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Biodiversity Assessment of Some Benthic Macro Invertebrates in Ajiwa Reservoir, Katsina State, Nigeria

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Abstract
Benthic macro invertebrates represent a useful tool in the evaluation of environmental quality through studies of the structure of communities and their relationship to anthropic activities within a reservoir. The objective of this study was to assess diversity of some benthic macro invertebrates in Ajiwa reservoir. The study was carried out from September, 2014 to August, 2015. Benthic macro invertebrate samples were collected with the aid ofEkman grab at 5 different sampling locations once monthly. Samples collected were sieved with a set of Tyler sieves of 20cm diameter and mesh sizes of 2mm, 1mm, and 150µm respectively and transferred into labelled plastic storage bottle and preserved with 4% formalin prior to sorting and identification with the aid of some keys. Twenty four (24) taxa from a total of 1420 individual's organisms were recorded. These include 5 species each of Mollusca and Diptera, 1 species of Odonata, 4 species of Hemiptera and 3 species each of Coleoptera, Oligochaete and Nematoda. The relative percentage composition of the major taxonomic groups to the overall macro benthic population at the different stations revealed that the study area was inhabited by Oligochaete (40.28%), Molluscs (24.08%), Diptera (19.29%), Odonata (5.78%), Coleoptera (3.94%), Nematodes (3.38%) and Hemiptera (3.24%).The indices of general diversity (H), evenness (E), dominance and relative abundance were in the following order of increasing magnitude: station 5 > station 1 > station 4 > station 2 and > station 3 respectively. Factors which influenced the abundance and distribution of invertebrates; including the nature of the water body, habitat richness and stability, immediate substrate, tropic condition, resource partitioning and predation coupled with habitat differences observed in this study, acted singly or in combination to influence the variation in abundance of benthic macro invertebrate of Ajiwa Reservoir.
Keyword: Abundance, Assessment, Benthic, Biodiversity, Invertebrates, Reservoir.

INTRODUCTION

Lakes are stagnant water bodies with unique faunal compositions. Organisms living in such habitats are known to show some morphological differences from those found in flowing water bodies (Vadeboncoeur, *et al.*, 2002). Benthic macro invertebrates are organisms that are found on the substrata of an aquatic ecosystem (Dernie, *et al.*, 2003). Their densities are customarily highest in regions that contain dense growth of macrophytes (Beaty, 2004). According to Jayne and Joann (1999) an impoverished macro-invertebrate benthic fauna community could be attributed to the physico-chemical and geochemical nature of the sediment (fertility), water depth, sediment type, water current and sediment erosion due to intensive farming and clearing of ground cover which cause silting and adverse effect on the macro-invertebrate benthic community.

Macro invertebrate community plays significant role in many ecological processes in lakes and rivers (Dernie, *et al.*, 2003). They also play a key role in bioaccumulation and transfer of contaminants to higher trophic level in aquatic and as well as terrestrial food webs (Harold, *et al.*, 1998). Macro invertebrate's communities have an important influence on matter transportation and energy budget in the lake ecosystem, they thus become attractive targets of biological monitoring in aquatic ecosystems (Jansson, *et al.*, 2000). Benthic macro invertebrates form an integral part of an aquatic environment and are of ecological and economic importance (Efitre, *et al.*,2001). They also play a key role in mineralization of organic matter and serve as food for economically important fish and shellfish species in most aquatic environments (Furey,*et al.*, 2006). The relative stability of benthic communities and their sensitivity to changes in the aquatic environment have made many species as bio-indicators of water quality (Ogbeibu andOribhabor, 2001). Their long larval life cycles allow studies conducted by aquatic ecologists to determine any decline in environmental quality (Ajao and Fagade, 2002).

Benthic macro invertebrates (bottom-dwelling organisms including aquatic insects, crayfish, clams, snails, and worms) are often used in studies to determine the quality of waters because of their high numbers, known pollution tolerances, limited mobility, wide range of feeding habits, varied life spans, and dependence on the land environment around the water bodies (Usman, 2016). Within the aquatic communities, benthic macro invertebrates represent one of the groups most affected by reservoir construction. These organisms inhabit river, lake, and reservoir bottoms, and their distribution is directly related to food availability and quantity, sediment type, substrate and water quality (Godwin, 2015).

Data on macro benthic community distribution and structure have been used in ecological monitoring programs, and is an important ecological tool to describe spatial and temporal changes (Leal and Esteves, 1999). Depending on the distance between the dams along the river, reservoir systems have the potential to increase river impoundment effects on aquatic organism composition and distribution. A change in the richness/diversity of benthic macro invertebrates is to be expected along the reaches and sections, in accordance with the use of the drainage basin (Godwin, 2015). This study had as its major objective to evaluate macro invertebrate diversity and also differences between the regions and reaches, while using these organisms as water-quality bio indicators.

MATERIALS AND METHODS

Study site

Ajiwa reservoir is located at Batagarawa Local Government Area of Katsina State on latitude and longitude 12°54'69" - 12°57'58" N and 7°42'53" - 7°47'50" E (Figure1). It is in the Sudan savannah zone of Nigeria with two distinct seasons (wet and dry). The wet season period on the average last from May to October and dry season from November to April. The main purpose of the reservoir is irrigation and water supply to the people of Katsina, Batagarawa, Mashi, and Mani local government areas. The reservoir was constructed in 1973 and commissioned in 1975. Its major source of water is river Tagwai. It has original height of 12m but after being rehabilitated in 1998 the height is now 14.7m, original reservoir crest length was 880m, but after being rehabilitated reservoir crest length is now 1491.8m. It also has surface area of 607.0ha. The storage capacity of the water is about 22,730,000m^3 (Parkman and Haskoning, 1996). The reservoir serves as source of livelihood to the nearby communities such as Ajiwa, Masabo, Tsagero, Kwatami, Maje and Gajerengiwa villages.

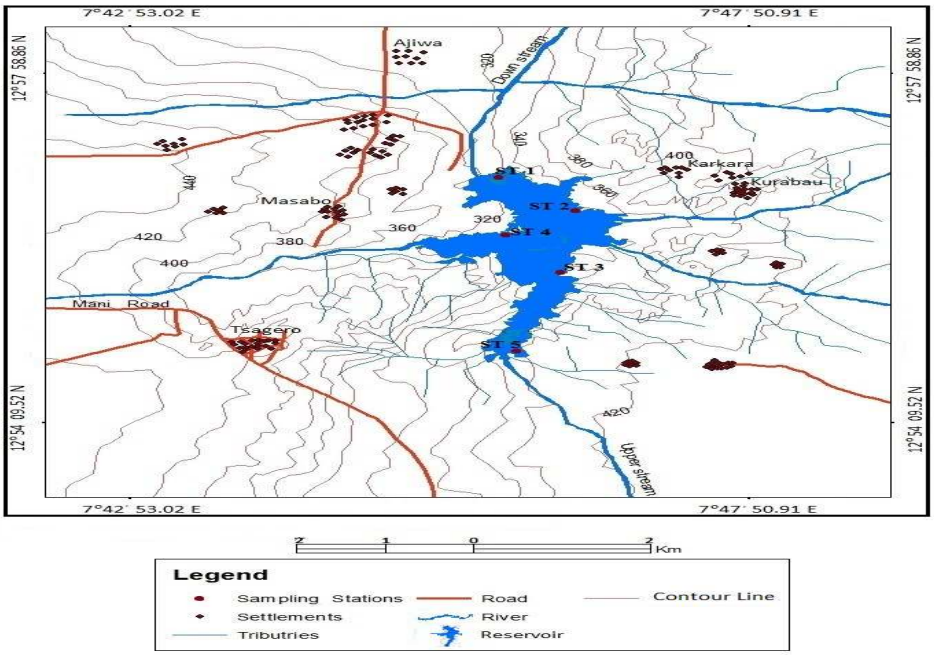

Figure 1: Map of Ajiwa reservoir Katsina state Nigeria, showing sampled stations. (Source: NASA/NOAA Spot Image 2014).

Sampling techniques

Sampling of macro benthic fauna was carried out monthly around 7:30am from each sampling stations using an Ekman grab from all the five sampling locations.At each station, 3 grabs were taken, dredge materials and samples of the periphytic macrofauna on rocky substrates were collected and sieved with a set of Tyler sieves of 20cm diameter and mesh sizes of 2mm, 1mm, and 150µm respectively. The remaining benthic samples were washed through a sieve of 1mm x 1mm mesh size to collect the benthos. The residues were immediately transferred into labelled plastic storage bottle and preserved with 4% formalin. In the laboratory, Sorting was done by pouring out the contents of each jar into separate large plastic basin. Sample was picked with the aid of a pair of forceps or a pipette as required. Dissecting and compound microscope was used for the identification of the specimens. The identification of the benthic macro-invertebrates collected in the study were based mainlyon the keys provided by Horst (1965); Klemm, *et al*. (1990); Olomukoro and Egborge (2003); Thompson (2004); Bouchard (2004) and Verma (2006).Description of specimens of taxa was based on scale drawings, photographs and/or microphotography of parts.

Fauna diversity of the macro benthic community was determined using biological indices such as Magalef"s index (d), Shannor-Weiner index (H) and Evenness (E).

RESULTS

The overall macro benthic invertebrate composition, distribution, abundance and frequency of occurrence in the study stations are shown in Table 1 and 2. Twenty four (24) taxa from a total of 1420 individuals were recorded. These include 5 species each of Mollusca and Diptera, 1 species of Odonata, 4 species of Hemiptera and 3 species each of Coleoptera, Oligochaete and Nematoda. Figure 2, present a summary of the relative percentage composition of the major taxonomic groups to the overall macro benthic population at the different stations revealed that the study area was dominated by Oligochaete (40.28%), Molluscs (24.08%), Diptera (19.29%), Odonata (5.78%), Coleoptera (3.94%), Nematodes (3.38%) and Hemiptera (3.24%). These groups were well represented in the five stations.

Table 1: Distribution and abundance of benthic macro invertebrate population in Ajiwa reservoir Katsina State, Nigeria (individual/metre)

Taxon	Station 1	Station 2	Station 3	Station 4	Station 5
Mollusca					
Bulinus sp	46	12	8	52	74
Biomphalaria glabrata	24	8	2	34	16
Lymanea stagnalis	2	0	0	12	4
Anodonta anatine	4	0	0	2	8
Pila ovate	0	2	4	2	26
Diptera					
Chironomus borealis	38	14	2	8	4
Culex richeti	44	26	12	28	52
Tanytarsus africanus	16	8	2	0	4
Polypedilum pedestre	0	0	0	0	8
Tanypus sp	2	0	0	0	6
Odonata					
Lestes dryas	18	4	2	22	36
Hemiptera					
Hebrus sp	4	2	0	14	6
Nepa sp	0	0	0	2	2
Plea sp	2	4	0	0	0
Notonecta undulate	0	0	0	2	8
Coleoptera					
Acilus sulcatus	6	2	0	12	18
Dyticus marginalis	2	0	0	2	6
Amphiops gibbon	4	2	0	0	2
Oligochaeta					
Nais sp	66	24	18	12	134
Aulophorus vagus	2	0	0	0	6
Lumbricula sp	54	128	14	2	112
Diplogaster sp	4	2	0	0	4
Dorylaimus stagnalis	2	6	2	4	0
Haplolaimus sp	0	0	0	6	18
Total No. of Organisms	**340**	**244**	**66**	**216**	**554**
No. of species	**19**	**14**	**10**	**17**	**22**

Table 2: Composition, distribution and abundance of benthic macro invertebrates in Ajiwa reservoir Katsina state

	Station									
Taxon	**1**	**2**	**3**	**4**	**5**	**T**	**D _D**	**S _1-D**	**S_H**	**E_e^ H/S**
Benthic Macro Invertebrate (Individual/Metre)										
M	76 (22.22)	22 (6.43)	14 (4.09)	102 (29.82)	128 (37.43)	**342 (24.08)**	0.28	0.72	1.37	0.79
D	100 (36.50)	48 (17.52)	16 (5.84)	36 (13.14)	74 (27.01)	**274 (19.29)**	0.26	0.74	1.46	0.86
O	18 (21.95)	04 (4.88)	02 (2.44)	22 (26.83)	36 (43.90)	**82 (5.77)**	0.32	0.68	1.29	0.72
H	6 (13.04)	6 (13.04)	00 (0.00)	18 (39.13)	16 (34.78)	**46 (3.24)**	0.31	0.69	1.27	0.89
C	12 (21.43)	04 (7.14)	00 (0.00)	14 (25.00)	26 (46.43)	**56 (3.94)**	0.33	0.67	1.22	0.85
Ol	122 (21.33)	152 (26.57)	32 (5.59)	14 (2.45)	252 (44.06)	**572 (40.28)**	0.31	0.69	1.30	0.73
N	06 (12.50)	08 (16.67)	02 (4.17)	10 (20.83)	22 (45.83)	**48 (3.38)**	0.30	0.70	1.38	0.79
	340 (23.94)	244 (17.18)	66 (4.65)	216 (15.21)	554 (39.01)	**1420**				

Key: M = Mollusca, D = Diptera, O = Odonata, H = Hemiptera, C = Coleoptera, Ol = Oligochaeta, N = Nematoda, D = Dominance_D, S = Simpson_1D, Sh = Shannon_H, Ev = Evenness_e^H/S, T = Total

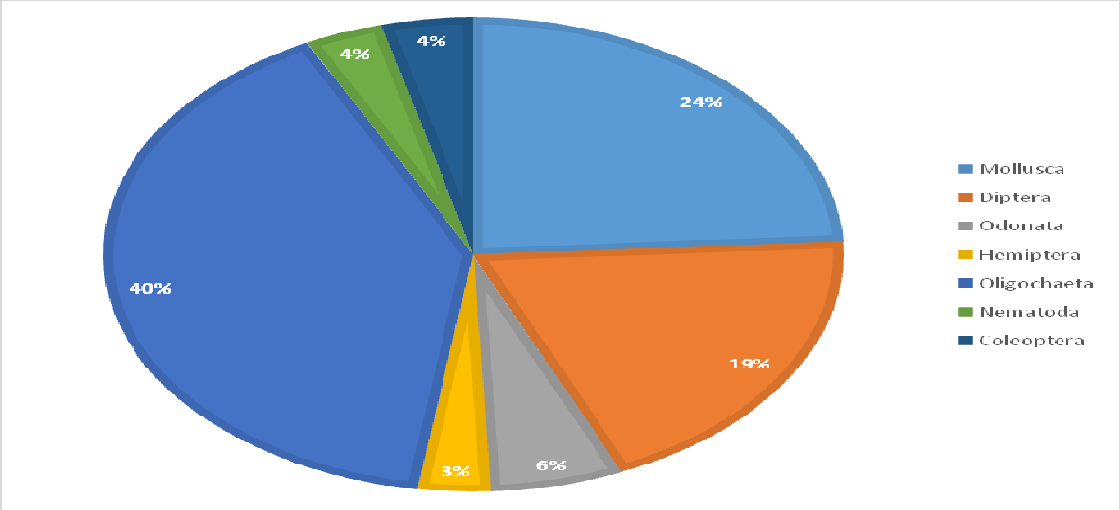

Figure 2: Relative percentage composition of some Benthicmajor taxonomic groups in Ajiwa Reservoir Katsina State.

Some inhabited groups in station 1 includes Diptera (36.50%) mainly represented by *Chironomus* sp and *culex* sp. Molluscs (22.23%) mainly represented by *Bulinus* sp and *Biomphalaria* sp. Odonata (21.95%) mainly represented by *Lates dryas*. Coleoptera (21.43%) mainly represented by *Acilus* sp and *Dysticus* sp, Oligochaetes (21.33%) mainly represented by *Nais* sp and *Lumbricula* sp, Hemiptera (13.04%) mainly represented by *Hebrus* sp and *Plea* sp, and Nematodes (12.50%) mainly represented by *Diplogaster* sp and *Dorylaimus* sp. In station 2, Oligochaetes (26.57%) were the most dominant group followed by Diptera (17.52%) and Nematodes (16.67%). Hemiptera (13.04%), Coleoptera (7.14%), Mollusca (6.43%) and Odonata (4.88%) were the sub-dominant groups. Similarly, in station 3, the Diptera (5.84%), Oligochaetes (5.59%), Nematodes (4.17%), Mollusc (4.09%) and Odonata (2.44%) were the most common groups. Hemiptera and Coleoptera were not found in station 3. In station 4, Hemiptera (39.13%) were the most dominant group, followed by Mollusca (29.82%), Odonata (26.83%), Coleoptera (25.00%) and Nematodes (20.83%). Diptera (13.14%) and Oligochaetes (2.45%) were the sub-dominant groups. Lastly In station 5, Coleoptera (46.43%) were the most dominant group, followed by Nematodes

(45.83%), Oligochaetes (44.06%), Odonata (43.90%) and Hemiptera (39.13%). Mollusca (37.43%) and Diptera (27.01%) and were the sub-dominant groups.

The indices of general diversity (H), evenness (E) and dominance calculated for the five stations are presented in Table 3. Although diversity was higher at station 1, station 4 and station 5. Evenness, dominance and relative abundance were higher in the following order of increasing magnitude station 5 > station 1 > station 4 > station 2 and > station 3 respectively.

Table 3: Diversity of some benthic macro invertebrate fauna in Ajiwa reservoir Katsina State

Indices	STN 1	STN 2	STN 3	STN 4	STN 5
No. of Taxa (S)	19	14	10	17	22
No. of Individuals	340	244	66	216	554
Relative Abundance (%)	23.94	17.18	4.65	15.21	39.01
Magalef"s index (d)	4.83	4.36	3.97	4.67	4.91
Shannon-Wienner's index (H)	1.43	1.32	1.25	1.38	1.46
Evenness index (E)	0.86	0.79	0.72	0.84	0.89

STN- Station

DISCUSSION

The result of benthic macro invertebrates revealed that a total of twenty-four benthic macro-invertebrate species made up of seven classes were recorded in Ajiwa reservoir, these community structure comprising dominant groups in this increasing order of magnitude Oligochaetes> Molluscs > Diptera > Odonata> Coleoptera> Nematodes > Hemiptera.

Oligochaetes (*Lumbricula* sp) were relatively abundant in the reservoir and well represented. The chironomid larvae (filter feeder) were abundant species in the reservoir. This might be due to high organic content of the reservoir as in the case of other tropical waters (Leveque,*et al*.,1983; Harrison, 1987;Hansen, *et al*., 1998; Olomukoro and Oviojie, 2015). High abundance of the diptera species was observed in wet season. High abundance of Hemiptera as well as the Coleoptera was observed in some stations of the reservoir. This may be attributed to the absence of predators like Fish (Ogbeibu and Oribhabor, 2001; Beaty, 2004). The Oligochaeta and Mollusca showed no habitat restrictions as they occurred in abundance in the five stations. Oligochaeta can also be described as deposit feeders, as such more tolerant to silting and decomposition than other groups of benthic organisms (Olumukoro and Victor, 2001).

Generally, across the stations in the reservoir, Organisms were high in abundance in the wet season compared to dry season. Species diversity as a measure of species richness in the study area was generally high in the reservoir with relatively similar values recorded in some stations.

There was a general increase in the richness of organisms during the rainy season especially in the months of August and September; this is because of high influx of nutrient from the surrounding farm lands. Station 5 recorded the highest species richness, while station 1, 2 and 4 had more organisms in abundance as compared to station 3. However, evenness index revealed that macro benthic organisms were evenly distributed across the stations.

In comparison to the available studies of inland waters the macro-invertebrate benthic species recorded in Ajiwa reservoir can be considered to be rich in taxa distribution but poor in the total of individuals collected during the sampling period. For instance, in Ajiwa reservoir twenty-five species comprising 1420 individuals were recorded for twelve months of the sampling period, while in Opa reservoir seven species comprising 378 individuals were recorded (Nathaniel, 2001). 12,076 individuals in Bindare and Galma rivers (Adakole and Annune, 2003). In Lake Kainji (the largest man-made lake in Nigeria) thirteen species comprising 23,261 individuals were recorded (Taiwo, 1983), forty-one taxa comprising of 4,614 individuals (Ogbeibu and Oribhabor, 2001), eighty-nine taxa comprising 2,535 individuals (Edokpayi and Osimen, 2001). Factors which influenced the abundance and distribution of invertebrates; nature of the water body, habitat richness and stability, immediate substrate, tropic condition, resource partitioning and predation (Mbagwu, *et al*., 1992; Ogbeibu and Oribhabor 2001; Olomukoro and Oviojie, 2015). These factors, coupled with habitat differences observed in this study, acted singly or in combination to influence the variation in abundance of macro invertebrate of Ajiwa Reservoir.

CONCLUSION

Ajiwa reservoir is considered to be rich in taxa distribution, a trend was also observed in some regions of the reservoir, this may be attributed to the abundance of light, shelter and food supply to these areas of the reservoir.

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