Adamawa State University Journal of Scientific Research
Volume 9 Issue 1, 2021; Article no. ADSUJSR 0901001
ISSN: 2705-1900 (Online); ISSN: 2251-0702 (Print)
http://www.adsujsr.com

Evaluation of Zooplankton Dynamics of Kiri Reservoir, Shelleng Local Government, Adamawa State, Nigeria

Zira J. D.[1*] and Edward A.[2]
[1]Dept. of Fisheries, Adamawa State Ministry of Environment, P.M.B 2170, Yola, Adamawa State, Nigeria
[2]Dept. of Fisheries and Aquaculture, Adamawa State University Mubi, Adamawa State, Nigeria
Contact: *zirajoshuadali@yahoo.com*

(Received in February 2021; Accepted in July 2021)

Abstract
A study on the evaluation of zooplankton of Kiri reservoir was conducted over a period of eighteen months (March, 2017- August, 2018) using standard methods. Twenty two (22) species were observed during this study and 7 species were represented by Clodocera (*Moina sp., Bosmina sp., Chydorus sp., Daphnia, Sida, Leptodora sp., Simocephalus sp.),* 4 species of Copepoda were identified *(Nauplius larvae, Cyclos, Metacydops, Diaptomus),* 9 species of Rotifera, *(Asplancia, Rotaria sp., Trichocerca sp., Filinia sp., Brachionus sp., Euclanis sp., Notholca sp., Testidunella., Monostyla sp).,* Ostrecoda with only 1 species (*Cypridopsis sp.)* and Decapoda, 1 species *(peneaus sp.)* was also identified. The abundance of zooplankton in Kiri reservoir followed a sequence as Rotifera > Cladocera > Copepoda > Ostracoda>Decapoda. Zooplankton was higher during the dry season than the rainy season for the period of this study. This may be as a result of water clarity and increased primary productivity of the Reservoir. They differ significantly in season and sites with site II recorded the highest abundance of the Zooplankton.

Keywords: Dynamics, Evaluation, Zooplankton, Kiri Reservoir, Rotifera

Introduction
Zooplanktons are the animal component of plankton and form a vital link in aquatic food chains between microscopic photosynthetic algae and fish. Ovie (2011) defined zooplankton as the free-floating, aquatic invertebrates, often described as microscopic because of their usual small sizes that range from a few to several micrometers and are rarely exceeding a millimeter. They are also food for sea birds (Verma and Agarwal, 2007). Zooplanktons form major part of fish natural food as main source of protein. Economically, they are the major mode of energy transfer between phytoplankton and other aquatic animals including fish. Ecologically, zooplankton are the most important biotic components influencing all the functional aspects of all aquatic ecosystems, viz; food chains, food webs, energy flow/transfer and cycling of matter. Generally, they play an important role in fish nutrition, both in aquaculture and capture fisheries. Suresh *et al*., (2011) reported that different environmental factors that determine the characters of water have great importance upon the growth and abundance of zooplankton. Thus, water quality influences zooplankton abundance, clustering and biomass. The distribution of zooplankton communities depends on many factors, some of which are change of climatic conditions, physico-chemical parameters and vegetation cover. According to Rajagopal *et al.,* (2011) zooplankton plays an integral role and serves as bio-indicator and it is a well-suited tool for understanding water pollution status. Removing just one species from an ecosystem damages the flow of energy in that system (Verma and Agarwal, 2007). Zooplanktons respond rapidly to environmental changes, and hence their standing crop and species composition are more likely to indicate any damage in the aquatic environment. The interrelationship between the physicochemical parameters and plankton production of dam water and its relation with fluctuation of zooplankton are of great importance and basically essential for fish culture (Sandeep and Noor-ul, 2013). Factors such as temperature, pH, DO, transparency, and electrical conductivity form part of abiotic components of an aquatic ecosystem. When water temperature is outside tolerable range, abundance of zooplankton is affected directly

(Imam, 2011). High acidic or high alkaline pH could result to the death of aquatic organisms including zooplanktons. Zooplankton requires oxygen for energy metabolism. Sensitivity to low oxygen concentration differs between species, various life stages (eggs, larvae and adults), and different life processes including feeding, growth and reproduction (Imam, 2011). Water transparency influences vertical migration of zooplankton, which affects their diurnal rhythms (Verma and Agarwal, 2007).

The composition of zooplankton especially in relation to filter feeders depends on the quality of nutrient supply. Some zooplankton species (mainly rotifers, branchiopods and copepods) could be used as indicators of reservoir trophic status because their composition is affected by any of the several environmental parameters e.g. pH or alkalinity and salinity and other biological parameters (Hassan *et al*., 2010). Zooplankton abundance is usually closely related to phytoplankton concentration and species composition increases with increasing nutrients concentrations. Zooplanktons occupy an important food source for many species of aquatic ecosystem as they constitute the most important link in energy transfer between phytoplankton and higher aquatic fauna. Zooplankton organisms are identified as important component of aquatic ecosystems (Okogwu, 2010). The help in regulating algal microbial productivity through grazing and in the transfer of primary productivity to fish and other consumers. Okogwu (2010) reported that by grazing on phytoplankton and bacteria, Zooplankton help in improving water quality. The amount of zooplankton in water depends generally on the amount of phytoplankton and detritus available to feed on (Hassan *et al*., 2010). Zooplankton is ecologically an important group of aquatic organisms that occupy a wide range of habitats they constitute essential biotic component which influences the efficiency of an aquatic ecosystem such as energy flow through various trophic interactions (Park and Shin, 2007). They are so closely linked to the environment and they tend to change more rapidly than do larger aquatic animal such as fish, thus these organisms have proved valuable indicator of apparent and subtle alterations in the quality of aquatic environment (Marine Biology Organization,2007).

Balakrishna *et al*., (2013) reported changes of zooplankton species densities as affected by changes in physicochemical parameters in different seasons. According to Waikato Environmental Technical Report (2008), presence of rotifers can be used to grade eutrophic status of the lakes. Understanding the patterns of variability of zooplanktons both temporally and spatially provides a good source of information on the processes affecting them. Imaobong, (2013) reported zooplankton species abundance and distribution was determined by levels of eutrophication in lakes of Nigeria. Variations in seasonal abundance and diversity as a result of changes in physicochemical parameters were also reported by (Keder *et al.*, 2008). The Zooplanktons are classified in various groups viz. Cladocera, Copepoda, Rotifer and Ostracoda. The availability of food is more due to decomposition of organic matter and the density of zooplankton might be high due to fewer predators (Shivashankar *et al.* 2013). The study of zooplankton is necessary to evaluate the fresh water reservoir in respect to their ecological and fishery status (Goswami and Mankodi, 2012).

MATERIALS AND METHODS

Study Area

Kiri Reservoir is on coordinate’s 9°40′47″N 12°00′51″E on the southern part of Adamawa State, Nigeria as shown in fig. I below. It is situated within Shelleng Local Government Area and about 20km from Numan Local Government. It is a 1.2 km long, 20m high zoned embankment with an internal clay blanket. The Reservoir fig. II was mainly completed in 1982. The reservoir has an area of 107.00 km2 and discharge/second capacity of 4000m3 (Institute of Civil Engineering, 1990). It has a capacity of 690 million m^3 and it was built to provide irrigation for the Savannah Sugar Company (SSC), a large-scale sugar cane plantation and processing company set up as a joint venture between the Nigerian Federal Government and the Commonwealth Development Corporation, London.

Collection and Determination of Zooplankton

Zooplankton grab samples were collected using plankton net mesh size 70µm. It was towed vertically distance of one meter and haul out of the water. The sample was collected into plastic bottle tied at the end of the net, and then was emptied into the closed labeled 100ml vial bottle for identification and counting of the zooplanktons. The samples were preserved with 4% formalin. The zooplankton sample collection after condensation by sedimentation was taken for sorting and counting. A binocular microscope was used for zooplankton identification. Identification to genus level was performed using protocols of Yamaguchi and Bell (2007). Zooplankton density (abundance) was computed.

Result and Discussion

Table 1 shows the monthly diversity and abundance of zooplankton species. Dry season months such as April, 2017 (7.7%)) and March, 2018 (8.0) recorded the highest abundance of zooplankton, while rainy season months recorded the lowest diversity. *Branchionus* sp. recorded the highest mean diversity of 434(19.1%) among all the sampled species during the period of this study, while *Sida* sp. recorded the lowest species diversity of 27(1.2%). The result revealed that five (4) class of zooplankton, namely; Cladocera, Copeepoda, Rotifer, and Ostracoda were identified and was represented by twenty one (21) during the period of the study.The species *branchionus* sp. was highly distributed at site I, II and III. Site II has the highest diversity and abundance 1030(45.35%) of all the species, while site I recorded the lowest abundance 576(25.36%) species (table 2). The identified species differ significantly ($p<0.05$) in number between months and sites.

Zooplanktons play a vital role in the food web of aquatic ecosystems. They are good indicator of water quality. Zooplankton dynamics obtained from the current study revealed that, four (4) taxa namely; Clodocera, Copepoda, Rotifera and Ostracoda, and were represented by twenty two (21) species. Kadam *et al.* (2014) reported four taxa namely; Rotifera, Cladocera, Copepoda and Ostrocoda from Pillowa Reservoir District Morena Madhya Pradesh. Among twenty two (21), species seven (7) species were represented by Clodocera.*; Moina* sp., *Bosmina* sp., *Chydorus* sp., *Daphnia*, *Sida*, *Leptodora* sp., four (4) species of Copepoda of were identified; *Nauplius larvae*, *Cyclos*, *Metacydops*, *Diaptomus*, nine (9) species of Rotifera; *Asplancia*, *Rotaria* sp., *Trichocerca* sp., *Filinia* sp., *Brachionus* sp., *Euclanis* sp., *Notholca* sp., *Testidunella.*, *Monostyla* sp. and Ostrecoda one (1) species *Cypridopsis* sp., were also identified. The abundance of zooplankton in Kiri reservoir followed a sequence Rotifera 1312(57.8%)> Cladocera 503(22.1%) > Copepoda 358(15.8))> Ostracoda 98(4.3). Similar observations were made (Solomon *et al.*, 2009; Agouru and Audu, 2012). The dominance of Rotifera in this study agreed with other observation (Dede and Deshmukh, 2015; Eyo and Paul, 2015). This was in variance with the work (Yakubu *et al.*, 1998; Ajuonu *et al.*, 2011), who both reported Cladocera and Copepoda as the most dominant in their separate studies. The dominance of the species *Brachionus;* a nutrient loving Rotifer, might be attributed to nutrients enrichment provided by the water body as reported (Iloba and Ruejoma, 2014). The zooplanktons from the study area were higher during the dry season than rainy season for the period of this study. This varied with the results reported (Jose and Kumar, 2012; Dede and Deshmukh, 2015), who both recorded higher zooplankton more especially the taxa Rotifera during the summer in they separate study. This could be due to the availability of nutrient, phytoplankton, optimal temperature, high transparency and dissolved oxygen. The Zooplanktons community fluctuates according to physicochemical parameter of the environment, especially Rotifer species change with biotic factors (Karuthapandi *et al.*, 2013).

Site II and III recorded higher zooplankton diversity and abundance. This could be due to an increased in the primary productivity (phytoplankton) of the reservoir from the faeces of Hippopotamus and other anthropogenic activities such as disposal of domestic waste into the water ways and application of fertilizers which encouraged the growth of phytoplankton and thereby used as food by the zooplankton (Zira *et al.*, 2019). It could also be as a result of the higher free carbondioxed (CO_2), Alkalinity and transparency observed at site II as reported by Zira *et al.* (2019). The population density, composition and abundance of zooplanktons varies according to the season and type of freshwater body, its physicochemical parameters and biotic components was studied by different researchers (Thirupathaiah *et al.*, 2011; Patel *et al.*, 2013). This suggests that such parameters attributed to the diversity and abundance of the zooplankton at the study sites. Seasonal and sites variation were observed in the diversity and abundance of zooplankton.

Table 1: Monthly Mean Diversity and Abundance of Zooplanktons

						2017											2018			
Zooplanktons	**Mar**	**April**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**April**	**May**	**Jun**	**Jul**	**Aug**	**Total**	**%Comp**
Cladocera																				
Moina sp.	6	8	4	2	3	2	4	5	3	2	5	7	9	5	3	4	4	3	79	3.5
Bosmina sp.	2	1	3	3	1	0	0	2	3	3	3	4	2	2	1	1	0	1	32	1.4
Chydonis sp.	12	7	10	3	5	4	3	3	4	3	4	3	5	7	8	5	2	3	91	4.0
Daphnia	13	14	7	3	5	6	5	4	9	7	6	12	25	10	8	5	8	7	154	6.8
Sida sp.	2	4	3	1	1	0	0	1	2	1	2	4	2	2	1	1	0	0	27	1.2
Leptodora sp.	2	2	3	1	1	1	2	2	1	3	3	3	5	2	4	1	2	1	40	1.8
Simocephalus sp.	4	3	7	2	3	1	4	5	1	6	6	7	9	4	8	2	4	2	80	3.5
Copepoda																				
nauplius larvae	11	10	11	8	5	6	4	3	5	11	9	8	8	12	7	5	4	4	133	5.9
Cyclops	3	2	2	2	1	1	1	2	1	3	5	3	3	3	4	2	1	1	41	1.8
Metacydops	9	8	7	6	5	3	6	2	3	7	17	10	7	8	6	4	5	4	67	3.0
Diaptomus	7	5	3	2	2	2	3	4	2	2	4	6	8	4	2	3	4	3	117	5.2
Rotifera																				
Asplanchia	13	7	6	6	7	3	4	4	3	4	5	4	3	2	0	1	0	2	100	4.4
Rotaria sp.	5	4	2	3	2	1	2	5	3	3	3	5	6	3	3	2	3	2	58	2.6
Trichocerca sp.	8	10	9	6	5	5	4	4	5	5	11	14	10	7	7	6	3	4	123	5.4
Filinia sp.	3	5	3	1	0	0	1	2	2	1	2	3	3	2	3	1	1	0	36	1.6
Branchionus sp.	27	26	23	24	15	13	13	14	15	19	26	25	26	35	16	13	12	10	434	19.1
Euclanis sp.	7	9	8	7	4	4	5	3	4	6	10	16	8	9	5	5	5	3	118	5.2
Notholca sp.	10	12	11	10	7	6	6	5	5	9	12	10	17	10	6	6	5	4	197	8.7
Testidunella	14	16	8	7	4	4	4	6	7	8	8	10	20	15	9	8	7	6	161	7.1
Monostyla sp.	7	10	9	5	4	3	4	2	3	4	3	4	3	6	7	4	3	3	85	3.7
Ostracoda																				
Cypridopsis sp.	8	14	7	6	6	4	4	3	5	4	3	5	2	1	2	0	2	0	100	4.4
Total Abundance	173	177	149	108	86	69	79	81	86	111	147	163	181	149	110	79	75	63	2271	100
% Composition	7.6	7.8	6.6	4.8	3.8	3.0	3.5	3.6	3.8	4.9	6.5	7.2	8.0	6.6	4.8	3.5	3.3	2.8	100	

Source: Experimentation March, 2017 – August, 2018

Table 2: Diversity and Abundance of Zooplanktons according to Sites

Class	Species	Site I	Site II	Site III	Total	Species % Comp.	Class % Comp.
Cladocera	*Moina* sp.	18	36	25	79	3.5	
	Bosmina sp.	14	10	8	32	1.4	
	Chydonis sp.	21	47	23	91	4.0	
	Daphnia	40	69	45	154	6.8	503(22.1)
	Sida sp.	3	19	5	27	1.2	
	Leptodora sp.	14	17	9	40	1.8	
	Simocephalus	24	37	19	80	3.5	
Copepoda	*nauplius larvae*	33	54	46	133	5.9	
	Cyclops	8	22	11	41	1.8	358(15.8)
	Diaptomus	12	31	24	67	3.0	
	Metacydops sp.	32	49	36	117	5.2	
Rotifera	*Asplanchia*	29	43	27	100	4.4	
	Rotaria sp.	0	27	32	58	2.6	
	Trochocerca sp.	25	58	40	123	5.4	
	Filinia sp.	7	16	13	36	1.6	
	Branchionus sp.	116	183	135	434	19.1	1312(57.8)
	Euclanis sp.	37	61	20	118	5.2	
	Notholca sp.	41	102	54	197	8.7	
	Testidunella	35	78	48	161	7.1	
	Monostyla sp.	36	28	21	85	3.7	
Ostracoda	*Cypridopsis* sp.	31	43	24	100	4.4	98(4.3)
Total abundance		576	1030	665	2271	100	2271
Percentage Composition (%)		25.36	45.35	29.28	100		

Source: Experimentation March, 2017 – August, 2018

Conclusion

Five classes of zooplankton each were identified which was represented by twenty two (22) species for the period of this study. Zooplankton was identified to be higher during the dry season than the rainy season. It is therefore recommended that, proper management of the reservoir be taking into consideration to increase it productivity.

Acknowledgements

All materials published and unpublished used for the purpose of this research are dully acknowledged

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