



Zooplankton Abundance and Diversity of River Kaduna and College of Agriculture and Animal Science Dam (CAAS) Kaduna, Nigeria

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ABSTRACT

The study was carried out to assess Zooplankton Diversity and abundance of River Kaduna and College of Agriculture and Animal Science Dam in Kaduna. Water samples were collected once a month for a period of twelve months. Water samples were collected from four sampling stations each for River Kaduna and CAAS Dam. Samples were then taken to the laboratory for analyses and identification of organisms. The abundance of zooplankton species at the College of Agriculture and Animal Science is 26 from 6 families and total species is 318, species abundance for dam during the wet season was 147 and 192 in the dry season. For the river's abundance of zooplankton species was 28 from 6 families and total species was 352, species abundance of river in the wet season is 140, dry season total species in the river is 187. The assessment of the zooplankton diversity of CAAS Dam and River Kaduna shows that zooplankton species were higher in the River than the Dam except both seasons; Dam species were more than that of the River. However, species richness is higher in the River than the Dam.

Key words: Zooplankton, Diversity, River, Kaduna.

INTRODUCTION

Zooplanktons are minute drifting organisms found near the surface of the water bodies. They range in size from tiny microbes to jellyfish, although most zooplanktons are a tiny single celled organism. Ovie (2011) defined zooplankton as free-floating, aquatic invertebrates, often described as microscopic because of their normal small sizes that range from few to several micrometres and are not often exceeding a millimetre. Zooplankton can be divided into two categories which includes meroplankton and holoplankton. Meroplankton (also known as temporary zooplankton) are plankton that spends only part of their lifestyle as plankton. Examples include: fish and insect larvae. Holoplankton (also known as permanent zooplankton) are plankton that spends all their life as plankton. Examples include: Crustacea, Protozoa and Rotifers. Zooplankton in association with phytoplankton makes up the planktonic food supply (Encyclopedia Britannica, 2012).

In aquaculture, small sized zooplankton e.g. rotifers are often used as food for fish larvae. In nature, phytoplankton is fed on by zooplankton, which is in turn fed on by other higher animals such as larger zooplankton, fin fish and shellfish. Almost all aquatic life depends on zooplankton at least at an early stage of their life. In nature, larvae of most fish and shellfish species eat small phytoplankton and Zooplankton. Such a diet does not only provide a much-diversified composition, but because of its auto-digestion characteristics that facilitate nutrient uptake in the larvae. Zooplanktons are valuable pointers of the future fisheries strength as they are a food source of organisms at higher trophic levels (Davies *et al.*, 2009). Zooplanktons are recognized as a vital component of the aquatic ecosystems (Okogwu 2010). Zooplankton aid regulation of algal microbial productivity through grazing and in the transfer of primary productivity of fish and other consumers (Dejen *et al.*, 2004). The response of zooplankton to the water quality variation of ecosystem and species dependence vary in and between the lakes (Ravera 1996).

Some specific type of the zooplankton occupies a particular marine environment, each species is uniquely adapted to the factors such as light, temperature, turbulence and salinity in its habitat.

Zooplanktons are extremely responsive to the nutrient levels, temperature, pollution, light intensity, and increase in predation. They also provide an essential link in the marine food chain. The diversity of species, the amount of biomass and abundance of zooplankton communities can be used to establish the health of an ecosystem. Zooplankton prey on phytoplankton, the amount of zooplankton increases in response to the spring while the reaction of zooplankton is dependent on the species type as well. This would be expected to aid increase in the transfer of primary production to higher trophic levels. Thus zooplankton is generally preferred food for the post-larval planktivorous fish (Brooks and Dodson, 1995; Carpenter and Kitchell, 1993; Elser, 1999; Jeppesen *et al.* 2003; Schffer, 1998).

MATERIALS AND METHODS

Study area

The sampling was carried out at the College of Agriculture and Animal Science (CAAS) dam, Mando Road Kaduna and River Kaduna within the city of Kaduna metropolis which is located in the northern part of the country bounded by latitude N 10° 35'.531", longitude 007° 25'.414" and latitude N 10° 28'.927", longitude 007° 23'.616" (fig 1). There are two seasons basically in the northern region where the study areas are located; the rainy and dry seasons. The rainy season lasts from March to October while the dry season, which begins early November lasts till late march which originated from the Sahara prevailing. Thus, early rainfall starts from March while late rainfall ends in October. The rains are concentrated between July and August. The average annual rainfall ranges between 92.1mm to 128.6mm. Annual average relative humidity varied from 61.1% to 50.5% and the maximum average temperature also varies from 32.4°C and 31.4°C.

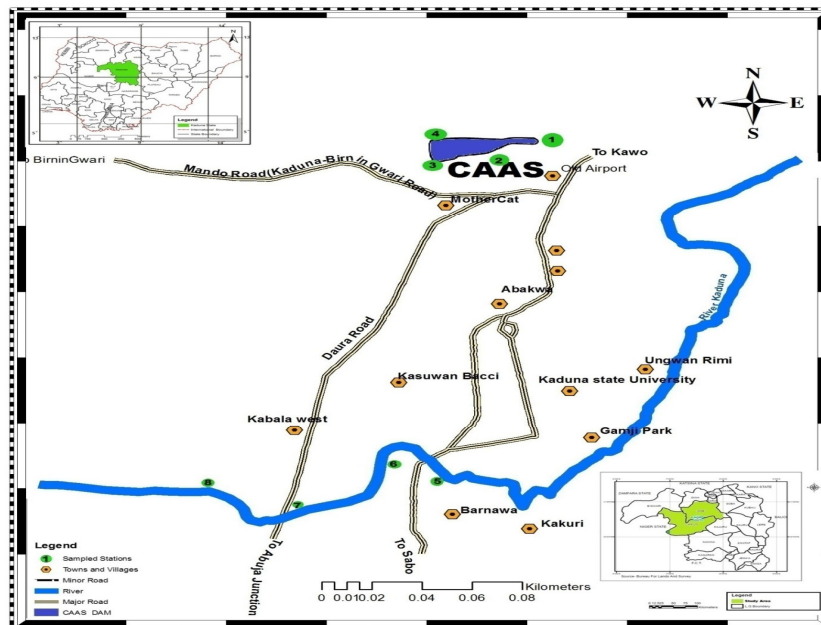


Figure 1: Map of Kaduna metropolis showing the sampling stations.

Method of sampling zooplankton

The zooplankton was collected using silk plankton net attached with a 50ml capacity bottle at base. At each station (four), the collection was made by sinking the net and towed through a distance of 1m depth of water. The samples were then poured into plastic bottle of 70 ml capacity and preserved with 4 % formalin.

The preserved sample was taken to the Laboratory of the Water Resources, Aquaculture and Fisheries Technology Department, Federal University of Technology, Minna for the analysis of Zooplankton. At the laboratory, the samples were centrifuged and decanted before 1ml of

the sub-sample from the original stock was collected with 1ml pipette. The pipette content was transferred onto a Sedgewick-Rafter counting chambers for species enumeration which were examined under the Leitz Wetzler Binocular Microscope using the scanning, low-power and high-power objectives at 100-200 \times , 100-400 \times magnifications. Counting and Identification were carried out using various keys for identification as described by Jeje and Fernando (1986).

Evaluation of zooplankton diversities

Evaluation the zooplankton diversity was done based on the following formulae:

- i) Species diversity index = Number of species in the water body/ total number of zooplankton in the water body X 100
- ii) Generic diversity index = Number of genera in the water body/total number of zooplankton in the water body X 100
- iii) Family diversity index = Number of families in the water body/ Total number of zooplankton in the water body X 100
- iv) Species abundance = Number of zooplankton per species/ total number of zooplankton in the water body X 100
- v) Generic abundance = Number of zooplankton per genus/ total number of zooplankton in the water body X 100
- vi) Family abundance = Number of zooplankton per family/ total number of zooplankton in the water body X 100

Stations, months and seasonal evaluation of zooplankton

Normal counting of zooplankton for abundance was done and were sorted into stations, months and the seasons of the year in which the sample were collected.

Zooplankton dominance

Zooplankton richness, dominance and evenness were estimated using Simpson's Index as follows:

$$i) \text{ Simpson index (Species Richness)} = \frac{\sum n(n-1)}{N(N-1)}$$

$$ii) \text{ Dominance} = 1 - \left[\frac{\sum n(n-1)}{N(N-1)} \right]$$

$$\text{Shannon-weiner index (Diversity)} = -\sum \left[\frac{n}{N} \cdot \log_2 \left(\frac{n}{N} \right) \right]$$

$$\text{Evenness} = -\sum \frac{\left[\frac{n}{N} \cdot \ln \left(\frac{n}{N} \right) \right]}{\ln N}$$

Where n = the total number of organisms of a particular species, N = the total number of organisms of all species

RESULTS AND DISCUSSION

Evaluation of zooplankton diversities

Table 1 shows the result of Species diversity index, Generic diversity index, Family diversity index, Species abundance, Generic abundance and Family abundance in the CAAS Dam and River Kaduna.

Zooplankton species in the CAAS Dam and River Kaduna

A total of thirty-eight (38) zooplankton species were collected during the sampling period in the CAAS Dam and River Kaduna. The organism's sampled/station/months in the wet and dry seasons are present in the Tables 2, 3, 4, 5, 6 and 7.

Table 1: Evaluation of zooplankton diversities River Kaduna and CAAS Dam, Kaduna

Evaluations/values	CAAS Dam	River Kaduna
Species diversity index	100	100
Generic diversity index	50	50
Family diversity index	23	21
Species abundance	1285	1232
Generic abundance		
i <i>Daphia</i>	708	757
ii <i>Calanoid</i>	127	239
iii <i>Cyclopoid</i>	204	79
iv <i>Copepod</i>	162	96
v flatworm	81	4
vi <i>Rotifers</i>		7
vii <i>Harpacticoida</i>	4	43
Family abundance		
i Daphniidae	46	46
ii Calanoidae	15	21
iii cyclopoidae	19	7
iv copepodae	12	11
v unidentified	4	7
vi Harpacticodae	4	7

Table 2: Zooplankton species and abundance in the CAAS Dam during wet season

Species	Number/Station				Total
	I	II	III	IV	
<i>Moina micrura</i>	1	-	-	-	1
<i>Daphnia Minnehaha</i>	3	-	-	-	3
<i>Daphnia longispina</i>	-	7	2	-	9
<i>Diaehonosoma sarsi</i>	1	-	-	3	4
<i>Daphnia pervula</i>	1	-	-	-	1
<i>Thermocyclos neglectus</i>	-	7	-	4	11
Fish larva	-	-	-	-	-
<i>Daphnia</i>	-	1	-	-	1
<i>Daphnia spp</i>	-	-	-	6	6
<i>Daphnia ambigua</i>	9	5	6	-	20
<i>Nauplius larva</i>	3	11	9	6	29
<i>Calanoid</i>	1	-	-	2	3
<i>Calanoid spp</i>	-	-	3	-	3
<i>Copepod</i>	-	-	3	-	3
<i>Cyclops spp</i>	-	-	7	-	7
<i>calonoid copepod</i>	-	-	-	1	1
<i>Rotaria species</i>	-	-	2	-	2
<i>Cypris larvae</i>	-	3	-	-	3
<i>Copepod nauplius</i>	-	-	-	-	2
<i>Harpacticoida species</i>	-	2	-	-	2
<i>Harpacticoida nauplius</i>	-	-	-	5	5
	-	-	-	2	2
Total	32	40	38	31	141

Table 3: Zooplankton species and abundance for CAAS Dam during the dry season

Species	Number/Station				Total
	I	II	III	IV	
<i>Daphnia Minnehaha</i>	-	-	5	-	5
<i>Daphnia pervula</i>	5	18	2	-	25
Fish larva	-	-	2	-	2
<i>Daphnia pulex</i>	10	6		11	27
<i>Daphnia spp</i>	-	12		11	23
<i>Daphnia ambigua</i>	1	-	-	-	1
<i>Daphnia pulcaria</i>	1	-	11	3	15
<i>Calanoid nauplius</i>	-	6	4		10
<i>Nauplius larva</i>	-	2	3	3	8
<i>Calanoid</i>	3	-	-	-	3
<i>Calanoid spp</i>	5	-	-	-	5
<i>mesocyclops spp</i>		-	-	5	5
<i>Copepod</i>	3	5	4	3	15
<i>Cyclopoid nauplius</i>	-	-	6	-	6
<i>Cyclops spp</i>	-	-	3	-	3
<i>Cycloppoida</i>	-	4	2	-	6
Flatworm	2	1	4	5	12
Total	30	54	46	41	171

Table 4: Monthly abundance of zooplankton species in CAAS Dam

Species	Number/Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
<i>Daphnia Minnehaha</i>	-	-	5	-	-	5	9	-	11	-	-	-	40
<i>Daphnia longispina</i>	-	-	-	-	-	1	6	-	4	-	-	-	11
<i>Diaehonosoma sarsi</i>	-	-	-	-	-	1		-	-	-	-	-	1
<i>Thermocyclos neglectus</i>	-	-	-	-	-	0	2	-	-	-	-	-	2
Fish larva	-	-	-	-	-	0	-	-	-	0	0	2	2
<i>Daphnia</i>	12	-	-	-	-	-	-	-	-	3	-	-	19
<i>Daphnia pulex</i>	-	2	11	6	3	-	-	-	-	-	5	3	30
<i>Daphnia spp</i>	-	10		11	15	-	-	-	-	-	2	-	38
<i>Daphnia ambigua</i>	-	-	-	1		-	-	-	-	-	-	-	1
<i>Daphnia pulcaria</i>	-	-	-	1		-	-	-	-	-	14	-	15
<i>Calanoid nauplius</i>	-	-	1	4	-	-	-	4	-	7	6	-	22
<i>Nauplius larva</i>	6	-	-	2	-	-	-	-	-	-	-	3	11
<i>Calanoid</i>	-	-	-	-	-	-	-	-	-	-	3	-	3
<i>Calanoid spp</i>	-	-	5	-	-	-	-	-	-	-	-	-	5
<i>mesocyclops spp</i>				5	-	-	-	-	-	-	-	-	5
<i>Copepod</i>	4	3		5	-	-		5	3	13	3		36
<i>Copepod spp</i>					5								5
<i>Copepod egg sac</i>	-	-	-	-	-	-	-	1	-	-	-	-	1

<i>Cyclopoid copepod</i>	-	4	-	-	-	-	-	-	-	-	-	-	4
<i>Cyclopoid nauplius</i>	-	6	-	-	-	-	-	-	-	-	-	-	6
<i>Cyclops spp</i>	-	-	-	3	-	-	-	-	-	-	-	-	3
<i>Cycloppoida</i>	-	-	4	-	-	-	-	-	-	29	2	-	35
<i>Harpacticoida</i>	-	-	-	-	-	-	-	-	-	1	-	-	1
<i>Flatworm</i>	4	3	2	-	4	-	-	2	1	-	-	5	21
Total	26	28	28	38	27	7	17	16	19	53	35	13	317

Table 5: Zooplankton species and abundance in River Kaduna at the different during wet season

Species	Number/Stations				Total
	I	II	III	IV	
<i>cariodaphia corinuta</i>	1	-	-	-	1
<i>Moina micrura</i>	3	-	-	-	3
<i>Daphnia Minnehaha</i>	-	7	2	-	9
<i>Daphnia longispina</i>	1	-	-	3	4
<i>Moinodaphnia macleayi</i>	1	-	-	-	1
<i>Daphnia pervula</i>	-	7	-	4	11
Fish larva	-	1	-	-	1
<i>Daphnia pulex</i>	-	-	-	6	6
<i>Daphnia spp</i>	9	5	6	-	20
<i>Calanoid nauplius</i>	3	11	9	6	29
<i>Nauplius larva</i>	1	-	-	2	3
<i>Calanoid</i>	-	-	3	-	3
<i>mesocyclops spp</i>	-	-	3	-	3
<i>Cyclopoid nauplius</i>	-	-	7	-	7
Flatworm	-	-	-	1	1
<i>calanoid copepod</i>	-	-	2	-	2
<i>Rotaria species</i>	-	3	-	-	3
<i>cypris larvae</i>	2	-	-	-	2
<i>Copepod Nauplius</i>	-	2	-	-	2
<i>Harpacticoida species</i>	-	-	-	5	5
<i>Rotifers</i>	-	-	-	2	2
Total	32	40	38	31	141

Table 6: Zooplankton Species and abundance in River Kaduna during the dry season

Species	Number/Stations				Total
	I	II	III	IV	
<i>Daphnia dubris</i>	-	1	-	-	1
<i>Daphnia catawa</i>	-	-	1	1	2
<i>Daphnia longirerius</i>	6	1	-	-	7
<i>Daphnia pervula</i>	10	-	11	3	24
Fish larva	-	1	-	-	1
<i>Daphnia pulex</i>	15	1	12	27	54
<i>Daphnia spp</i>	-	22	11	6	39
<i>Daphnia ambigua</i>	3	-	3	4	10
<i>Calanoid Nauplius</i>	3	15	4	-	22
<i>Nauplius larva</i>	-	3	-	-	3
<i>Copepod</i>	3	11	-	3	17
<i>calanoid copepod</i>	-	2	-	-	2

<i>cypris larvae</i>			1									1
<i>Harpacticoida species</i>			1							3		4
<i>Harpacticoida nauplius</i>										3		3
<i>Rotifers</i>												
Total			44		58			42	50			194

Table 7: Monthly zooplankton species abundance in River Kaduna

Species	Months												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
<i>Daphnia dubris</i>	-	-	-	-	-	-	-	-	-	-	1	-	1
<i>D. catawa</i>	-	-	-	-	-	-	-	-	-	-	-	25	25
<i>D. longirerius</i>	6	-	-	-	-	-	-	-	-	-	1	-	7
<i>Cariodaphia corinuta</i>	-	-	-	-	-	-	1	-	-	-	-	-	1
<i>Moina micrura</i>	-	-	-	-	-	3	-	-	-	-	-	-	3
<i>D. minnehaha</i>	-	-	-	3	-	4	-	3	2	-	-	-	12
<i>D. longispina</i>	-	-	-	-	-	-	4	4	-	-	-	-	8
<i>Moinodaphnia macleayi</i>	-	-	-	-	-	1	-	-	-	-	-	-	1
<i>D. pervula</i>	2	-	6	-	-	-	-	1	5	4	12	9	39
Fish larva				1									1
<i>D. pulex</i>	19	26	18		4					2			69
<i>Daphnia spp</i>	-	-	16	17	20	-	-	-	-	-		6	59
<i>D. ambigua</i>	6	-	-	-	-	-	-	-	-	-	1	3	10
Total	33	26	40	21	24	8	5	8	7	6	15	43	236

Table 8: Monthly zooplankton species abundance in River Kaduna

Species	Months												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
<i>Calanoid nauplius</i>	-	9	7	-	-	6	20	-	-	-	-	6	48
<i>Nauplius larva</i>	3	-	-	-	-	-	-	3	-	-	-	-	6
<i>Calanoid</i>	-	-	-	-	-	-	-	-	3	-	-	-	3
<i>Copepod</i>	-	-	9	8	2	-	-	3	3	-	-	-	25
<i>Cyclopoid nauplius</i>	-	-	-	-	-	-	-	-	-	7	-	-	7
<i>Cyclops spp</i>	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cycloppoida</i>	-	-	-	-	-	-	-	-	-	15	-	-	15
Flatworm	-	-	-	-	-	-	-	1	-	-	-	-	1
<i>calanoid copepod</i>	2					2							4
<i>Rotaria species</i>	-	-	-	-	-	-	-	-	-	2	-	-	2
<i>cypris larvae</i>	-	-	-	1	-	-	-	2	-	-	-	-	3
<i>Copepod nauplius</i>	-	-	-	-	2	-	-	-	-	-	-	-	2
<i>Harpacticoida species</i>	-	4	-	-	5	-	-	-	-	-	-	-	9
<i>Harpacticoida nauplius</i>	-	-	-	3	-	-	-	-	-	-	-	-	3
<i>Rotifers</i>									2				2
Overall total	38	39	56	33	33	16	25	17	15	30	15	49	366

Species Diversity in the CAAS Dam and River Kaduna

Table 9 shows the results of species diversity, species richness, dominance, and evenness, number of organisms or individual and the number of species in the CAAS Dam and River Kaduna while table 3b shows the seasonal result of species diversity, species richness, dominance, and evenness, number of organisms or individual and the number of species in the CAAS Dam and River Kaduna.

Table 9: Zooplankton species diversity in the CAAS Dam and River Kaduna

Tool	Location	Value
Simpson index (Species Richness)	Dam	0.08
	River	0.11
Dominance	Dam	0.92
	River	0.89
Shannon-weiner index (Diversity)	Dam	3.95
	River	3.77
Evenness	Dam	0.83
	River	0.78
Number of organism	Dam	312
	River	352
Number of Species	Dam	26
	River	28

Zooplankton occurrence, distribution and diversity are influenced by physico-chemical parameters of the aquatic ecosystem as revealed from this research because of the correlation between some physicochemical parameters and zooplankton recorded in this study. This is an agreement with the findings of Ewa *et al.* (2017) who also reported significant correlation between the occurrence of some zooplankton species and certain environmental parameters in the coastal Vistula lagoon. Suresh *et al.* (2011) also reported that different environmental factors, affecting the characteristic of water have enormous impact upon the growth and abundance of zooplankton. The result of zooplankton species, both in the Dam and River revealed that both water bodies were highly rich in the assemblage of zooplankton with almost all species represented in both water bodies. This could be as a result of favourable environmental conditions. This was supported by the assertion of Alexander (2012) who affirmed that the occurrence of planktonic fauna depends on a number of factors such as climate change, habitat's physicochemical properties and biotic factors. Species of zooplankton sampled were similar in both wet and dry seasons. The comparison of zooplankton diversity of CAAS Dam and River Kaduna shows that zooplankton species were higher in the River than the Dam, though the total number of organisms were higher in both seasons in the dam than that of the River. However, species richness was higher in the River than the dam which could be attributed to high number of channels that supplies water to the river while the species dominance, diversity and evenness were higher in the dam than the river.

Table 10: Seasonal zooplankton species diversity in the CAAS Dam and River Kaduna

Tool	Location	Season	Value
Simpson index (Species Richness)	Dam	Wet	0.11
		Dry	0.08
	River	Wet	0.08
		Dry	0.18
Dominance	Dam	Wet	0.89
		Dry	0.92
	River	Wet	0.92
		Dry	0.82
Shannon-weiner index (Diversity)	Dam	Wet	3.49
		Dry	3.82
	River	Wet	3.91
		Dry	2.92
Evenness	Dam	Wet	0.85
		Dry	0.9
	River	Wet	0.87
		Dry	0.73
Number of organism	Dam	Wet	147
		Dry	195
	River	Wet	140
		Dry	187
Number of Species	Dam	Wet	17
		Dry	19
	River	Wet	22
		Dry	16

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