ASSESSMENT OF ZOOPLANKTON IN RELATION TO PHYSICOCHEMICAL PARAMETERS AFTER POST-DREDGING OF AHMADU BELLO UNIVERSITY (ABU) RESERVOIR ZARIA, KADUNA STATE, NIGERIA

Supported by tetfund

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Received: March 9, 2021 **Accepted:** June 10, 2021

Abstract: Assessment of Zooplankton in relation to physicochemical parameters after post-dredging of Ahmadu Bello University (ABU) Reservoir Zaria, Kaduna State Nigeria was investigated. Five sampling stations were selected for the collection of water samples, Zooplankton and physicochemical parameters. Data collected were subjected to One-Way Analysis of variance and mean separation using Duncan Multiple Range Test, Canonical Correspondent Analysis was used to determine the influence of physicochemical parameters on Zooplanktons, Shannon – Wiener diversity index was used to determine the species richness and diversity of Zooplankton in ABU Reservoir using Paleontological Statistical Software Package (PAST) V.2.17c and SAS version 9.1.3. The results on Zooplankton population may have been regulated by other factors (such as dredging and post-dredging activities). Water parameters show weak contribution in controlling Zooplankton population. Total of 587 Zooplankton comprising 4 Classes, 11 Families and 13 Species were recorded. Zooplankton in monthly variation; July dominated with 161(27.4%) in wet season but least in March 59(10.1%) in the dry season while in seasonal variation; the highest was recorded in wet season 340(57.9%) and lowest in dry season 247(42.1%). Therefore, the presence of pollution bioindicators such as: Rotifers, Oligochaeta, Dragon fly nymph and Chydorus species indicated that ABU reservoir is likely polluted. Also proper conservation and restorative strategies should be directed towards improving the reservoir, biodiversity and productivity of ABU reservoir.

Keywords: Aquatic, biodiversity, post-dredging assessment, physicochemical parameters, zooplankton

Introduction

Plankton are minute free floating or drifting aquatic organisms found in open waters, they form the base for aquatic food chain and maintain fish stock around the globe (Kumar and Kumar, 2015). Also Zooplankton (From Greek word: Zoon, animal; planktons, wandering) are myriads of diverse floating or drifting aquatic animals living suspended in the water column with limited swimming ability whose distributions are closely tied to the movement of the water mass in which they reside. Majority of them are microscopic (Ojutiku *et al*., 2017; Dhan *et al*., 2019). The plankton community is composed of Phytoplankton (Primary Producers) and Zooplankton (Secondary producers) (Davies *et al*., 2009). Zooplankton are important biotic component in energy transfer between Phytoplankton and other aquatic animals. Zooplankton in association with Phytoplankton makes up the planktonic food supply (Srivastava *et al*., 2017). Zooplankton abundance, composition and species diversity are used as bio-indicator of aquatic health (Contreras *et al.,* 2009; Muhammad *et al.,* 2016; Dhan *et al.,* 2019).

Zooplanktons are divided into two categories which include h oloplankton or permanent (Rotifer, Cladoceran, Protozoa and Copepod). Meroplankton (temporal)these organism that are planktonic for only a part of their life cycle, usually the eggs, larvae and juveniles stages of aquatic fauna (e.g. Fishes). While the former ones are distributed throughout the year (Kolo *et al.,* 2010), the latter forms are only seasonal in occurrence and are generally found distributed in shallow neritic waters (Arazu and Ogbeibu, 2017) and in mangroves (Ojutiku *et al*., 2017). Zooplankton abundance and species composition is used as an indicator of physical, chemical, and biological condition of the Reservoir (Contreras *et al.,* 2009; Rajagopal *et al.,* 2011; Muhammad *et al.,* 2016; Dhan *et al.,* 2019). Hence, there is little or sparse information on assessment of Zooplankton in relation to physicochemical parameters after post-dredging of ABU Reservoir Zaria, Kaduna State Nigeria. Therefore, the investigation aimed at assessment of zooplankton in relation to physicochemical parameters after post-dredging of ABU Reservoir Zaria, Kaduna State Nigeria

Materials and Methods

The study was carried out at ABU Reservoir which was constructed in 1972 with the catchments area of 57 km^2 (22square miles), width of 122 m (400f), mean depth of 6 m (Abolude, 2007). Its width is located between latitude 11^{0}08'N -11^{0}09'N and longitude 7^{0}38'E - 7^{0}39' E to South of Ahmadu Bello University Zaria at an elevation of 2111 ft above sea level. ABU reservoir serves as the major source of water supply to Ahmadu Bello University and its environs Zaria which lies in the northern guinea savannah zone, within 11^{0}3'N, 7^{0}42'E, a region that has a tropical Savannah climate with distinct wet (May-October) and dry (November-April) Seasons. The reservoir two major tributaries are Samaru and Kampangi streams, the reservoir was last dredged in the year 2014 and 2015.

Based on the preliminary survey of the reservoir particularly the size, water level, fluctuations, nature of prevailing wind and seasons, 5 sampling stations were selected along the ABU reservoir based on the accessibility and the anthropogenic activities. Samples of water and Zooplankton of the reservoir were collected monthly from March to August which covered the peaks of the dry and rainy seasons. Samples were collected between 7:00 am and 09:00 am.

Station 1: Located (Lat: 11^o 8'N Long 07^o 38'E) at an elevation of 1650 m above sea level and Reservoir area of 57 km^2 and mean depth of 6 meters. Activities are canoe ridding, fishing, and waste run-off from Samaru stream with effluent from Samaru market.

Station 2: Located on Lat. 11^o 08'N Long. 07^o 39'E at an elevation of 1250 m also include human interference, grazing, and fishing is located behind Postgraduate School and waste treatment plant.

Station 3: Located towards the middle of the reservoir on Lat. 11º 08ˈN Long 07º 39ˈE at an elevation of 1000 m, profounder central open water Zone with less human interference an area with mainly fishing, and also an area of sedimentation coming from Samaru and Kampangi stream leading through the center of the reservoir then through the spill-way at station 4, Station 3 appears to be less disturbed compared to stations 2 and 1.

Station 4: is located along the spillway (11º 8ˈN-7 º 39ˈE) at an elevation of 850 m, at the spill-way of the reservoir with a deep strong current flow through the spill-way during rainy season. Activities around this station include grazing, fishing and picnicking.

Station 5: Most of the streams course in this station is located along Kampangi stream up-towards Abu phase two at an elevation of 750 m.

Zooplankton samples were collected with silk plankton net of 25 cm diameter and 70 mesh/cm attached with a collection bottle of 50 ml capacity at the base. The net was sunk just below the surface and then towed through a distance of 1 m. The obtained sample was then poured into plastic bottle of 60 ml capacity and preserved in 4% formalin and took to the laboratory for sorting and viewing (Agnieska *et al.*, 2012). Plankton collection, preservation and identification were done according to (Jeje and Fernando, 1986).

Zooplankton samples were collected from the same location with physicochemical samples parameters in order to ensure maximum correlation of findings (APHA, 2005). The plankton net was towed through the water at a distance of 1m at each sampling station. Zooplankton were collected by hauling or towing a finely woven silk plankton nets mesh size of (<20 µm) and (>50 µm) behind a vessel or streaming nets out from a fixed object in a swift current. Sample per tow was collected in a plastic graduated bottle of 60 ml capacity and was preserve in a 4% formaline prior to identification and analysis (APHA, 2005). Species identification was done through the use of various identification keys described by Dhan *et al.* (2019). Larger specie of Zooplankton of five millimetres long was seen with the naked eyes e.g. *Dapniapulex, Busmina* and *Magma* while other species were seen with the aid of a microscope (Dhan *et al.*, 2019). Identification of Zooplankton species was performed under the light source microscope by utilising keys of standard references (Pennak, 1978; Adoni *et al.*, 1985).

Data analyses

Data were collected both during dry and rainy season, one way Analysis of variance (ANOVA) was used to determine the mean monthly variation in physicochemical parameters of ABU Reservoir. Canonical correspondent analysis (CCA) was used to determine the influence of physicochemical parameters on Zooplankton composition ofABU Reservoir. The means was separated using Duncan Multiple Range Test (DMRT). Shannon – wiener diversity index was used to determine the species richness and diversity of Zooplankton in ABU Reservoir. Paleontological Statistical Software Package (PAST) V.2.17c and (SAS) version 9.1.3 was used to determine the influence of physicochemical parameters on Zooplankton (Shannon and Wiener, 1949) Statistics Analysis System (SAS) version 9.13 (2005) was used.

Results and Discussion

The results in Table 1 revealed the mean monthly variation of Zooplankton in ABU reservoir in relation to months recorded 11 Species from 4 Classes of Zooplankton identified include Protozoa, Rotifers, Copepod and Cladocera. The zooplankton richness and composition in ABU reservoir was generally low. Variation in Zooplankton number and composition could be due to differential response to variation in the environmental requirement. The low abundance of Zooplankton may be attributed to periodic changes in the ecosystem brought about by seasonal variation in the environmental conditions. This may directly or indirectly alter the reproduction time and rate depending upon availability of food, competition, predation and mortality as evident by location variation in the density and composition of Zooplankton. The Species richness in this study was lower compared with report on other water bodies by Usman and Yerima (2017) who reported 31 species belonging to four classes in Ajiwa reservoir Katsina State Nigeria, and Tanimu (2012) who reported a total of 54 species of Zooplankton with medium diversity index more 1.5 in Lake Tiga Kano State. Sharma *et al.* (2015) also reported 21 species in Lake Ribadu Adamawa State and Usman *et al*. (2019) also reported 21 species in River Kashimbila, Takum, Taraba State. The reason for low species richness in ABU reservoir could be due to its high pH, low Dissolved Oxygen and low conductivity (Adakole and Annune, 2003; Edokpayi *et al.,* 2016).

The mean monthly distribution of protozoa showed that the density of protozoa was high during the months of June and no occurrence was recorded in the month of March, April, May and August. The mean occurrence of protozoa was significantly associated with month and season. The month of June had the highest occurrence of protozoa while July had the least occurrence. Rotifers is represented by (3) Species of *Keratella* sp, *Rotifer branchionus* sp, and *Ostracode* sp, rotifers had its highest monthly distribution in the month of April and least in June. The occurrence of rotifers showed significant association with month and season and the month of April in the dry season had the highest occurrence while month of March had the lowest occurrence, no occurrence was observed during the remaining months of the Sampling. In Tables 1 and 2, the occurrences of rotifers were significantly affected by month and season.

Copepod is represented by (3) Species of *Cyclop* sp, *Cyclopoid* sp and *Calanoid* sp. The highest mean monthly distribution of copepod occurred in the month of May and the least in March. There was no occurrence during the remaining month of the research (Table 1). There was significant association in copepod occurrence with month and season with the month ofMay and March being the highest and lowest in the dry season, respectively. *Cladocera* is represented by Species of *Bosmina* sp, *Ceriodaphnia* sp, *Daphnia* sp, *Diaphanosoma* sp and *Chydorus* sp. The peak number of mean monthly distribution of Cladocera occurred in the month of July and the least in June and no occurrence was recorded during the remaining month of the research (Table 1). Cladoceran occurrence showed significant association with month and season with the month of July being the highest in the wet season. The progression in low abundance of zooplankton in the month of March in this study is similar to the findings of Usman and Yerima (2017) who reported low zooplanktons in March. This could be related to disturbed flow of the reservoir.

Table 1: Monthly variation in zooplankton composition and distribution in ABU Reservoir

Class/Species (13)	March	April	May	June	July	August	Total	Diversity Index
PROTOZOA								
Euglena	0	0	0	10	6	0	16	0.662
Paramecium	0	0	0	34	15	0	49	0.616
							65	
COPEPOD								
Calanoida	0	0	0	31	40	13	84	1.001
Cyclop	10	0	41	0	0	0	51	0.495
Cyclopoid	0	0	12	0	0	0	12	0.001
							147	
ROTIFER								
Rotifer Branch	5	39	37	0	41	0	122	1.224
Keratella	0	25	0	21	0	0	46	0.689
Ostracod (Cypris)	0	0	0	0	0	28	28	0.001
							196	
CLADOCERAN								
Bosmina	18	0	26	0	0	0	44	0.677
Daphnia	26	0	0	0	0	0	26	0.001
Ceriodaphnia	0	0	8	16	6	0	30	1.001
Diaphanosoma	0	0	0	0	53	0	53	0.001
Chydorus	0	0	0	0	0	26	26	0.001
							179	
TOTAL	**59(10.1%)**	**64(10.0%)**	**124(21.1%)**	**112(19.1%)**	**161(27.4%)**	**67(11.4%)**	**587**	

Low= 0-1 Medium=1.1-2 High= 2.1-3

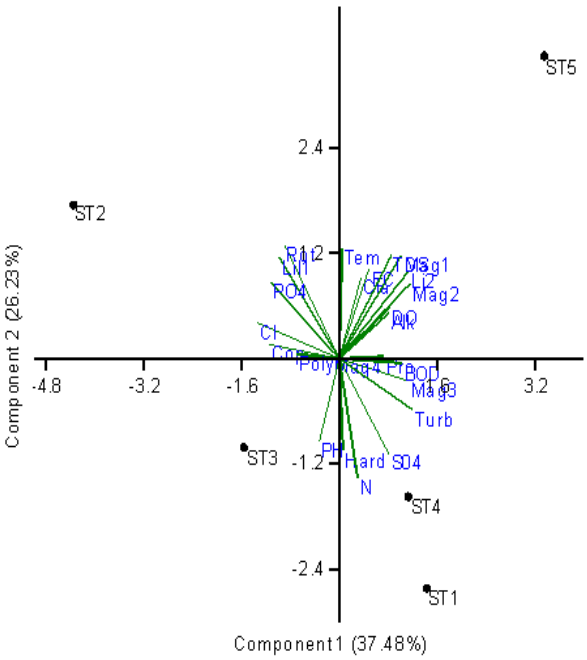
Table 2: Seasonal Variation in Zooplankton Composition and Diversity in ABU Reservoir

Family (11)	Species (13)	Dry	Wet	Diversity Index
PROTOZOA				
Euglenaceae	*Euglena*	0	16	0.662
Parameciidae	*Paramecium*	0	49	0.616
COPEPOD				
Aetideiidae	*Calanoid*	0	84	1.001
Cyclopidae	*Cyclop*	51	0	0.495
Ozmanidae	*Cyclopoid*	12	0	0.001
ROTIFER				
Branchionidae	*Rotifer B.*	81	41	1.224
Branchionidae	*Keratella*	25	21	0.689
Cypridinidae	*Ostracod (Cyorissp)*	0	28	0.001
CLADOCERAN				
Bosminidae	*Bosmina*	44	0	0.677
Daphniidae	*Daphnia*	26	0	0.001
Daphniidae	*Ceriodaphnia*	08	22	1.000
Sididae	*Diaphanasom*	0	53	0.001
Chydoridae	*Chydorus*	0	26	0.001
TOTAL		**247 (42.1%)**	**340 (57.9%)**	**587**

Low = 0-1 Medium = 1.1-2 High= 2.1-3

The results (Table 2) revealed that Protozoans were found in the wet season while none in the dry season with generally low diversity index. This could mean that Protozoans do not tolerate or adapt in polluted environments. However, Copepods, Rotifers and Cladocerans were found in both dry and wet season with Species showing medium diversity index. The present study revealed that *Rotifer* has the highest abundant rate. This study is in line with the findings of Tanimu (2012) who reported rotifer to be the highest in term of species diversity and abundant value, while the report contradict that of Usman *et al.*, 2019 who reported low species diversity and abundance. The high abundance of *Rotifer* throughout the study period could be attributed to the fact that some zooplankton thrive in polluted environment. This agreed with the report of Usman and Yerima (2017) who stated that Rotifers, Copepods and Cladocerans were more tolerant to environmental pollution and that makes it the richest occurring organism.

The Canonical Correspondent Analysis (CCA) (Fig. 1) showed the inter-relationship between the physicochemical parameters and Zooplankton in ABU reservoir. The first two components – i.e. component 1 and 2 of the CCA accounted for 63.71% of the total variation observed in the CCA. The Class of zooplankton (*Cladocera* and *Protozoa*) of ABU reservoir showed positive correlation with Temp, EC, TDS, DO, BOD, ALK, SO_4^{-}, S, TURBIDITY, with the exception of pH, Hardness, PO_4 and Chloride which showed Negative correlation with the class of zooplankton (Copepod and rotifer). There is a significant relationship between physicochemical parameters and Zooplankton in stations 1, 4, and 5 showed a positive association.



pH= Hydrogen ion, Water Temp= water temperature, EC= Electrical Conductivity, TDS = Total Dissolved Solids, DO= Dissolved Oxygen, BOD= Biological Oxygen Demand, ALK= Alkalinity, Hard= Hardness, NO_3^-N= Nitrate Nitrogen, SO_4^-S= Sulphate, PO_4^-P=Phosphate Phosphorus, TBD=Turbidity Cl= Chloride

PRO= PROTOZOA CLA= CLADOCERA ROT= ROTIFER COP=COPEPOD, MAG= MAGNOLIOPSIDA LIL= LILIOPSIDA POLY= POLYPOLIOPSIDA

Fig. 1: Zooplankton in relationship to physicochemical parameters

The ecological dynamics of ABU reservoir were associated with rainfall, wind and solar radiation. These driving forces determine the intensity of different processes operating in the reservoir ecosystem and other factors like reservoir hydrology and nutrients influence population dynamics of the reservoir. The physical factors studied in this research interact with the chemical factors to produce energy flow, nutrient cycling and organic materials all of which contributed significantly in producing a moderately, viable, sustainable reservoir ecosystem rich in diverse aquatic health indicator Zooplankton. The reservoir is governed by direct rainfall, in-flow from Samaru, Kampangi streams, Evapo-transpiration and water withdrawal for municipal, domestic and agricultural uses. The significance difference in physicochemical parameters and Zooplankton diversity of ABU reservoir varied throughout the study period. These changes further resulted in differences in the seasonal composition and diversity of Zooplanktons, this affirm the report of Edokpayi *et al.* (2016) who stated that changes in physicochemical parameters could affect seasonal or biodiversity of aquatic organisms. These factors probably induced disruption of life cycles, food chain and impose physiological stress on the Zooplankton and associated organisms (Ojutiku *et al*., 2017).

Conclusions and Recommendations

The Zooplankton composition of ABU reservoir comprised of protozoa, copepod, rotifer, cladocera etc. an indicator species of organic pollution Zooplankton (*Rotifer*) were observed to be the most dominant species in the present study. The Shannon – Weiner diversity indices indicated dry season to be more diverse than wet season. Canonical correspondent analysis indicates DO, nitrate, alkalinity and temperature to influence the presence of Zooplankton in ABU reservoir. The low dissolved oxygen, low richness and diversity, high abundance of *rotifer* and various groups of Zooplankton could be indicative of high organic pollution attributed to periodic changes in the ecosystem brought about by seasonal variation in the environmental conditions. Also this may directly or indirectly alter the reproduction, time and rate depending upon availability of food, competition, predation and mortality as evident due to presence of species pollution indicator Zooplankton like rotifer, Oligochaeta, dragon fly nymph and Chydorus tend to suggest ABU reservoir is likely polluted. Proper conservation and restorative strategies (anthropogenic activities should be restricted around the study area) should be directed towards reducing loss of the reservoir, biological diversity and productivity monthly location variation in density and composition of Zooplankton.

Conflict of Interest

The authors declare that there is no conflict of interest reported in this work.

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