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Zooplankton Composition and Abundance in River Wuye, Abuja, Nigeria

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ABSTRACT

A study of the zooplankton assemblage of River Wuye, Abuja, Nigeria was undertaken from December, 2019 - November, 2020. The aim was to determine the composition and abundance of zooplankton in the river. Water samples for zooplankton analysis were collected monthly from four sampling stations with varying anthropogenic activities along the river from upstream, through midstream to downstream. Thirteen (13) species of zooplankton belonging to three (3) phyla were encountered: Amoebozoa (3 species), Arthropoda/Cladocera (3 species) and Rotifera (7 species) with relative abundance of 52.48%, 2.13% and 45.39%, respectively. The most dominant species encountered was *Difflugia accuminata* with 41 Organisms/L (29.08%) and the least abundant species were *Chydorus alexandrovi, Diaphanosoma sarsi* and *Moina macrocopa*, 0.71%, respectively. Total abundance of zooplankton was 141 Organisms/L. Within the Stations, the highest abundance of zooplankton was encountered in Station 4 (52.48%) and the lowest in Station 3 (11%). The highest monthly abundance occurred in January with 29.79% and the least in July and October with 1.42%, respectively. Seasonal variation in the composition and abundance of zooplankton revealed that Rotifera was dominant in the wet season with 50.75% and Arthropoda (Cladocera) was the least abundant, 4.48%. In the dry season, Amoebozoa (Protozoa) was the most abundant with 59.46% and Arthropoda (Cladocera) was the least with no representation, 0%. Analysis of variance (ANOVA) indicated no significant difference in the values between stations, months and seasons ($p>0.05$) respectively for Rotifera ($p=0.213, 0.120, 0.122$) and Arthropoda/Cladocera ($p=0.219, 0.020, 0.212$). However, ANOVA values showed significant difference ($p<0.05$) in the values between stations, months and seasons respectively for Amoebozoa ($p=0.018, 0.00, 0.026$). Shannon-Wiener Species Diversity Index (H') and Simpson's Diversity Index values were respectively highest in Station 1 (2.207, 0.8699) and lowest in Station 2 (1.617, 0.7603), with the order of diversity Station 1>4>3>2. The highest value of Margalef's Richness Index was 3.04 in Station 3 and the lowest, 1.618 in Station 2 (order for richness, Station 3>1>4>2). Pearson's Correlation showed several significant positive relationships between zooplankton species and a few inverse relationships. Effective monitoring of the river and control of anthropogenic activities with community enlightenment are recommended; as well as further work on the interaction between zooplankton and environmental variables (physicochemical parameters) towards quality enhancement, productivity and sustainability of the freshwater resource.

Keywords: Zooplankton, Composition, Abundance, Diversity, River, Variation, Human Activities, Waste, Monitoring

1. INTRODUCTION

Zooplankton are microscopic invertebrates that swim or drift in the water, aligning with the flow of the current. They are an important link between primary producers (mostly phytoplankton) and secondary consumers, mostly fish [1] and thereby mediate the energy transfer from a lower trophic level to the higher one. They bring about changes in the composition and abundance of aquatic organisms which could have an important impact on public health and the sustainability of the river [2]. As primary consumers, they feed on small algae, bacteria and other phytoplankton. Zooplankton have been described as a dynamic community influenced by environmental variables, such as physicochemical parameters, seasonal dynamics as well as feeding ecology and predation pressure [3]. They are good bioindicators of water quality as they have the ability to reproduce and mature quickly under conditions that are not favourable [1, 2].

Studies on zooplankton dynamics have been useful in population ecology experiments and early warning systems, particularly in global warming and climate change modeling of biological populations [4].

Usman and Yerima, 20I7 found Protozoa, Rotifera and Cladocera to be tolerant and dominating under conditions of increased organic matter, run-off from fertilized fields and other human-induced impacts [5]. Zooplankton and water quality would be negatively impacted in the absence of proper monitoring and management. River Wuye is one of the freshwater bodies in Abuja, FCT, Nigeria [6]. Several research studies have been undertaken on the composition and abundance of various freshwater bodies, including rivers, water quality indices, fisheries of lakes and other water bodies; however, data and information on the zooplankton of River Wuye has been limited. This study aimed to document data and information on the zooplankton of River Wuye for conservation, sustainable use and management of the freshwater resource.

2. METHODOLOGY

2.1. Study Area

River Wuye takes its source from Zuba, Federal Capital Territory, Abuja, Nigeria. It lies between latitude 8.931940 and 9.118771^{0}N of the equator and longitude 7.105830 and 7.253962^{0}E of the Meridian. It is approximately 44.37km long with six tributaries and an estimated 316.4km^2 total area drained by the basin (Figure 1). It flows downward through some major settlements, including, Angwan Dodo, Gwako, Giri, Idon Kassa, from an elevation of 320.0 meters at Zuba; and empties into River Usuma in Gwagwalada, a tributary of River Gurara which empties into River Niger [6].

Anthropogenic activities vary along the river from the upper stream through the mid-stream and downstream. They include washing of clothes, extraction of water for irrigation (crop farming), domestic uses, drinking, sand mining/dredging, cattle watering. swimming and block-making.

2.2. Sampling Stations

Four sampling stations were selected based on human activities along the river: one upstream (around the source of the river), two midstream and one downstream by the mouth of the river. Highlights on the respective stations are as follows:

Station 1 (SP1), located upstream at the source of River Wuye at Zuba at latitude 9.118771^{0}N, longitude 7.25396^{0}E and altitude of 320 meters above sea level. A

major part of its substratum was rocky and the bank had mounds of rocks and coarse sand. Crop farming around the river, washing of clothes and fetching of water for domestic use were the main activities identified at the Station.

Station 2 (SP2) - located 23.4km downstream of the first station at latitude 9.01097^{0}N, longitude 7.21393^{0}E and altitude of 263 meters above sea level. It was at the point of intersection of the second tributary of River Wuye with significant anthropogenic activities including sand mining, cattle rearing, crop farming and sand mining. The river passed through an Army Cantonment and a cattle ranch by which a small stream flowed and emptied into River Wuye.

Station 3 (SP3) - located at latitude 8.99236^{0}N, longitude7.15283^{0}E and altitude of 213.0 meters above sea level. It was after the point of intersection of a tributary from Wusa/Pasere Hill Ranges with River Wuye at Giri. Activities around the sampling station were sand mining, crop farming, cattle grazing and watering; waste disposal, bathing and swimming.

Station 4 (SP4) - It was at the mouth of River Wuye (downstream) before emptying into River Usuma at Gwagwalada, latitude, 8.93194^{0}N, longitude, 7.105830^{0}E and altitude, 177.0 meters above sea level. Activities around the sampling station were crop farming, cattle rearing, block-making and human settlement.

2.3. Sample Collection and Analysis

Surface water samples were collected monthly in the morning between 6.30 and 10.30am from the four sampling stations for twelve months, December, 2019 to November, 2020. The water samples were collected using a fabricated handheld plankton sampler with net of 55 microns mesh size, linked to a 500ml collection bottle at the bottom [7-10]. The net was towed horizontally after lowering it below the water surface. The collected zooplankton samples were preserved with 4% formalin in labelled 250ml polyethylene bottles (with screw lid) and transported in ice chest to the laboratory for identification and counting. The preserved samples were allowed to settle (sedimentation) for 3 days after which decantation method was used to reduce to 10ml. The concentrated samples were well mixed and the drop count method was used to enumerate zooplankton and identify the organisms using an Olympus Binocular Microscope and a digital microscope (Celestro LCD Deluxe Digital Microscope, Model: #44345). Taxonomic

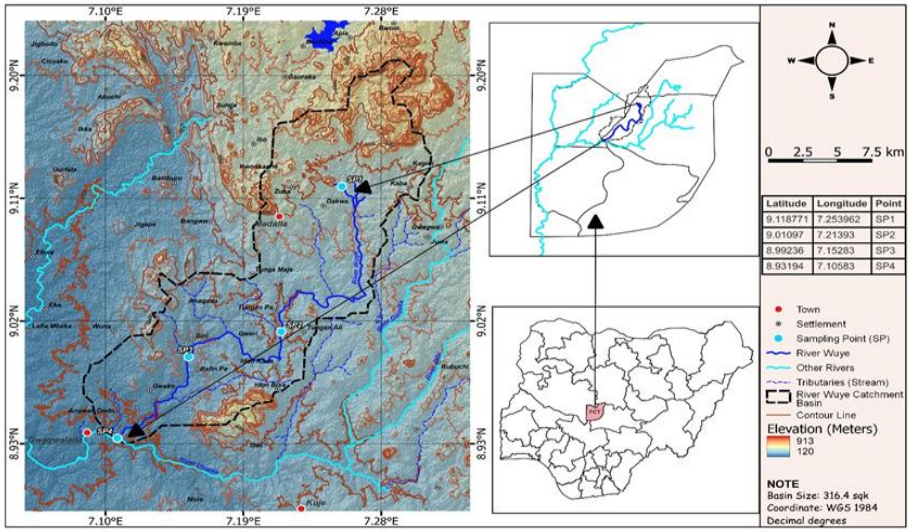

Figure 1. Map of the Study Area showing sampling stations

keys were used for identification, which included [11-19].

Shannon Wiener, Simpson Diversity Index (H') were used to calculate species diversity and analysis of variance (ANOVA) was used to determine the level of significance of zooplankton abundance across stations, months and seasons. Values were considered significant at $p<0.05$ (95% confidence level). Statistical analysis was performed using Paleontological Statistic (PAST) Programming Software version 2.12, XLSTAT and Statistical Package for Social Sciences (SPSS).

3. RESULTS AND DISCUSSION

The results of the assessment of zooplankton of the river are summarized in Tables 1-6 and Figures 2-5.

3.1. Zooplankton Composition and Abundance

A total of thirteen (13) species of zooplankton belonging to three (3) Phyla, four (4) Classes, five (5) Orders and nine (9) Families were encountered. The Phyla were: Amoebozoa (3 species), Arthropoda (Cladocera, 3 species) and Rotifera (7 species) with relative abundance of 52.48%, 2.13% and 45.39%, respectively (Table 1).

The most dominant species encountered during the period was *Difflugia accuminata* with 41 Organisms per Litre / Orgs/L (29.08%) and the least abundant species were *Chydorus alexandrovi*, *Diaphanosoma sarsi* and *Moina macrocopa*, with 1 Org/L, (0.71%, respectively. Total abundance of zooplankton was 141 Orgs/L with Amoebozoa (Protozoa) as the dominant phylum, 74 Orgs/L, 52.48%; followed by Rotifera with 64 Orgs/L. 45.39%, but contributing the highest number of species and Arthropoda (Cladocera), 2.13% as the least represented.

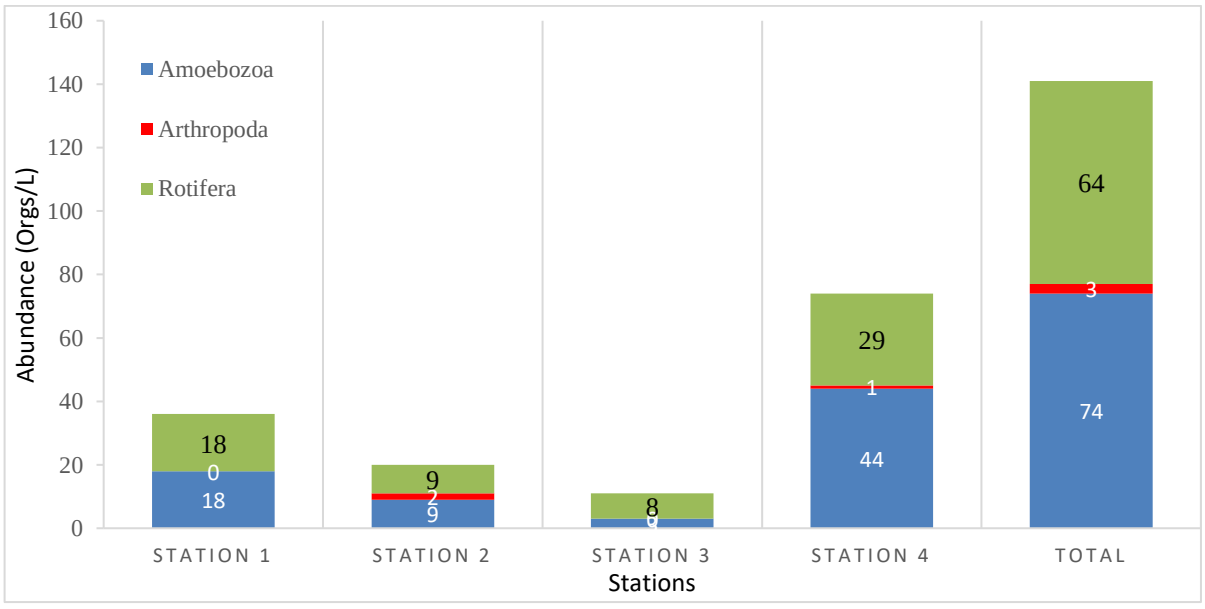

Figure 2. Zooplankton relative composition and abundance by station in River Wuye

The most abundant Class and Order were Tubulinea (Phylum Amoebozoa) and Arcellinida, 52.48%, respectively, followed by Monogononta (Phylum Rotifera) and Ploima, 38.30%, respectively. The most dominant Family was Difflugidae (2 species), contributing 39.01% of total abundance of the zooplankton assemblage. It was followed respectively in descending order of abundance by the Family Brachionidae (Phylum Rotifera), 3 species, with 19.16% relative abundance; Trichocercidae (2 species), 17.73%, Centropixidae (1 species), 13.48%, and Philodinidae, 7.09% relative abundance, The families with the least abundance were: Lecanidae, 1.42%; Chydoridae, Sididae and Moinidae with 0.71% abundance, respectively.

Within the stations, the highest abundance of zooplankton was encountered in Station 4 with 74 Orgs/L, 52.48% and the lowest in Station 3, 11 Orgs/L, 7.80% – Figure 2.

3.2. Monthly Variation in Zooplankton Composition and Abundance in River Wuye

Monthly variation in Zooplankton Composition and Abundance in River Wuye are shown in Table 2. The highest monthly abundance of zooplankton species was recorded in January, 2020, 42 Organisms/L, accounting for 29.79% of the total zooplankton community (Table 2). This was followed by April, with 13.48%, May, 12.77%, June, 2020, 8.51%, December, 2019, 9.93%, respectively. The least abundance recorded were in July and October, 0.71%, respectively. The variation of

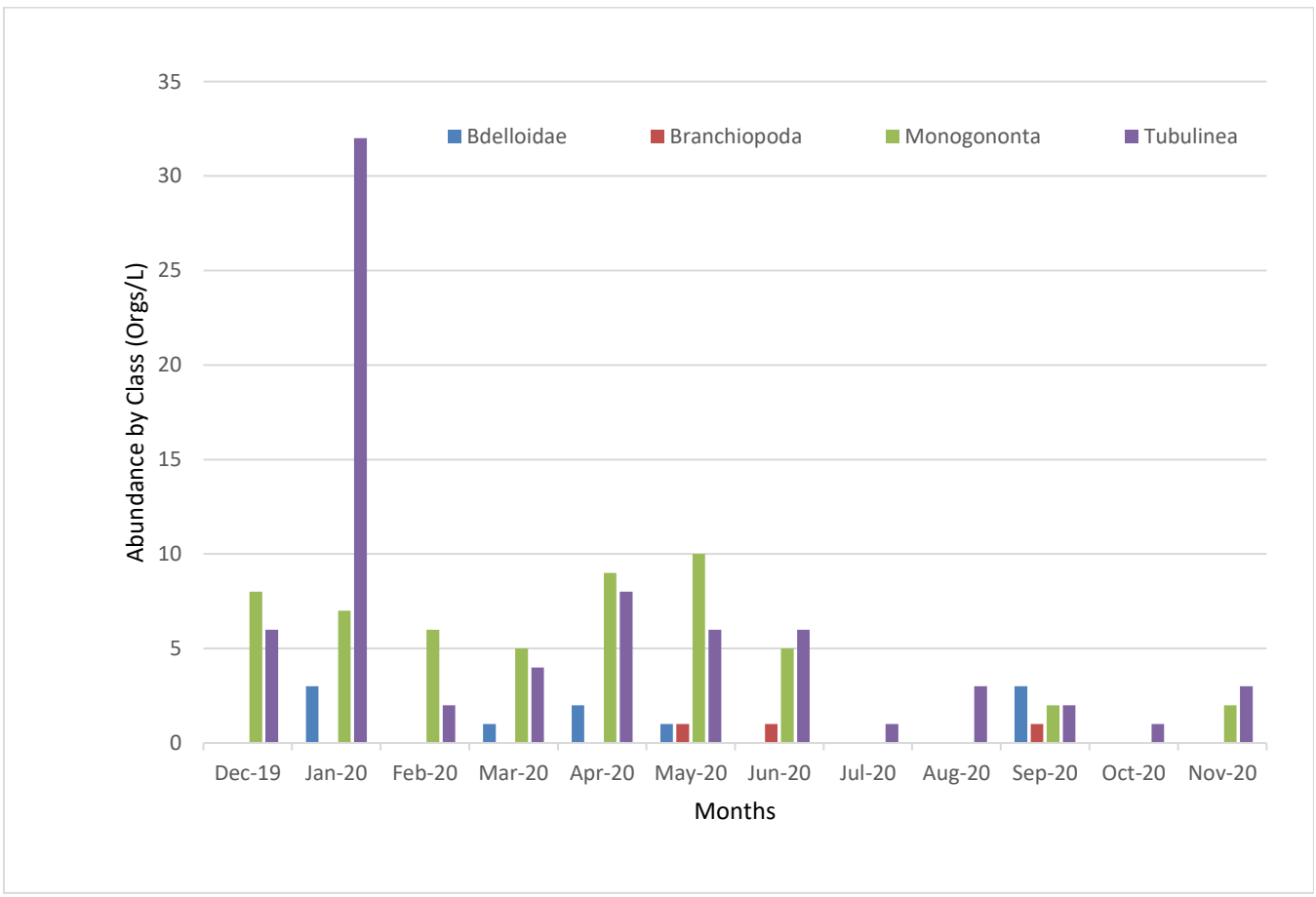

Figure 3. Monthly Variation in Zooplankton Abundance by Class

zooplankton composition and abundance by class are as illustrated in Figure 3.

3.3. Seasonal Variation in Zooplankton Composition and Abundance in River Wuye

Seasonal variation in zooplankton composition and abundance showed that Rotifera was the most abundant phylum in the wet season (50.75%) and ranked second in the dry season (40.54%) - Figure 4. Amoebozoa ranked first in the dry season (59.46%) and was second in the wet season (44.78%). Arthropoda (Cladocera) recorded the lowest abundance in both the wet and dry seasons. The overall total abundance by phylum recorded for the dry season (74 organisms/L) was higher than the wet season (67 Orgs/L) - Table 3.

Seasonal variation in zooplankton species composition and abundance are presented in Figure 5. The most abundant species in the wet season was *Difflugia accuminata* which also topped the list as the most abundant species in the dry season. In the wet season, it was followed in descending order by *Argonotholca foliacea* and *Trichocerca longiseta*. The least abundant members in the wet season were *Chydorus alexandrovi*, *Diaphanosoma sarsi* and *Moina macrocopa*.

In the dry season, the most abundant species was followed in descending order by *Centropyxis aculeata*, *Difflugia elegans*, *Trichocerca longiseta*, *Argonotholca folicea, among others*. All members of the zooplankton community encountered had representation in the wet season. However, some members had no representation in the dry season, namely, *Chydorus alexandrovi*, *Moina macrocopa* and *Plationus potulus potulus*.

3.4. Analysis of Variance (ANOVA)

Analysis of Variance for zooplankton in River Wuye showed no significant differences in the values between stations ($p>0.05$) for Rotifera ($p=0.213$) and Arthropoda ($p=0.219$). However, for Amoebozoa ($p=0.018$), there was significant differences in the values between stations ($p<0.05$)). For monthly values, ANOVA showed no significant differences in the monthly values ($p>0.05$) for Rotifera ($p=0.120$) and Arthropoda ($p=0.623$). However, for Amoebozoa, there were significant differences in the monthly values ($p<0.05$; $p=0.00$). ANOVA for seasonal

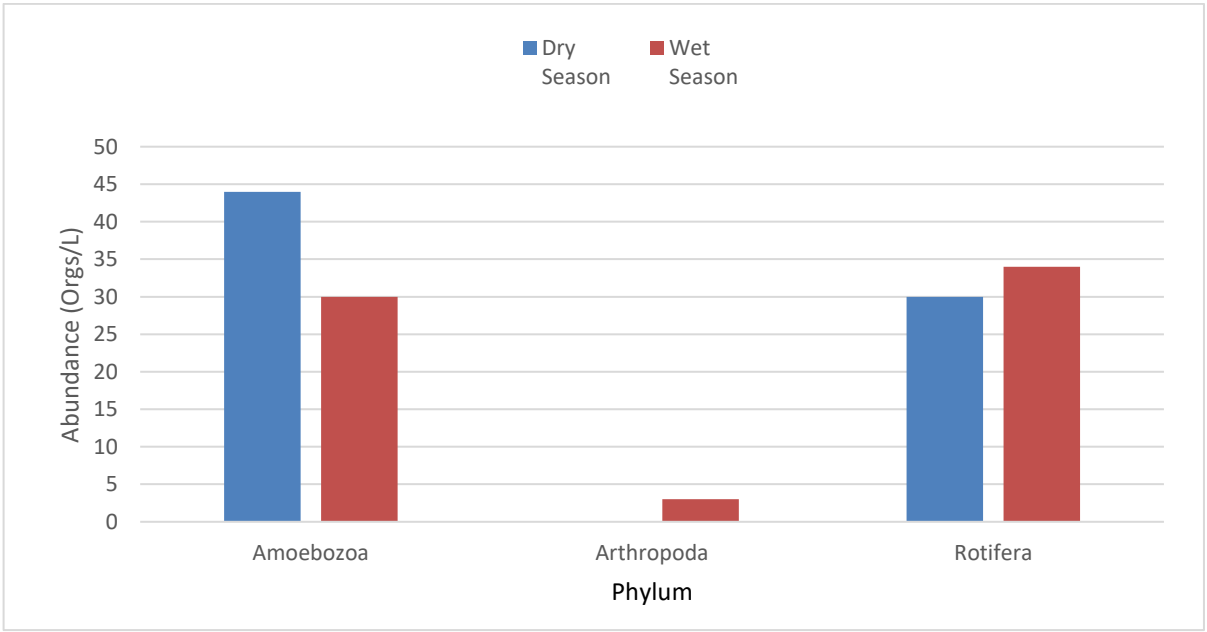

Figure 4. Seasonal Variation in Zooplankton Abundance by Phulum in River Wuye

Zooplankton abundance showed that the differences between the values for the wet and dry seasons were not significant ($p>0.05$) for Rotifera ($p=0.122$) and Arthropoda ($p=0.212$). The seasonal values were however significantly different ($p<0.05$) for Amoebozoa ($p=0.026$) -Table 4.

3.5. Diversity Indices

The highest Margalef Index of species richness was recorded as 3.04 in Station 3 whilst the lowest was 1.618 in Station 2. The order of Margalef Indices was Station 3>1>4>2. Simpson's Diversity Index was highest in Station 1, 0.8699 and lowest in Station 2, 0.760. The order was Station 1>4>3>2. For Shannon-Weiner Index (H'), the highest was in Station 1, with the value, 2.207 followed by Station 4, 2.17, Station 3, 2,025 and Station 2, 1.617. The order for Shannon-Wiener Species Diversity Index was Station 1>4>3>2. Highest value of Dominance index was 0.2397 in Station 2 and the lowest was 0.1301 in Station 1. The order for Dominance Index was Station 2>3> 4>1. The indices showed among other things that the most diverse station was Station 1 followed by 4 (based on both Shannon Wiener and Simpson's Index of diversity). Highest richness, evenness and equitability was in Station 3 (Margalef, Evenness and Equitability Indices), followed by 2 for Evenness and 1 for richness. Highest Dominance was in Station 2 followed by Station 3. Station 2 had the least diversity and richness whilst Station 4 had the least value of Evenness -Table 5.

3.6. Pearson's Correlation

Pearson's Correlation Analysis showed either a positive or negative relationship between different species of the three zooplankton phyla, where some were significant and others were not - Table 6. For example, there was a high positive relationship between: *Difflugia accuminata*

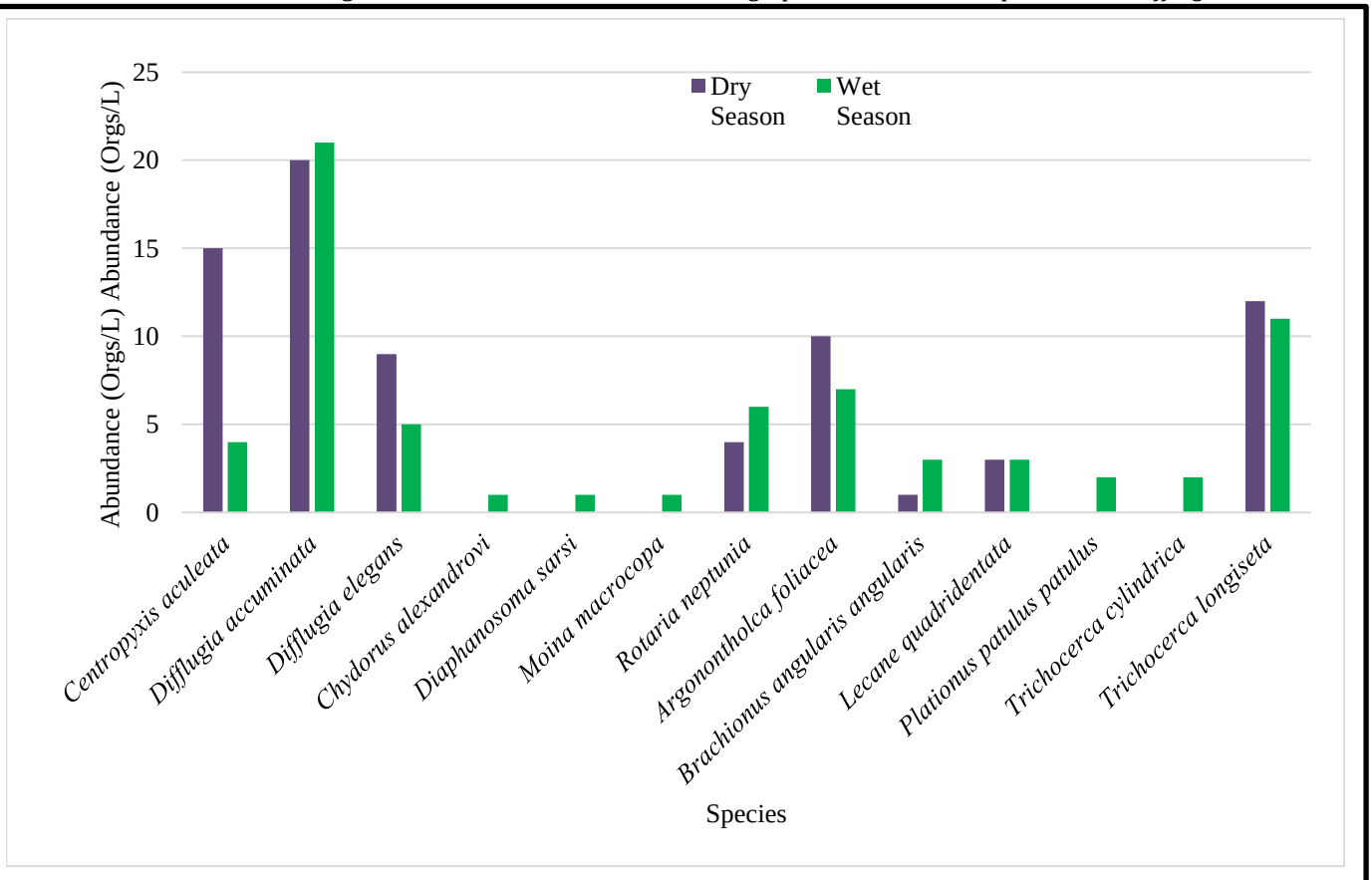

Figure 5. Seasonal Variation in Zooplankton Species Composition and Abundance in River Wuye (2019-2020)

and *Centropyxis aculeata* which is however not significant, r = 0.875, p = 0.125>0.05. The relationship between: *Trichocerca longiseta* and *Centropyxis aculeata*, r =0.980, p = 0.020, p<0.05, was significant at the 0.05 level; *Trichocerca longiseta* with *Difflugia elegans* showed another high positive correlation, r=0.962, p =0.038, p<0.05 (significant); with *Moina macrocopa*, r = 0.968, p = 0.032, p<0.05 (significant). For *Moina macrocopa* and *Difflugia elegans*, r = 0.997, p = 0.003, p<0.05 (significant), indicating a very strong and significant linear relationship. For *Rotaria neptunia* and *Moina macrocopa*, r =0.968, p = 0.032, p<0.05 (significant); *Difflugia elegans* and *Rotaria neptunia*, r = 0.957, p = 0.043, p<0.05 (significant). *Chydorus alexandrovi* and *Diaphanosoma sarsi* show a perfect significant negative correlation, r = -1.000, p = 0.000, p<0.05), *Lecane quadridentata* and the pair of *Chydorus alexandrovi* / *Diaphanosoma sarsi* also displayed a perfect negative correlation, r = -1.000, p = 0.000, p<0.05 (significant) [20] on River Asu noted from earlier works that zooplankton of freshwater ecosystems are characterised by the dominance of Rotifers, Copepods and Cladocerans. Although River Wuye assemblage included rotifers (with the largest number of species during the study period) and the presence of Cladocera (Order Diplostraca) from three families, Chydoridae, Sididae and Moinidae and Amoebozoa (Protozoa), the number of zooplankton groups, species and numbers were fewer in River Wuye than those found in River Asu [20] and Akor River where four zooplankton groups - Cladocera (9), Copepod (10), Protozoa (5) and Rotifer (7) were reported by Odo *et. al.* (2021).

According to [2] on River Alaknanda, Rotifers were more adaptable to various environmental conditions compared to other zooplankton species. The influence of physicochemical parameters on the composition, distribution and abundance of zooplankton were also reported.

The most abundant Class and Order in River Wuye were Tubulinea and Arcellinida (Phylum Amoebozoa, Kingdom Protozoa /Protista) followed by Monogononta and Ploima (Phylum Rotifera), respectively.

Rotifera was dominant in the wet season, 50.75% followed by Amoebozoa, 44.78% and Arthropoda (Cladocera), 4.48%, the least abundant. In the dry season, Amoebozoa (Protozoa) was the most abundant, 59.46% followed by Rotifera, 40.54% and Arthropoda, 0% (no representation). The most abundant species encountered was *Difflugia accuminata*, 29.08%, followed by *Trichocerca longiseta*, 16.3%. and *Centropyxis aculeata*, 13.49%. The dominance of *Difflugia* species in River Wuye is quite comparable to the case of Akor River, reported by [21] where four dominant species of zooplankton were recorded to include *Difflugia lebes*, *Diaphanosoma brachyurum* and *Brachionus plicatilis*.

[23] in Spatio-Temporal Distribuion and Abundance of Zooplankton Fauna in Relation to Physicochemical Characteristics of Ede-Erinle freshwater Reservoir found that rotifers had the highest number of species; while another group, Copepoda was the most abundant. This is quite comparable to the observation in River Wuye with Rotifera also having the largest number of species during the study period, while Amoebozoa (Protozoa/Protista) was the most abundant. Rotifers were also most abundant during the wet season for River Wuye.

[23] reported that the floating movements of plankton are so feeble that any little changes in water current influence the movement and composition of the organisms. Other studies also identified different factors based primarily on the nature of anthropogenic activities. It was indicated that very low abundance of some of the species may be attributed to environmental factors / changes in the ecosystem. V Furthermore, according to [24], zooplankton abundance and

composition are influenced by seasons and environmental conditions. Seasonal variation recorded in this study on the composition and abundance of zooplankton in River Wuye is consistent with the finding of [24] among other works such as [3] who attributed seasonal variation/succession of zooplankton communities in the tropics to a number of factors, such as the environmental characteristics of the water, predation, quality and quantity of edible algae and competition.

According to [25], the dominance of the phylum Rotifera and the order Ploima may be attributed to their ability to undergo vertical migration which minimizes competition through niche exploitation and food utilization. The lower abundance of some zooplankton species recorded in the dry season were also considered could be due to predation by fish. [26] reported that the juveniles of *Oreochromis* spp. and *Clarias* spp. were obligate planktivores.

[22] in a study of present and past Cladocera diversity, found that many species present earlier were not found in the study due to increasing pollution. The study concluded among other things that environmental changes have great influence on distribution of Cladocera, and therefore, they act as excellent indicators of pollution/ environmental changes. The limited number and diversity of Cladocera (Arthropoda, Order Diplostraca) in River Wuye are notable for further study and investigation in relation to environmental changes/parameters.

4. CONCLUSION

This study revealed that the composition and abundance of zooplankton in River Wuye varied by station (spatial), months and seasons. The results showed that the composition and abundance of zooplankton in River Wuye for the twelve-month period of the study comprised 13 Species belonging to 3 Phyla, Amoebozoa, Arthropoda and Rotifera, 4 Classes, 4 Orders and 9 Families. Total abundance was 141 Organisms/L with Amoebozoa as the dominant Phylum for the period, 52.48%; followed by Rotifera with 45.39% and Arthropoda (Cladocera), 2.13% as the least represented. Rotifera contributed the highest number of species (7 species). Seasonal variation in the composition and abundance of zooplankton species revealed the phylum Rotifera was dominant in the wet season, 50.75% followed by Amoebozoa, 44.78% and Arthropoda (Cladocera), 4.48% as the least abundant. The study has provided data and information that should promote understanding of the River and encourage further work for the management of the river to enhance its productivity and conserve its biodiversity.

5. RECOMMENDATION

Effective monitoring of the river, control of anthropogenic activities and enlightenment of the relevant communities are recommended for quality enhancement, productivity and sustainability of the water body [27-29]. Further work on the interaction between zooplankton and environmental variables (physicochemical parameters) should also be done. Necessary provision should be made for potable water for the community to reduce stressors on the freshwater resource.

6. ACKNOWLEDGEMENT

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7. CONFLICT OF INTEREST

The authors have declared that there is no conflict of interest.

8. SOURCE/S OF FUNDING

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Annexure 1

Table 1. Zooplankton Composition and Abundance in River Wuye (Dec 2019-Nov 2020)

Phylum	Class	Order	Family	Genus and species	No. of Organisms/Litre					% Abundance by:				
					Stations				Total					
					1	2	3	4		Species	Phylum	Class	Order	Family
Amoebozoa	Tubulinea	Arcellinida	Centropixidae	*Centropyxis aculeata*	5	0	1	13	19	13.48	52.48	52.48	52.48	13.48
			Difflugidae	*Difflugia accuminata*	13	8	2	18	41	29.08				39.01
				Difflugia elegans	0	1	0	13	14	9.93				
Arthropoda	Branchiopoda	Diplostraca (Cladocera)	Chydoridae	*Chydorus alexandrovi*	0	1	0	0	1	0.71	2.13	2.13	2.13	0.71
	Branchiopoda		Sididae	*Diaphanosoma sarsi*	0	1	0	0	1	0.71				0.71
	Branchiopoda		Moinidae	*Moina macrocopa*	0	0	0	1	1	0.71				0.71
Rotifera	Bdelloidae	Bdelloida	Philodinidae	*Rotaria Neptunia*	0	0	2	8	10	7.09	45.39	7.09	7.09	7.09
	Monogononta	Ploima	Brachionidae	*Argonontholca foliacea*	6	6	1	4	17	12.06		38.30	38.30	19.16
				Brachionus angularis angularis	1	0	1	2	4	2.84				
				Plationus patulus patulus	2	0	2	2	6	4.26				
			Lecanidae	*Lecane quadridentate*	2	0	0	0	2	1.42				1.42
			Trichocercidae	*Trichocerca cylindrica*	2	0	0	0	2	1.42				17.73
				Trichocerca longiseta	5	3	2	13	23	16.31				
				Total Abundance	36	20	11	74	141					
				% Abundance	25.53	14.18	7.80	52.48						

Table 2. Monthly Variations of Zooplankton Species Distribution and Abundance in River Wuye (Dec. 2019 – Nov. 2020)

Phylum	Class	Genus and species	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Total	% Abundance Species
Amoebozoa	Tubulinea	*Centropyxis aculeata*	3	12	0	0	0	0	3	0	1	0	0	0	19	13.48
		Difflugia accuminata	3	12	2	3	6	6	1	1	2	2	1	2	41	29.08
		Difflugia elegans	0	8	0	1	2	0	2	0	0	0	0	1	14	9.93
Arthropoda	Branchiopoda	*Chydorus alexandrovi*	0	0	0	0	0	0	0	0	0	1	0	0	1	0.71
		Diaphanosomasarsi	0	0	0	0	0	0	1	0	0	0	0	0	1	0.71
		Moina macrocopa	0	0	0	0	0	1	0	0	0	0	0	0	1	0.71
Rotifera	Bdelloidae	*Rotaria Neptunia*	0	3	0	1	2	1	0	0	0	3	0	0	10	7.09
	Monogononta	*Argonontholca foliacea*	3	4	1	2	2	2	2	0	0	0	0	1	17	12.06
		Brachionus angularis angularis	0	0	0	1	0	2	1	0	0	0	0	0	4	2.84
		Lecane quadridentata	2	0	1	0	0	1	2	0	0	0	0	0	6	4.26
		Plationus patulus patulus	0	0	0	0	0	2	0	0	0	0	0	0	2	1.42
		Trichocerca cylindrica	0	0	0	0	0	0	0	0	0	2	0	0	2	1.42
		Trichocerca longiseta	3	3	4	2	7	3	0	0	0	0	0	1	23	16.31
Total			14	42	8	10	19	18	12	1	3	8	1	5	141	

Table 3. Seasonal Variation Of Zooplankton Composition And Abundance By Phylum

	Dry Season		Wet Season	
Phylum	**Total Abundance (Orgs/L)**	**% Abundance**	**Total Abundance (Orgs/L)**	**% Abundance**
Amoebozoa	44	59.86	30	44.78
Arthropoda	0	0.00	3	4.48
Rotifera	30	40.54	34	50.75
Total	**74**		**67**	

Table 4. Analysis Of Variance (ANOVA) by Station, Months and Seasons for River Wuye, 2019-2020

Phylum	P- Value by:		
	Stations	Months	Seasons
Amoebozoa	0.000	0.018	0.026
Arthropoda	0.623	0.219	0.212
Rotifera	0.120	0.213	0.122

Table 5. Diversity Indices of Zooplankton Abundance in Different Sites in River Wuye (Dec 2019-Nov 2020)

	STATIONS			
	1	2	3	4
Taxa_S	11	6	8	12
Individuals	31	22	10	75
Dominance_D	0.1301	0.2397	0. 14	0. 1378
Simpson_H	0.8699	0.7603	0.86	0.8622
Shannon_H	2.207	1.617	2.025	2. 17
Evenness	0.8263	0.8394	0.9473	0.7299
Margalef	2.912	1.618	3.04[1]	2.548
Equitability	0.9204	0.9023	0.974[1]	0.8733

Table 6. Pearson's Correlation between Zooplankton Species and River Wuye (2019- 2020)

		1	2	3	4	5	6	7	8	9	10	11	12	13
Centropyxis aculeata	R													
Difflugia accuminata	R	0.875	--											
	P_Value	0.125												
Difflugia elegans	R	0.91	0.755	--										
	P_Value	0.09	0.245											
Chydorus alexandrovi	R	-0.536	-0.219	-0.262	--									
	P_Value	0.464	0.781	0.738										
Diaphanosoma sarsi	R	-0.536	-0.219	-0.262	1.000**	--								
	P_Value	0.464	0.781	0.738	0.000									
Moina macrocopa	R	0.931	0.754	.997**	-0.333	-0.333	--							
	P_Value	0.069	0.246	0.003	0.667	0.667								
Rotaria Neptunia	R	0.872	0.585	.957*	-0.44	-0.44	.968*	--						
	P_Value	0.128	0.415	0.043	0.56	0.56	0.032							
Argonontholca foliacea	R	0.054	0.53	-0.033	0.494	0.494	-0.071	-0.317	--					
	P_Value	0.946	0.47	0.967	0.506	0.506	0.929	0.683						
Brachionus angularis angularis	R	0.898	0.596	0.771	-0.816	-0.816	0.816	0.863	-0.346	--				
	P_Value	0.102	0.404	0.229	0.184	0.184	0.184	0.137	0.654					
Lecane quadridentate	R	0.536	0.219	0.262	-1.000**	-1.000**	0.333	0.44	-0.494	0.816	--			
	P_Value	0.464	0.781	0.738	0.000	0.000	0.667	0.56	0.506	0.184				
Plationus patulus patulus	R	0.028	0.268	-0.367	-0.333	-0.333	-0.333	-0.44	0.494	0	0.333	--		
	P_Value	0.972	0.732	0.633	0.667	0.667	0.667	0.56	0.506	1	0.667			
Trichocerca cylindrica	R	0.028	0.268	-0.367	-0.333	-0.333	-0.333	-0.44	0.494	0	0.333	1.000**	--	
	P_Value	0.972	0.732	0.633	0.667	0.667	0.667	0.56	0.506	1	0.667	0		