F.O. and Odihirin, O.K., (2005). Composition, Distribution, and Abundance of Macroinvertebrates of the upper reaches of River Ethiope, Delta State, Nigeria. *The Zoologist* Vol.3: 68-81.

Iroko, I. A.,(2003).Effect of Erelu Water Dam on LivelihoodActivities of Settlers in Atiba Local Government Areaof Oyo State.An Unpublished Thesis in the Departmentof Agricultural Extension and Rural Development,University of Ibadan, Nigeria.Pp 48-50

Lenat, D.R., Smock, L.A. and Penrose, D.L., (1980). Use of benthic macroinvertebrates as indicators of environmental quality In: Biological Monitoring for Environmental Effects, Lexinton Books, Toronto, Canada, Pp. 7-114.

Mason, C.F., (1990). Biological Aspects of Freshwater pollution. In Harrison, R.M., Pollution, causes, effects and control. 2nd ed. The royal society of Chemistry, Cambridge, CB4, 4WF, PP. 99-125.

Merritt, R.W., and Cummins, K.W., (1996). An introduction to the Aquatic insects of North America 3rdEdn'. Dubuque, IOWA: Kendall-Hunt. 862pp.

Ndaruga, A.M., Ndiritu, G.G., Gichuki, N.M., and Wamicha, W.N.,(2004). Impact of water quality on the macroinvertebrate assemblages along a tropical stream in Kenya'.African Journal of Ecology, 42 (3), 862Pp.

Needham, J.G., Westfall, M.J. and May, M.L., (2000).Dragonflies of North America.Revisededition.Scientific Publishers, Inc., Gainesville, FL. 940PP.

Oben, B.O., (2000). Limnological assessment of the impactof agricultural and domestic effluents of three man-made lakes in Ibadan, Nigeria.Ph.D Thesis submitted to the department of Zoology, University of Ibadan,'Nigeria. 344pp.

Odum, E.P, (1971). Fundamentals of Ecology, W.B. Saunders ltd and; *the philadelplais*, 610pp

Ogbeibu, A.E. and Oribhabor, B.J., (2002). 'Ecological Impact of River Impoundment using Benthic Macroinvertebrates as indicator'. *Water Research*, 36, 2427-2436.

Ogbogu, S.S., (2001). Observation on the seasonal dynamics of Caddisfly larvae (Tricoptera) in an intermittent Reservoir outflowat Ile-Ife, Nigeria.*Journal of Aquatic Sciences*, 16 (2): 139-143.

Oke, O.O., (1990). Limnology and macro-benthos of Owena Reservoir, M. phil. Thesis, submitted to the Department of Zoology, University of Ibadan, Ibadan Nigeria.pp.70- 75.

Otalekor, A., (2009). Physico chemical parameters studies and the use of Aquatic Insects as Bioindicators of water quality in Awba stream and Reservoir, M.Sc. Thesis submitted to the Department of Zoology, University of Ibadan, Ibadan. Nigeria.Pp. 55-56.

Pennak, R.W., (1978). Freshwater invertebrates of the United States.Second Edition. John Wiley and Sons, New York. 810pp.

Phyllis, M., Miles, H.B., and Graham, V.E., (1970).Tropical fresh water Ecology.Hulton Educational Publication Ltd. 55/59 Saffron Hill, London Ec1 Great Britain pp.27-103

Simboura, N., Zenetus, A., Panayotides, P., and Makra, A., (1995).Changes in Benthic Community structure along an Environmental pollution gradient. *Mar. Poll. Bull.*, 30: 470-474.

Situ, A.T., (1983). Studies on the Benthic fauna of Lake KainjiNigeria. M.Sc. Thesis submitted to the Department of Zoology, University of Ibadan, Ibadan Nigeria. Pp. 50-55.

Tyokumbur, E.T., Okorie, E.T., Ugwumba, O.A. (2002). Limnological assessment of the effects of effluents on macroinvertebrates fauna in Awba stream and Reservoir, Ibadan, Nigeria. *The Zoologist,* 1(2), 59-62.

Ufoegbune, G.C., Oparinde, O.C. and Eruola, O.A., (2011). Municipal Water supply planning in Oyo Metropolis, Oyo state South Western Nigeria. Journal of Geography and Regional planning Vol. 4 (7) Pp.392-400.

William, J.S., (1997). Ecological Census Techniques. University of Cambridge, United Kingdom.pp.281-316.

Wolf, W.J., (1974). Benthic diversity in Rhine Meuse Estuary. *Hydrob. Bull Amsterdam*8:242-252.

Zabbey, N. and Hart, A.Z., (2006). Influence of some physico- chemical parameters on the composition and distribution of benthic fauna in Woji Creek, Niger Delta, Nigeria'. *Global Journal of pure and Applied Sciences*, 12 (1): 1-5.

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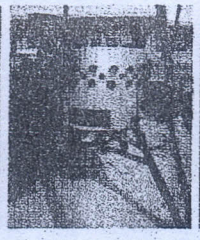
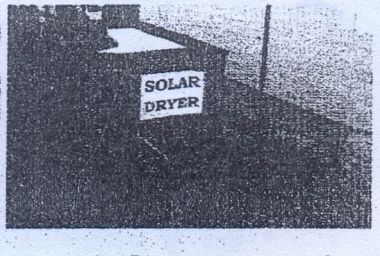

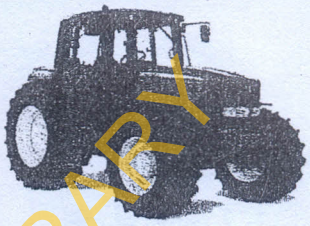

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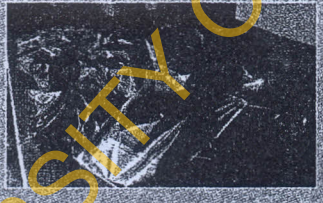
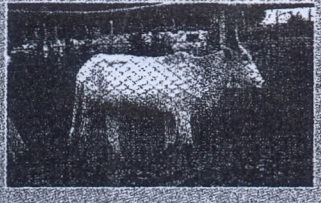


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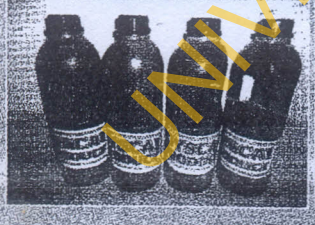

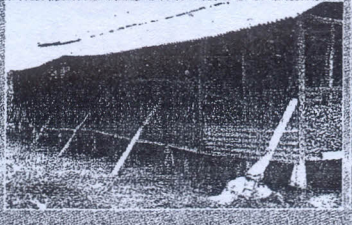


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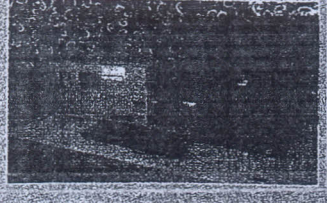
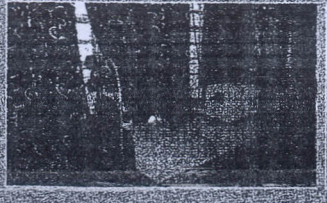
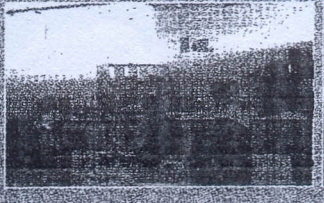


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