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Macroinvertebrates as Indicators of Water Quality in Thomas Dam, Dambatta, Kano State, Nigeria

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Abstract

A study on the water quality assessment using benthic macroinvertebrates in Thomas Dam, Dambatta Kano State was carried out fortnightly for a period of four months (January – April, 2016). Four sampling sites were chosen based on the vegetation pattern and impact of human activities on the dam. Modified Ekman grab sampler was used for benthic Macroinvertebrates collection and identified using standard identification keys. Standard methods were used to determine the physicochemical parameters. The mean range of physicochemical parameters studied were; water temperature (19.6±1.12 - 23.0±1.00 °C), pH (7.6±0.20 - 8.2± 0.25), DO (6.1±2.88 - 9.4±0.24mg/L), BOD (3.0±0.30-5.6±0.25mg/L), TDS (150.6±2.88-183.3±5.77mg/L), Tubidity (18.8±0.80 - 41.9±0.26NTU), Electrical conductivity (161.3±1.52 - 195.6±0.57µS/cm), $N0_3^-N$ (1.2±0.19 - 3.5±0.20mg/L), and $PO_4^{3-}P$ (0.1±0.05 - 0.3±0.03mg/L).There was no significant difference between the sampling sites in physicochemical parameters (P<0.05). Nine (9) taxa comprising of 33 species belonging to Arthropoda, Annelida and Mollusca were identified accounted for 1162 individuals. Increasing dominance of benthic Macroinvertebrates followed the order: Mollusca (35%) > Coeloptera (28%) > Diptera (12.7%) > Annelida (11.4%) > Trichoptera (4.96%) > Placoptera (3.6%) > Ephemeroptera (3%) > Hemiptera(0.85%) > Odonata (0.08%). Correlation analysis between benthic Macro invertebrates distribution and abundance and physicochemical parameters showed a strong positive relationship (P<0.05). Presence of pollution tolerant Macroinvertebrates notably *Chironomus* sp. and *Tubifex* sp. indicates the Dam is under pollution stress. Species diversity indices showed a variation in the community structure in the dam and the implications of this to the biotic status of the dam is discussed

Key words: Benthic Macro-invertebrates, Physicochemical parameters, Pollution, Thomas Dam, Water quality

INTRODUCTION

Physico-chemical water quality parameters provide snapshots of the condition of a water body at a given point in time though may not effectively provide an integral measure of the overall health of the water body and can, at times, inadequately identify impaired waters (WHO, 1993; Balarabe 2001). An integrative approach incorporating biological measures like benthic macroinvertebrates community structure alongside other physico-chemical water quality parameters, can thus provide a more comprehensive assessment of the health of a water body over time (Brain and Richer, 2003; Bonada *et al.,* 2006).Biological assessments of water quality have long been incorporated within physical and chemical assessment to provide complete information for an effective water management (Metcalfe, 1989). Camargo (1993) revealed that biological monitoring based on macroinvertebrates showed more important pollution indicator than physico-chemical monitoring alone. According to Rosenberg and Resh (1993) water bodies can be assessed by different approaches using macro invertebrates which include Richness measures, enumeration, diversity indices, and similarity indices, biotic and Multimetric approach.

Excessive loading of domestic waste into water bodies can alter the physical, chemical and biological characteristics of the aquatic system beyond their natural self purification capacity (Balogun *et al.*, 2005; Akaahan *et al.,* 2016). Higher levels of turbidity, nutrients, suspended and dissolved solids as well as coliform bacteria in rivers are all indicative of compromised systems attributed to increased pollutant load, resulting largely from anthropogenic activities (Akaahan *et al*, 2010). Such changes in water quality can alter the community structure of benthic macroinvertebrates and other aquatic biota therein (Boyle and Fraleigh, 2003).

Biomonitoring studies and the use of macroinvertebrates to rate the quality of water bodies which include both lotic and lentic types have been widely reviewed elsewhere (Ogbeibu and Oribhabor, 2002; Imoobe and Ohiozebau, 2009; Omoigberale and Ogbeibu, 2010; Olomukoro and Dirisu, 2012).

Macroinvertebrates, which were utilized in aquatic pollution studies, include: Mayflies (Ephemeroptera), caddisflies (Trichoptera), stoneflies (Plecoptera), beetles (Coleoptera), crayfish and amphipods (Crustaceans), aquatic snails (Mollusca), biting midges (Chironomids) and leeches (Hirudinea) in Nigeria, North America and Europe (Tampus *et al.*, 2012).Benthic macro invertebrate assemblages and distribution frequently change in response to pollution stress in predictable ways, thus their importance as biological criteria for evaluation of anthropogenic influences of aquatic systems (Boyle and Fraleigh, 2003). In view of the foregoing, this study was conducted in Thomas Dam Dambatta, Kano in order to assess some of its Physico-chemical Parameters and biodiversity and abundance of aquatic Benthic Macro-invertebrates to generate data on the pollution indicator species in the dam using biotic indices.

MATERIALS AND METHODS

Study area

Thomas Dam is located within Sudan savannah zone of Nigeria (Latitude 12^0 16 44” N - 12^0 18’35N and (Longitude 8°30’5’’E - 8° 31’34’’E)

with two distinct wet and dry seasons. The rainy season lasts from May to October and dry season runs from November to April (Shitu, 2006). The dam is about 585 square meters, while its depth is about 30m. The dam is sited near Danmarke village of Dambatta Local Government area of Kano State, 30km away from the ancient Kano City (Kutama *et al.*, 2013).

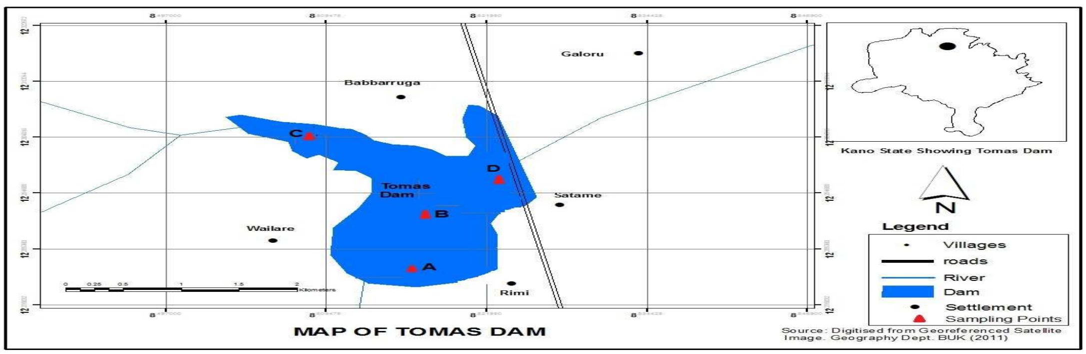

Figure 1: Map of Thomas Dam Showing Marked Sampling Sites (Source: Cartography Lab. Geography Dept. Bayero University Kano 2016).

Sampling Sites

Four (4) sampling sites were chosen on the water course of the dam for the purpose of this study and designated as A, B, C, and D. The choice of the sites was based on the ecological setting of the study area.

Site A: Southern part of the dam (Latitude 12°16’07”N, Longitude 8°31’06’’E). It is one of the shallow parts of the dam; irrigation activities take place during the dry season. Vegetations are subjected to chemicals input from fertilizer application.

Site B: This site (Latitude 12°17’32”N, Longitude 8°31’07”E). Is the mid shore of the dam where there are less human activities apart from fishing.

Site C: This site (Latitude 12°18’16”N, Longitude 8°31’30”E). Is the entrance of the oases which supply water to the Dam.

Site D: At this site (Latitude 12°18’28’’N, Longitude 8°30’40’’E), human activities like washing and bathing take place. The water here is partially contaminated with mainly detergent from car, motor cycle washings and other laundry activities.

Determination of Physico-Chemical Parameters

Water Samples were collected fortnightly for a period of four months (January – April, 2016). The samples were collected from four sampling stations (Site A, B, C and D) between the hours of 8:00 am -11:00am. The following physiochemical parameters were determined as described by APHA (2005): Surface water temp, total dissolved solids, pH, dissolved oxygen, biochemical oxygen demand$_5$, turbidity, electrical conductivity and nitrate – nitroge while phosphate – phosphorus was determined as described by Boyd (1981).

Collection of Macro Invertebrates Samples

Macroinvertebrates Samples were collected using modified Ekman grab sampler as described by Maitland (1978). The grab was lowered into the dam bed at the sampling site. When the grab reached the bottom of the dam, the content was emptied into a labeled polythene bag.

Macroinvertebrates samples were preserved with 10% formalin and transported to the laboratory for Identification with aid of dissecting microscopes and hand lens. In the laboratory the samples were sieved in order to remove fine sediment and any other unwanted material. Each sediment sample collected was washed three times through three set of sieves to collect the macro invertebrates (2mm mesh size, 1mm and the 0.5mm). Macroinvertebrates collected were poured into a white enamel tray and sorted out. The sorting was effective by adding moderate volume of water into a container to improve visibility (George *et al.*, 2009). Large macroinvertebrates were picked out using forceps while the smaller ones were pipetted out. The identification was carried out using keys by Andrews (1972), Mellan by (1977), Pennak (1978), Merrit and Cummins (1996). Macro invertebrates sampled at each site were allocated with Modified Family Biotic Index (FBI) according to their sensitivity and tolerance to environmental stress as described by Mandaville (2002).

Determination of Biotic Indices

Shannon-Wiener (1949) diversity index (H), Equitability (E) and Margalef's index (d) were used to determine species composition, abundance and richness in the dam.

Shannon Index (H) = -Σ1ln **pi ln pi**

Where pi = the proportion of the i^{th} species in the sample ($\frac{No. of\ individual\ species}{total\ number\ of\ samples}$)

H = the Shannon – wiener` index of diversity

S= number of species or species richness

H_{max} =Maximum diversity possible

E = Eveness = $H/_{Hmax}$

Margalef's index (d) measures species richness and diversity in the community structure. The equation below was applied in the calculation.

d= $\frac{S-1}{In(N)}$

Where: d = species richness index S = Number of species population N= Total number of individual species. Shannon and wiener (1949); Margalef (1967).

Statistical Analyses

One way Analysis of variance (ANOVA) was used to compare the relationship between physico-chemical parameters and macro invertebrate, to ascertain whether there is significant difference or otherwise. Pearson correlation coefficient of biological parameters was used to ascertain the degree of linear relationship between macro invertebrate and physicochemical parameters.

RESULTS

Physicochemical Parameters

The results of mean physicochemical parameters are presented in Table 1 to 3. Water temperature ranged between 19.6°C±1.12 (January, 2016) and 23.0^{0}C±1.00 (Site C in March, 2016). Dissolved Oxygen ranged between 6.1mg/L± 0.13 (site A in February, 2016) and 9.4mg/L ± 0.24 (site B in April, 2016). Electrical conductivity ranged between 161.3µS/cm±1.52 (site A in February, 2016) and 195.6µS/cm ± 0.57 (site A in January, 2016). pH ranged between 7.6± 0.20 (site D in February, 2016) and 8.2±0.25 (site B in January, 2016). Total Dissolved Solids was between 150.6mg/L ± 2.88 (site C in February, 2016) and 183.3mg/L±5.77 (site D in April, 2016). Turbidity values ranged between 18.8NTU±0.80 (site B in April, 2016) and 41.9NTU±0.26 (site B in Mach, 2016). BOD ranged between 3.0mg/L ±0.30 (site D in April, 2016) and 5.6± 0.25 (site C in Mach, 2016). The highest phosphate value of 0.3mg/L±0.03 was recorded in January at site B, white the lowest was 0.1mg/L ±0.05 in March at site A. Nitrate-nitrogen values ranged between 1. 2 mg/L± 0.19 (site B in April, 2016) and 3.5mg/L± 0.20 (site D in March, 2016). All the above physicochemical parameters showed no significant difference among the four sampling sites at p<0.05 except depth (1.5-20.3m) and BOD which differed significantly (p<0.05) among the sites. LSD test revealed that site B depth was significantly higher than those of the other sites which were not different from each other at p<0.05.

Table1: Mean Monthly Values of Surface Water Temperature, Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD) from Thomas Dam Dambatta, Kano (January to April, 2016)

Month		Temperature				DO				BOD		
Site	A	B	C	D	A	B	C	D	A	B	C	D
JANUARY	20.6±0.81	21.6±1.54	19.6±1.1	20.3±1.5	6.3±0.23	6.9±0.15	8.1±0.25	8.36±0.35	4.53±0.30	5.0±0.58	3.3±0.20	3.3±0.30
FEB	21.06±0.17	21.0±0.15[a]	20.6±0.57	19.6±0.57	6.1±0.15	6.5±0.26	7.1±0.15	8.2±0.11	4.2±0.55[a]	4.2±0.25	3.2±0.23	3.0±0.20
MARCH	21.3±0.57	21.0±1.00	2.0±1.00	20.3±1.52	7.4±0.05	7.6±0.20	8.0±0.15	7.9±0.35[a]	4.1±0.15[a]	4.7±0.10	5.63±0.25	3.3±0.41
APRIL	21.3±0.57	20.0±0.57	20.3±0.57	21.66±0.57	8.13±0.25	9.4±0.24	8.5±0.26	8.2±0.30	5.1±0.20	4.6±0.30	5.3±0.32	3.0±0.30

Values are mean±S.D, values with the same superscripts within the same column are considered significantly different (p > 0.05)

Table 2: Mean Monthly Values of Total Dissolved Solids (TDS), Electrical Conductivity (EC) and Turbidity from Thomas Dam, Dambatta Kano (January to April, 2016)

Month		TDS				E.C				Turbidity		
Site	A	B	C	D	A	B	C	D	A	B	C	D
Jan	170.0±10.00	163.3±15.27	170.0±17.03[a]	173.3±11.54	195.6±0.57[a]	187.7±2.40	193.0±2.01	186.8±1.72	37.0±0.55	20.8±0.57[a]	24.5±3.41	39.3±0.66
Feb	152.0±3.60	169.1±3.55[a]	150.6±2.88	176.6±5.77	161.3±1.52	160.8±1.90	161.1±3.95	168.3±0.30	36.1±0.37	35.6±3.90	20.10±0.95	19.3±1.32
March	160.0±10.00	151.3±15.55[a]	163.6±11.54	166.6±5.77	166.7±0.41	165.9±0.60	168.3±0.36	191.3±1.15	31.5±0.40	41.9±0.26	23.2±0.35[a]	36.5±0.35
April	180.0±10.00	163.3±5.57[a]	170.0±10.00	183.3±5.77	183.6±0.28	175.0±0.20	169.0±0.50	165.4±0.34	24.6±0.49	18.8±0.80	28.1±0.80	32.5±0.45

Table 3: Mean Monthly Values of pH, Phosphate – phosphorus (PO_4^{-3}) and Nitrate – nitrogen (NO_3^{-}) from Thomas Dam Dambatta, Kano (January to April, 2016)

Month		pH				PO_4^{3-}				NO_3-		
Site	A	B	C	D	A	B	C	D	A	B	C	D
January	8.03±0.15	8.26±0.25	7.8±0.30	8.2±0.26	0.1±0.01	0.3±0.03	0.1±0.32	0.1±0.02	1.1±0.03	2.1±0.02	1.1±0.02	3.1±0.55[a]
February	8.0±0.15	7.8±0.15	7.8±0.15	7.6±0.20	0.1±0.02	0.1±0.02	0.2±0.01	0.1±0.02	1.1±0.03	2.4±0.20	1.8±0.02	1.5±0.55[a]
March	8.1±0.10	7.9±0.05	7.7±0.15	8..1±0.10	0.1±0.005	0.1±0.01	0.2±0.02	0.1±0.05	2.1±0.03	2.1±0.01	2.1±0.02	3.5±0.20
April	8.0±0.11	8.0±0.10	7.7±0.20	7.9±0.05	0.1±0.00	0.1±0.00	0.1±0.01	0.8±0.01	3.1±0.02	1.2±0.19	1.1±0.03	1.3±0.07

Values are mean±S.D, values with the same superscripts within the same column are considered significantly different (p > 0.05)

Table 4: Benthic macro invertebrates Species Composition, Abundance and Distribution in Thomas Dam, Dambatta, Kano (January to April, 2016).

Taxa/ Species identified	Site A	Site B	Site C	Site D	Total	% Prevalence
Annelida						
Eclipidrilus sp.	5	6	1	7	19	1.6
Stylodrilus sp.	-	3	6	1	10	0.8
Isochaetide freyi	-	4	5	8	17	1.4
Limnodrilus sp.	3	5	2	1	11	0.9
Potamothrix sp.	14	12	5	-	31	2. 6
Tubifex sp	21	4	1	5	31	2. 6
Chaetogaster sp.	1	-	-	-	1	0.08
Pristina sp.	-	1	4	8	13	1.1 **(11.4%)**
Mollusca						
Valvata sp.	2	6	-	-	8	0.7
Bulinus sp.	16	13	23	8	60	5.1
Biomphalaria sp.	10	167	37	10	224	19.2
Ammicola sp.	11	23	-	4	38	3.2
Pisidium sp.	4	38	11	5	58	5.1
Helisoma sp.	3	14	3	1	21	1.8 **(35.0%)**
Arthropoda						
Ephemeroptera (may flies)						
Ameletus sp.	2	3	-	2	7	0. 6
Callibaetic sp.	2	2	5	1	10	0.8
Baetis sp	9	7	3	-	19	1. 6 **(3.0 %)**
Odonata (dragon flies and damsel flies)						
Ischnura sp.	-	-	-	1	1	0.08 **(0.08%)**
Hemiptera (waterbugs)						
Hesperocorixa sp.	2	5	-	3	10	0.8 **(0.85%)**
Plecoptera (stone flies)						
Diura sp.	4	-	-	7	11	0.9
Ostrocerca sp.	-	1	-	-	1	0.08
Leuctra sp.	6	12	11	-	30	2.7 **(3.6%)**
Coeloptera (beetles)						
Hydrobius sp.	32	111	50	103	296	25.3
Agabetes sp.	2	7	8	-	17	1.4
Stelelmis sp.	-	-	11	1	12	1.0 **(28.0%)**
Trichoptera						
Macrostermum sp.	7	1	9	7	24	2.0
Hydroptica sp.	9	-	11	1	21	1.9
Setodes sp.	10	1	-	2	13	1.1 **(4.96%)**
Diptera (true flies)						
Chaobrus sp.	17	12	1	3	33	2.9
Simulium sp.	1	45	21	-	67	5.7
Chelifera sp.	-	1	1	-	2	0.2
Odontomesa sp.	4	-	-	2	6	0. 5
Chironomus sp.	34	3	1	2	40	3.4 **(12.7%)**
Total Sample collected	231	508	230	197	1162	100
Percentage	19.8	43. 7	19.70	16.60	100	100

Table 5: Summary of the Diversity and Faunal Indices of Benthic Macro Invertebrates at the Study Sites.

Description (Indices)	Site A	Site B	Site C	Site D
Number of taxa	9.00	9.00	9.00	9.00
Number of species per site	26	27	23	24
No of individuals	231	508	230	193
Shanno-diversity (H)	0.94	0.91	0.92	0.82
Evenness (E)	0.85	0.90	0.84	0.75
Margalef's index (d)	4.62	4.19	4.15	4.33

Table 6: Correlations between macroinvertebrates and Mean Physicochemical Parameters at the Sampling Sites in Thomas Dam, Dambatta Kano, Nigeria (January – April, 2016)

	MIC	pH	TEMP.	DO	BOD	TDS	Turb.	EC	NO_3^-	PO_4^{3-}
MIC	1									
Ph	-.221	1								
Temp.	-.445	.791	1							
DO	-.162	-.349	-.702	1						
BOD	.637	-.310	.003	-.714	1					
TDS	-.581	.782	.482	.248	-.833	1				
Turb.	-.452	.967*	.796	-.217	-.493	.890	1			
EC	-.799	.749	.703	.013	-.707	.917	.893	1		
NO^-_3	-.371	.260	-.202	.812	-.952*	.759	.392	.520	1	
PO_4^{3-}	-.168	.581	.027	.543	-.814	.847	.626	.565	.904	1

*Correlation is significant at 0.05 level (2-tailed).

Benthic Macroinvertebrates Composition, Distribution and Abundance

A total of 1162 benthic macroinvertebrates belonging to 9 taxa with 33 species from four (4) sites of the dam were collected, sorted and counted (Table. 5). Among the identified taxa, phylum Annelida, phylum Mollusca and order Diptera were the most diverse consisting of eight (8), six (6) and five (5) species respectively. Order Ordonata, Hemoptera and Placoptera were the least diverse, each with one species (Table 4).

General Diversity (H) and Equitability

The values of taxa richness, diversity and equitability are presented in Table 5. Margalef's taxa richness was highest at site A (4.62) and the lowest numerical value at site C (4.15). Shannon diversity and equitability were highest at site A and the lowest at site D (Table 6). In the present study, benthic macroinvertebrates recorded decreased in the following order: Mollusca(3.50%) Coeleoptera (28%) > Diptera(12.7%) to >Annelida (11.4%) > Trichoptera(4.96%) > Placoptera (3.6%) > Ephemeroptera (3.0%) > Hemiptera (0.85%) > Ordonata (0.08%). The highest abundance of benthic macroinvertebrates was found in mollusca with 409 individuals accounting for 3.50% of all the species, followed by Coeloptera 325 (28%) and the least was Odonata (0.08%). However, among the sites, 508 individuals accounting for 43.7% were recorded from site B followed by site A 231 (19.7%) and the least was site D 193 (16.9%). Statistically significant difference were observed between sites at P<.0.05. *Hydrobius* sp. had the highest number of individuals 296, accounting for 25.34% of all the benthic macroinvertebrates (Table 4). The least species were *Chaetogaster sp Ischnura* sp. and *Ostracerca* sp.each with one (1) species representing 0.08% each. The variation in taxa and number of individuals during the study period were not significantly different at p<0.05.

Moreover presence of pollution tolerant species such as *Chironomus* sp .and *Tubifex* sp.accounted for 3.4% and 2.6% respectively. On the contrary, indicators of clean water in the orders Placoptera, Trichoptera and Ephemeroptera combined accounted for 7.3% of the benthic macroinvertebrates recorded in this study. Table 7, illustrates the modified Family Biotic Index (FBI) developed by Mandaville (2002) for indicating tolerance value to organic pollution by benthic macro invertebrates.

Table 7: Modified Family Biotic Index (FBI) indicating Tolerance value organic pollution by the macroinvertebrates at Thomas Dam, Dambatta (January to April, 2016)

Taxa	FBI value
Annelida	
Eclipidrilus sp.	5
Stylodrilus sp.	5
Isochaetide freyi	8
Limnodrilus sp.	10
Potamothrix sp.	8
Tubifex sp	10
Chaetogaster sp.	7
Pristina sp.	8
Mollusca	
Valvata sp.	8
Bulinus sp.	7
Biomphalaria sp.	7
Ammicola sp.	5
Pisidium sp.	6
Helisoma sp.	6
Arthropoda	
Ephemeroptera (may flies)	
Ameletus sp.	0
Callibaetic sp.	7
Baetis sp.	6
Odonata (dragon flies and damsel flies)	
Ischnura sp.	8
Hemiptera (waterbugs)	
Hesperocorixa sp.	5
Plecoptera (stone flies)	
Diura sp.	2
Ostrocerca sp.	2
Leuctra sp.	2
Coeloptera (beetles)	
Hydrobius sp.	5
Agabetes sp.	5
Stelelmis sp.	5
Trichoptera	
Macrostermum sp.	3
Hydroptica sp.	6
Setodes sp.	2
Diptera (true flies)	
Chaobrus sp.	8
Simulium sp.	5
Chelifera sp.	6
Odontomesa sp.	5
Chironomus sp.	10

Source: Mandaville (2002).

DISCUSSION

Physicochemical Parameters

The aquatic life in a water body is governed by physicochemical and biological conditions of the water body (Idowu and Ugwumba, 2005). Dallas (2004) pointed out that various physicochemical and biological circumstances must be simultaneously taken into consideration for understanding fluctuation of biological population in water body. In Thomas Dam Dambatta, limnological variables were observed to fluctuate slightly during the study period, across the physical parameters which include depth, temperature and turbidity. These parameters varied gradually from January to April. The monthly mean values of the physicochemical parameters were presented in Table 1 to 3. The temperature of the dam ranged from 19.6°C to 23°C. The maximum water temperature of 23°C was observed in March, which could be due to increasing photoperiod and longer day length (Mohan *et al.*, 2013). pH value recorded in this study (7.6-8.2)was observed to increase slightly from January to April the pH recorded fall within the acceptable limits of 6.5- 8.5 for fresh water bodies set by National Standard for Drinking Water Quality,(2007). In the present investigation Dissolved Oxygen ranged between 6.13-9.4mg/L which is quite satisfactory perhaps due to good aeration rate and photosynthetic activity as reported by Jaji *et al.* (2007). The distribution of Dissolved Oxygen in water body has been reported to be governed by a balance between input from the atmosphere, rainfall, photosynthesis and losses by the chemical and biotic oxidations (Muralidharan *et al.*, 2010 Nkwoji *et al.*, 2010). TDS in water consist of inorganic salts and dissolved materials. High values of TDS may lead to change in water taste and deteriorate plumbing and appliances (Pandey, 1997). The TDS values recorded in the dam varied from minimum of 150.6mg/L (February) to maxium 183.3 of (April). This falls within the maximum limit of 600mg/L set by Pandey (1997). Phosphates- phosphorus (0.13- 0.36mg/L) and Nitrate- nitrogen (1.26-3.50mg/L) values recorded were found to be low, but a slight variation was observed (Table 1- 3). This contradicts the findings of Umar and Bashir (2014) who recorded higher values of both nitrate and phosphate in their work on seasonal comparism of physicochemical parameters in Thomas Dam, Kano State. The lower values of phosphate and nitrate concentrations could be attributed to the sampling period; during which the water body was relatively stable with low run off and minimal wind action from the surrounding communities (Ibrahim *et al.*, 2009)

Benthic Macro Invertebrates

Presence or absence of macroinvertebrate in any given fresh water ecosystem is a function of a substrate quality, physicochemical condition and food availability (Jaji *et al.*, 2007; Sulaiman and Abdullahi, 2011). Thomas Dam serves as critical water source for various activities such as fishing, bathing, domestic purposes, recreation among others that were ongoing during the study period. Observation made at all the sampling sites showed that all the sites were impacted with varying degree of anthropogenic activities that contribute to the water quality degradation and exposing the users to risk of water borne diseases. This is in tandem with the findings of Inanc *et al.* (1998) who attributed surface water contamination to solid and liquid waste resulting from anthropogenic activities and deposited either along the banks, in storms drains or directly into the water body.

In Thomas Dam Dambatta, the abundance and diversity of benthic macroinvertebrate have positive correlation with the physicochemistry of the water (Table 7). The overall benthic macro-invertebrates recorded in this study comprised of Annelida (11.4%), Mollusca (35.1%) Ephemeroptera (3.0%), Odonata (0.08%), Hemiptera (0.85%), Plecoptera (3.6%), Coleoptera (2.8%) Trichoptera (4.96%) and Diptera (12.7%). The 9 taxa comprising of 116 in individuals recorded in this study was low when compared with 21 taxa reported by Akaahan *et al.* (2016) in River Benue, 27 taxa recorded by Emere and Nasiru (2009) in River Kaduna; 33 taxa recorded by John and Abdurrahman (2014) in wetlands Southern Nigeria, 55 taxa reported for tropical streams; Ogbeibu and Oribhabor, 2002 and Adakole *et al.* (2008). The low species diversity may be attributed to fluctuation in some physicochemical parameters such as low Dissolved Oxygen, high pH, high TDS and low Electrical Conductivity. These factors could probably cause disruption of life cycle, reproductive cycle, food chain and migration or imposed physiological stress on even the tolerant Macro fauna (Adakole and Annune, 2003). However, the number of taxa recorded in this study is higher than what was obtained by (Indabawa 2010) in River Challawa, Kano and Anyona *et al.* (2014) in River Mara Kenya, both recorded eight(8) taxa each of macro-invertebrates respectively. *Hydrobius sp* were relatively abundant in the dam accounting to 25.3% of all the species recorded. This may largely be due to high organic content especially at site A where farming activities takes place all year round. It could also be due to absence of vertebrate predators like fish within the site as reported by Ogbeibu and Orihabor (2002).

Arthropoda had the highest species diversity, among the three phyla accounting for 53.3%, followed by Mollusca (35.1%) and the least Annelida (11.4%). They appeared to have shown no habitat destruction as they were recovered in all the four sites during sampling. Their abundance could be due to tolerance to organic pollution. Oligochaeta for instance have been described as deposit feeders as such more tolerant to silting and decomposition than other groups of benthic organisms (Olumukoro and Victor, 2001). The presence of pollution tolerant species such as *Chrinomus* sp., *Tubifex* sp. *and Limnodrilus* sp. in all the sampling sites is an indication of the presence of pollution in a localized state, which can have a devastating effect not only on the aquatic flora and fauna but also on other terrestrial organisms including humans (Ibrahim, 2009).

The presence *of Chironomous* sp. (3.4%) in this study corroborates with that of Sharma *et al.* (2013) who recorded 3.42% of *Chironomous* sp. in his work on macro-invertebrates community diversity in relation to water quality status of River Kunda India. The value recorded in the present study is lower than that recorded by Anyona *et al.* (2014) who recorded 99% of family Chironomidae among the Dipterans in River Mara, Kenya.

However, the presence of Ephemoroptera species that are considered to be sensitive to environmental stress showed a relatively positive condition (Merrit and Cummins, 1996). The abundance of these species is an indication of good quality and may be due to habitat preference, dilution during rains and availability of food (John and Abdurrahman, 2014). Three (3) species of Coeloptera were recorded during the sampling period. They are known to be mostly associated with lentic water bodies such as ponds and lakes as they are sheltered by macrophytes. With regards to Trichoptera that are known to be indicators of good water quality, three (3) species were recorded which were considered low when compared with the findings of Imoobe and Ohiozebau, (2009) in River Okhuo, Benin City, Nigeria. The presence of Trichoptera species may be attributed to the habitat in which they usually survive that is lotic waters with high level of Dissolved Oxygen. Their presence perhaps indicates that they were carried by surface run off into the dam. The relative abundance of Diptera species (12.7%) recorded in this study might be favoured by the conditions of the immediate substrates which include the alkalinity of the study area (Wallace and Hyne (1981)

Similarly, the total number of 33 species in this study was lower than that of Indabawa (2010) who recorded 67 macro-invertebrates species at Challawa River, Kano State and Kefas *et al.* (2015) that recorded 433 species at lake Geriyo, Yola, Adamawa State. Apart from order Ephemeroptera and Placoptera all other benthic macroinvertebrates recorded belong to the tolerant taxa which are indicators of organic pollution. This could be due to fluctuations in the physicochemistry of the water body such as oxygen depletion due to oxidation of iron, accumulation of sediments from irrigation run off (Emere and Dibal, 2009; George *et al.*, 2009).

The obvious change in the occurrence of benthic macro-invertebrate during this study showed that Thomas Dam experiences introduction of organic pollutant and fluctuation in physical and chemical condition of the water body. These factors may lead to the disappearance of some benthic macro-invertebrates. Yap *et al.* (2003) made similar observation that natural variation in a water body conditions played a major role in the distribution of benthic animal's community. Therefore, the diversity and abundance of the benthic macro-invertebrates frequently change in response to pollution stress in predictable ways as observed in the present study.

CONCLUSION AND RECOMMENDATIONS

The benthic macro-invertebrates at Thomas Dam, Dambatta during the study period were dominated by three phyla Annelida, Mollusca and Anthropoda. The occurrence of pollution tolerant species and pollution sensitive species in the water body is an indication of increase in environmental stress through anthropogenic activities, which may in turn facilitate the biodegradation of the dam. The status of water quality in the dam is not very clean because it is moderately polluted hence if not well monitored the dam may pose health risks to local residents who use the dam for different domestic purposes. Therefore, there is a need to regularly monitor and control the source of pollutants in the dam. Biological indicators and their indices should be adopted for use by relevant authorities as tools for assessing the condition of the dam. Government at all level and regulatory authorities should enforce pollution abatement laws in order to conserve and preserve biodiversity with view of protecting the healthy living of the environment and proper management of the dam.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest

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