ZOOPLANKTON COMPOSITION AND ABUNDANCE IN IKERE-GORGE, ISEYIN, OYO STATE, NIGERIA

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ABSTRACT

This study examines zooplankton composition and abundance in Ikere-Gorge (a man-made dam), Iseyin, Oyo State. *Zooplankton samples were collected monthly with plankton net between January 2017 and December 2018. The samples were preserved, analysed and identified with appropriate keys. Thirty-four genera of zooplankton belonging to four groups were identified in Ikere-gorge. The family of Copepoda recorded the highest number of zooplankton, followed by Cladocera, Rotifers and Ostracoda. But, Bosmina spp belonging to Cladocera group has the highest relative abundance of zooplankton population in Ikere-gorge. Alpha diversity varies between 29 and 32 among the sampling sites while beta diversity among the sampling sites was 0.1. Likewise, Dominance D varies between 0.05 and 0.06 while Simpson varies between 0.94 and 0.95. Shannon Weiner index for Site A is 3.16, Site B is 3.10, Site C is 3.18 and Site D is 3.21. Evenness index for site A and C is 0.73, site B is 0.76 and site D is 0.77. This zooplankton provides abundant food material for abundant fish production in Ikere-gorge.*

Keywords: Diversity, freshwater, ecosystem, copepoda, rotifers

INTRODUCTION

Zooplankton forms an important component of aquatic ecosystem. They are drifting animals that feed on drifting plants material called phytoplankton. Zooplankton is found floating freely in most freshwater ecosystems that are principally divided into two such as lentic and lotic ecosystems (Balasubramanian, 2011). Zooplankton that occurs in the open water such as lake, river, and reservoirs are fully adapted to planktonic drifting and are called pelagic species. Zooplankton that occurs among aquatic plants is not truly planktonic but constitutes an important part of aquatic biota. These are referred to as littoral species which are more diverse than pelagic zooplankton species (Dang *et al*. 2015; Suthers and Rissik, 2009; Shiel, 1995).

Zooplankton, a heterotrophic micro-invertebrate plays several important roles in the functioning of freshwater ecosystem. They are the energy transformer in aquatic ecosystems. They transfer energy from the primary producer, phytoplankton to higher trophic levels such as fish in the food web (Dang *et al*. 2015; Imoobe and Akoma, 2008), to support abundant fish production. They are water cleanser. They graze on phytoplankton and bacteria to improve water quality (Pinto-Coelho *et al*. 2005). They are good bio-indicator of health condition of freshwater ecosystems. They are highly sensitive to environmental variations of abiotic parameters such as climatic or hydrological limitation and biotic parameters like predation, competition (Beyst *et al*. 2001).

There are about six major groups of freshwater zooplankton. They include larval fish, copepods, cladocerans, rotifers, protozoans and ostracoda (Dang *et al*. 2015; Suthers and Rissik 2009). But four zooplankton groups are common in freshwater ecosystem. Rotifers are primarily freshwater zooplankton that are represented by about 2,030 species, cladocera are represented by about 620 species, copepoda are represented in freshwater by 2,814 species and ostracoda are represented in freshwater by 3,000 species (Dang *et al*. 2015). Their sizes vary between less than 1 mm and greater than 1 cm (Dang *et al*. 2015; Dumont, 1994). Cladocera, copepoda and ostracoda are classified as small crustaceans while rotifers are distinctive little animals (Suthers and Rissik 2009; Wade *et al*. 2004).

The abundance and distribution of zooplankton species composition in freshwater ecosystem is an importance indication of abundance fish production. The need to study zooplankton is important in fisheries management as they help to monitor water quality of freshwater ecosystem. Ikere-gorge is a freshwater ecosystem with multi-species fishery which, supports the livelihood of hundreds of fishermen and fish marketers or traders that depends on it. The sustainability of the fishery is very important through the continuous monitoring of Ikere-gorge biota for food and livelihood security. Therefore, this study aims to determine the abundance and composition of zooplankton in Ikere-gorge.

MATERIALS AND METHODS

Study Area

Ikere-gorge is located at Ikere Village, in Iseyin area of Oyo State and lies between longitude 8°10' and 8° 20'N and latitude 3° 40' and 3° 50'E

(Figure 1). Ikere- gorge is a man-made lake. It took its source from Sepeteri about 40 km to Ikere through Asamu and Alagbon. Ikere-gorge has Ogun River as its major tributary and River Amaka, River Oowe and River Owu as its minor tributaries. Four sampling sites were selected from 12 fishing villages that are in Ikere-gorge using stratified random selection method. The fishing villages were divided into four strata for easy access based on their geographical location and proximity to each other. The selected fishing villages are used as sampling sites. They are Irawote (N8º 13' 51.689; E3º 42' 42.468), Spillway (N8º 11' 37.290; E3º 43' 45.168), Agatu (N8º 09' 51.426; E3º 45' 00. 000) and Asamu (N8º 14' 03.294; E 3º 46' 56.028) fishing villages. Majority of people living in Ikere-gorge are fisher folks although some of them are farmers and charcoal producers.

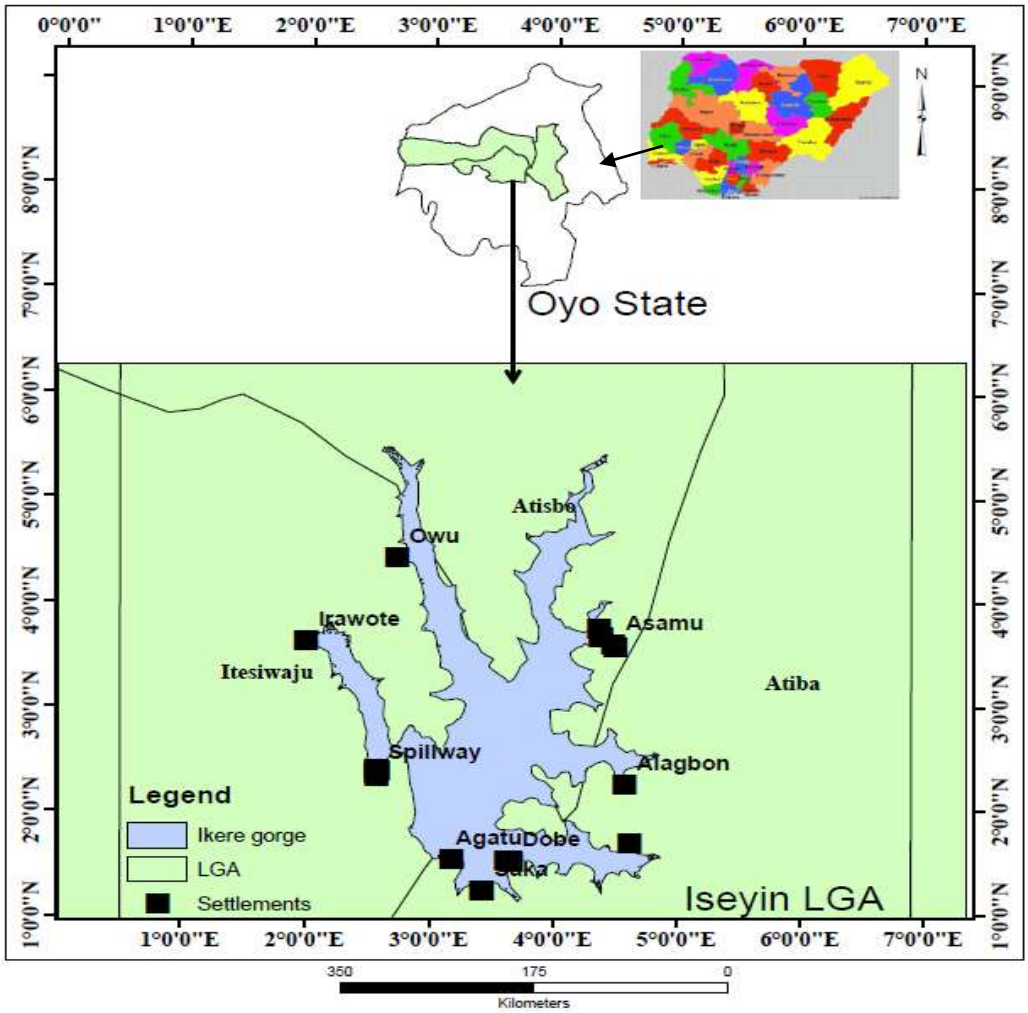

Figure 1: Map of Ikere-gorge (showing some fishing villages), Iseyin, Oyo State, Nigeria

Zooplankton sampling

Monthly zooplankton samples were collected during the early hours of the day (7:00 – 10:00 am) between January 2017 and December 2018. Plankton net with 25 cm diameter and 50 µm mesh size was used to collect zooplankton samples. Since the sizes of most microplankton like protozoa, rotifers etcetera are within the 20 – 200 µm (Shiel, 1995). The plankton net was towed horizontally at about 50 cm below the water surface for about 100 m distance. The contents of the net were then emptied into a wide-mouthed plastic 50 ml storage bottle and preserved with 10% formalin on the field. The preserve samples were brought to the Biotechnology laboratory of Forestry Research Institute of Nigeria (FRIN), Jericho, Ibadan for further analysis. In the laboratory, qualitative and quantitative analysis was done. This study adopted Lackey drop count method (Lackey, 1938) to count plankton cells.

i. The zooplankton samples were allowed to settle and top cleared layer was decanted, then zooplankton concentration sample was obtained.
ii. The concentrated sample was shaken and one drop was put on a clean micro slide with the help of a standard dropper holding it vertically.

iii. The whole drop was carefully covered with a cover slip of suitable size so that the sample does not run out.
iv. The slide was put under Celestron LCD digital microscope II at 100x, 200x, 300x and 400x magnification, focuses one edge of the cover slip.
v. Zooplankton was identified with appropriate keys. The identification of zooplankton species was done with the aid of identification keys like: Shiel (1995); Dang *et al*. (2015); Needham and Needham (1962); Witty (2004) and web zooplankton imagery.
vi. The total number of zooplankton species was estimated in one drop of concentrated plankton sample.
vii. In order to get the number of plankton that will be obtained in 1ml, the number of drops that make 1ml ml was estimated by adding drops of concentrated sample into a graduated centrifuge tube till it reaches 1 ml mark.
viii. It was found out that 28 drop is equal to 1ml. Then, the number of plankton in 1ml is calculated as: $N = dp$ …… (37)

Where:

N – The number of plankton cells per litre

d – The number of concentrated drops that make 1ml (d = 28)

p – The number of plankton cells per concentrated drop

Statistical analysis

The data obtained were subjected to descriptive and inferential statistical analysis using SPSS (Version 20.0) software to determine the abundance of zooplankton species. Zooplankton species diversity was determined by different diversity indices using Palaeontological Statistics (PAST) and R statistical package (Odulate *et al*. 2017; Hammer *et al.* 2001).

RESULTS

This study identified zooplankton groups to genera level. Thirty-four (34) genera of zooplankton belonging to four groups were reported in Ikere-gorge between January 2017 and December 2018 (Table 1). The family of Copepoda recorded the highest number of zooplankton (19) species contributing 56% to zooplankton relative abundance of Ikere-gorge. This is followed by Cladocera with 8 species (23%), Rotifers with 5 species (15.0%) and Ostracoda with 2 species (6.0%) of zooplankton (Figure 2).

Table 2 shows spatial distribution and relative abundance of zooplankton in Ikere-gorge. It is observed that sites A and C had the highest species richness of zooplankton (32), followed by site D (31) and site B (29). The most abundant zooplankton species in site A were *Bosmina spp* (6,636), *Megacyclops spp* (3,640), *Ceriodaphnia spp* (2,968), *Brachionus spp* (2,632), *Cypris spp* (1,820) and *Alona spp* (1,652). The most predominant species in site B were *Bosmina spp* (4,452), *Ceriodaphnia spp* (3,332), *Moina spp* (2,688), *Megacyclops spp* (2,604), *Brachionus spp* (2,324) and *Eubranchipus spp* (1,960). The predominant zooplankton species in site C were *Bosmina spp* (9,800), *Ceriodaphnia spp* (6,804), *Brachionus spp* (5,180), *Megacyclops spp* (5,124) and *Cypris spp* (2,744). The most abundant zooplankton in Site D are *Bosmina spp* (4,788), *Megacyclops spp* (2,856), *Brachionus spp* (2,744), *Ceriodaphnia spp* (1,764), *Alona spp* (1,568), *Scapholeberis spp* (1,568) and *Diacyclops spp* (1,428). The least abundant zooplankton species in site A are *Copepod spp* (420) and *Senecella spp* (364); in site B were *Arctodiaptomus spp* (336) and *Tropocyclops spp* (308); in site D are *Notholca spp* (336). These were the zooplankton species contribution less than 1% to the relative abundance. It is observed that site C does not have any zooplankton species with less than 1% relative abundance. Also across the sites, it is observed that dominant zooplankton species was *Bosmina spp* with 14.47% relative abundance, followed by *Ceriodaphnia spp* (8.38%), *Megacyclops spp* (8.02%) and *Brachionus spp* (7.26%). Others zooplankton species contributed less than 5% relative abundance. Moreover, *Notholca spp, Apocyclops spp, Polyarthra spp,* and *Arctodiaptomus spp* each contributed less than 1% relative abundance to the zooplankton abundance in Ikere-gorge.

Table 1: Checklist of zooplankton composition of Ikere-gorge, Iseyin, Oyo State, Nigeria

Zooplankton Groups/Families	Species
Cladocera	
Daphniidae	*Ceriodaphnia spp*
	Daphnia spp
	Moina spp
	Scapholeberis spp
	Simocephalus spp
Ilyocryptidae	*Ilyocryptus spp*
Chydoridae	*Alona spp*
Bosminidae	*Bosmina spp*

Rotifers		
	Brachionidae	*Brachionus spp*
		Notholca spp
	Asplanchnidae	*Asplanchna spp*
	Synchaetidae	*Polyarthra spp*
	Flosculariidae	*Ptygura spp*
Ostracoda		
	Cypridiidae	*Cypris spp*
		Gigantocypris spp
Copepods		
	Cyclopidae	*Acanthocyclops spp*
		Apocyclops spp
		Cyclops spp
		Diacyclops spp
		Epischura spp
		Copepod spp
		Senecella spp
		Limnocalamus spp
		Tropocyclops spp
		Megacyclops spp
		Eubranchipus spp
		Eurytemora spp
	Calanoida/Diaptomidae	*Copidodiaptomus spp*
		Hesperodiaptomus spp
		Leptodiaptomus spp
		Arctodiaptomus spp
		Diaptomus spp
		Skistodiaptomus spp
	Harpacticoida/Canthocamptidae	*Canthocamptus spp*

Table 2: Spatial Distribution and Relative Abundance of Zooplankton in Ikere-gorge, Iseyin, Oyo State, Nigeria

Zooplankton species	SITE A (Number/ml)	SITE B (Number/ml)	SITE C (Number/ml)	SITE D (Number/ml)	Total	%RA
Bosmina spp	6636 (25.85)	4452 (17.34)	9800 (38.17)	4788 (18.65)	25676	14.47
Ceriodaphnia spp	2968 (19.96)	3332 (22.41)	6804 (45.76)	1764 (11.86)	14868	8.38
Megacyclops spp	3640 (25.59)	2604 (18.31)	5124 (36.02)	2856 (20.08)	14224	8.02
Brachionus spp	2632 (20.43)	2324 (18.04)	5180 (40.22)	2744 (21.30)	12880	7.26
Cypris spp	1820 (25.39)	1316 (18.36)	2744 (38.28)	1288 (17.97)	7168	4.04
Alona spp	1652 (24.69)	1288 (19.25)	2184 (32.64)	1568 (23.43)	6692	3.77
Moina spp	1008 (15.32)	2688 (40.85)	1624 (24.68)	1260 (19.15)	6580	3.71
Eubranchipus spp	1540 (23.91)	1960 (30.43)	2408 (37.39)	532 (8.26)	6440	3.63
Diacyclops spp	644 (10.36)	1680 (27.03)	2464 (39.64)	1428 (22.97)	6216	3.50
Eurytemora spp	1428 (24.40)	1624 (27.75)	1624 (27.75)	1176 (20.10)	5852	3.30
Leptodiaptomus spp	980 (17.07)	1120 (19.51)	2604 (45.37)	1036 (18.05)	5740	3.23
Scapholeberis spp	1120 (21.51)	588 (11.29)	1932 (37.10)	1568 (30.11)	5208	2.93
Acanthocyclops spp	1484 (28.96)	532 (10.38)	2016 (39.34)	1092 (21.31)	5124	2.89
Skistodiaptomus spp	1120 (24.39)	700 (15.24)	1652 (35.98)	1120 (24.39)	4592	2.59
Cyclops spp	1260 (27.78)	784 (17.28)	1988 (43.83)	504 (11.11)	4536	2.56
Simocephalus spp	1092 (24.53)	840 (18.87)	1372 (30.82)	1148 (25.79)	4452	2.51
Asplanchna spp	784 (21.21)	1036 (28.03)	1120 (30.30)	756 (20.45)	3696	2.08
Daphnia spp	644 (21.70)	532 (17.92)	1344 (45.28)	448 (15.09)	2968	1.67
Epischura spp	728 (26.26)	616 (22.22)	672 (24.24)	756 (27.27)	2772	1.56
Hesperodiaptomus spp	616 (22.45)	812 (29.59)	728 (26.53)	588 (21.43)	2744	1.55
Gigantocypris spp	0 (0.00)	756 (29.35)	840 (32.61)	980 (38.04)	2576	1.45
Ilyocryptus spp	1008 (40.00)	0 (0.00)	784 (31.11)	728 (28.89)	2520	1.42
Diaptomus spp	420 (16.85)	448 (17.98)	1232 (49.44)	392 (15.73)	2492	1.40
Canthocamptus spp	420 (17.44)	588 (24.42)	924 (38.37)	476 (19.77)	2408	1.36
Copepod spp	420 (17.65)	532 (22.35)	1064 (44.71)	364 (15.29)	2380	1.34
Ptygura spp	448 (19.28)	756 (32.53)	1120 (48.19)	0 (0.00)	2324	1.31

Limnocalamus spp	924 (40.24)	0 (0.00)	868 (37.80)	504 (21.95)	2296	1.29
Senecella spp	364 (16.67)	364 (16.67)	812 (37.18)	644 (29.49)	2184	1.23
Copidodiaptomus spp	840 (40.54)	0 (0.00)	728 (35.14)	504 (24.32)	2072	1.17
Tropocyclops spp	756 (37.50)	308 (15.28)	952 (47.22)	0 (0.00)	2016	1.14
Notholca spp	728 (44.07)	588 (35.59)	0 (0.00)	336 (20.34)	1652	0.93
Apocyclops spp	812 (49.15)	0 (0.00)	840 (50.85)	0 (0.00)	1652	0.93
Polyarthra spp	0 (0.00)	0 (0.00)	868 (55.36)	700 (44.64)	1568	0.88
Arctodiaptomus spp	224 (25.00)	336 (37.50)	0 (0.00)	336 (37.50)	896	0.50

* Percentage relative abundance in parenthesis

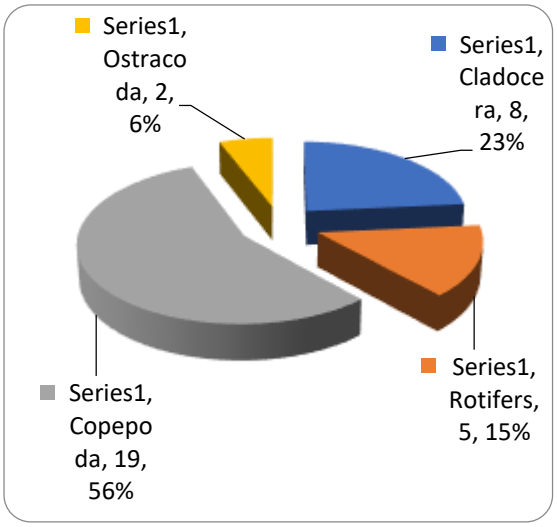

Figure 2: Percentage composition of zooplankton groups in Ikere-gorge, Nigeria

It is observed that highest abundance (66,416; 37.43%) of zooplankton was recorded in site C, followed by site A (41,160; 23.19%), site B (35,504; 20.01%) and site D (34,384; 19.38%). Higher abundance production of zooplankton (67.34%) was observed in the rainy season than in the dry season with 32.66% zooplankton abundance. Highest abundance of zooplankton (13.21%) was recorded in the month of June followed by the months of September (12.37%), August (12.24%) and July (10.87%). The least zooplankton abundance was recorded in the month of January (5.36%).

The analysis of diversity indices of the identified zooplankton species composition of Ikere-gorge is presented in Table 3. It is observed that the number of individual zooplankton collected from each sampling sites were Site A (41,160); Site B (35,504); Site C (66,416), Site D (34,384) and for the dam was 177,464. The total richness of zooplankton species obtained in Ikere-gorge was 34. The species richness of each sampling sites were Site A (32), Site B (29), Site C (32) and Site D (31). Other components of diversity are reported with their values for each site. Sampling sites A, B and C had the same value of Dominance D and Simpson index to be 0.06 and 0.94 respectively; while the value of Dominance D and Simpson index for site D are 0.05 and 0.95 respectively. Shannon Weiner index for Site A is 3.16, Site B is 3.10, Site C is 3.18 and Site D is 3.21. Evenness index for site A and C is 0.73, site B is 0.76 and site D is 0.77.

Table 3: Diversity indices of zooplankton of Ikere-gorge, Iseyin, Oyo State, Nigeria

Diversity variables	Site A	Site B	Site C	Site D	Ikere
Individuals	41160	35504	66416	34384	177464
Taxa_S (α)	32	29	32	31	34
Dominance_D	0.06	0.06	0.06	0.05	0.06
Simpson_1-D	0.94	0.94	0.94	0.95	0.94
Shannon_H	3.16	3.10	3.15	3.18	3.21
Evenness_e^H/S	0.73	0.76	0.73	0.77	0.73

Discussion

Zooplankton is an important component food web in freshwater ecosystem. This study examined the diversity, abundance and distribution of zooplankton in Ikere-gorge. Only 34 zooplankton genera belonging to four groups were identified in the lake. This is less than 75 species of zooplankton reported by Pinese *et al*. (2015) in the freshwater habitats of a Vereda Wetland Region in Minas Gerais, Brazil. Kar *et al*. (2018) also reported 46 taxa of zooplankton in wetlands of Cachar, Assam, India. Imoobe (2011) reported that there was a total of 51 species, made up of 3 families in Okhuo River, a Tropical Forest River in Edo State, Nigeria. Ajibare *et al*. (2019) reported twenty seven (27) species of zooplanktons including 9 families in the coastal waters of Ondo State, Nigeria.

It was also observed from the study that *Bosmina spp* belonging to Cladocera group has the highest relative abundance. But the family of Copepods recorded the highest number of zooplankton species in Ikere-gorge followed by Cladocera, Rotifer and Ostracoda. This is in agreement with the report of Maruthanayagam *et al* (2003) that copepods was the dominant zooplankton group followed by cladocera, rotifera and ostracoda

in Thirukkulam pond, Mayiladuthurai, Tamilnadu, India. Likewise, Kehinde and Ayoade (2012) reported that Copepods (54%) dominated the zooplankton fauna of Ikere-gorge, Iseyin. Also, Utah *et al*. (2008) reported that the Copepods were the most abundant zooplankton taxon constituting more than half (54.89%) of the zooplankton abundance in Calabar River, Nigeria. In aquatic environment including freshwater ecosystem, different stages of copepods are evenly distributed in separated regions in water column to avoid life-stage competition. Ezekiel *et al*. (2011) reported that Copepoda was the highest in Sombreiro River, Niger Delta, Nigeria.

The abundance of copepods in Ikere-gorge could be attributed to their higher life-cycle comparing to other planktonic organisms (Pinese *et al*. 2015). Barnes *et al*. (1988) reported that Copepods dominate most aquatic ecosystems because of their resilience and adaptability to changing environmental conditions and ability to withstand varying environmental stresses. According to Ferdous and Muktadir (2009), among the all zooplankton, copepods have the toughest exoskeleton and the longest and the strongest appendages which help them to swim faster than any other zooplankton. This adaptation helps them to escape their predators. Ezekiel *et al*. (2011) described copepod crustaceans as free-living filter feeder zooplankton and can be used in bio-monitoring of pollution. Copepods exhibit different feeding habits among their groups. Cyclopoids are commonly carnivorous feeding on other zooplankton, fish larvae, algae, bacteria and detritus. Calanoid are generally omnivorous. They feed on wide variety of phytoplankton species, ciliates, rotifers, algae, bacteria and detritus. The third group harpacticoid copepods are primarily benthic. Thus, their physical structures and versatile feeding habits ultimately assist them to hold up harsher environmental conditions as compared to cladocera (Ferdous and Muktadir 2009; Suthers and Rissik, 2009).

But, Pinese *et al*. (2015) reported that rotifers were the predominant group in freshwater habitats of a Vereda Wetland Region, Minas Gerais, Brazil; which is supported by Kar *et al*. (2018) that the rotifers dominated in terms of abundance in wetlands of Cachar, Assam, India. Imoobe (2011) also observed that the greatest diversity was observed among Rotifera with twenty-four taxa in Okhuo River, a Tropical Forest River in Edo State, Nigeria. This could be as a result of more abundance of aquatic plants in such water bodies than in Ikere-gorge. It is reported that rotifers is highest in association with submerged macrophytes, especially plants with richly divided leaves (Slideek, 1983; Edmondson, 1946). However, low representation of rotifers in Ikere-gorge could be an indication of low or moderate eutrophication of Ikere-gorge. This is because rotifers has been reported to be abundant in water body with excessive eutrophication ((Ferdous and Muktadir 2009)

Arazu and Ogbeibu (2017) reported that cladocera is the dominant zooplankton in River Niger at Onitsha stretch, Nigeria. Dimowo (2013b) also reported that Cladocera predominated both in terms of species composition and abundance in Ogun River, Abeokuta, Ogun State, Southwestern Nigeria. This study also reported appreciable percentage of Cladocera being the second largest group of zooplankton in Ikere-gorge. But, their low abundance in Ikere-gorge may be attributed to the fact that most fish heavily prey on them because they form an important fish food (Gogoi *et al*. 2016) while they also rely on phytoplankton as a food sources. According to Ferdous and Muktadir (2009) cladocerans are a crucial group among zooplankton and form the most useful and nutritive group of crustaceans for higher members of fishes in the food chain. Labaj *et al*. (2017) explained that cladocera respond both to bottom-up (changes in primary production) as well as top-down (changes in predation) shifts in the food web. Therefore, the population of cladocera are highly moderated by both the availability of phytoplankton as their food materials and the fish population that prey on them.

Low relative percentage of Ostracoda group reported in this study could be attributed to their ecology as bottom dwellers (Ferdous and Muktadir, 2009) and as a result escape plankton net during sampling. This study observed that there is higher abundant of zooplankton in rainy season than in the dry season. This corroborates the findings of Maruthanayagam *et al* (2003) that community size of zooplankton was the highest in rainy season while the lowest density of zooplankton was in summer due to the higher temperature. This could be attributed to increase nutrient concentration wash into the water body during the rainy season.

CONCLUSION

Zooplankton is an important biota of freshwater ecosystems. They are the major link in the food web of aquatic ecosystem. They graze on phytoplankton and in turn form a significant component of fish diet. The presence and abundance of these zooplankton groups in Ikere-gorge is an indication of abundance availability of natural food materials for fish production. They also simultaneously put phytoplankton population under control and thereby improving water quality of Ikere-gorge. The abundance of copepod in Ikere-gorge is an indication of pollution level in the dam. Therefore, the management of Ikere-gorge should be improved by paying strict attention to pollution control of the ecosystem.

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