Assessment of water quality of Lake Dogodogoin Burundibased onzooplankton diversity indices

Abstract

A study of zooplankton diversity and water qualityof Lake Dogodogo located in West Burundi was carried out from April to July 2021 in six sampling stations,with four selected in the littoral zoneand two remaining in pelagic one.The main objective was to assess thewater quality using zooplankton diversity indices for a better management of this fishery resource essential for the surrounding populations. The zooplankton sampling was collected twice a month between 8 A.M and 11 A.M each time. The samples were taken vertically using plankton net with a 50 µm of mesh size, 26 cm in diameter and 0.5m depth. We recorded30 zooplankton species, 19 of rotifers, 9 of copepods and 2 of cladocerans. The number of speciesvaried from one station to another and from the littoral zone to pelagic zone. The abundance of zooplankton was higher in the pelagic zone than the littoral one. We then highlighted species specific for pelagic zone,such as*Anuraeopsisfissa*, *Brachionusangularis*, *Brachionuscalyciflorus*, *Brachionusfalcatus* and *Keratellatropica*. These latter are indicators of a high trophic level. According to the diversity indices calculated, the Dogodogo'swater quality is moderately polluted bya low level contamination of agricultural origin. Therefore, it is necessary to protect this important resource for fish production purposes, which is essentialin protein supply for human life.

Keywords: Aquatic Ecosystem,Cibitoke Province,Zooplankton Composition, Biodiversity

1. INTRODUCTION

Agricultural activities carried out by humans, organic matter loads and dissolved substances from domestic effluents contribute to changes of watercomposition in aquatic environments [1]. Many substances are washed away by drainage water or runoff leaching fertilizers and phytosanitaryproductsand wastewater from urban areas enriched with organic matter.

In rural areas, these waters are subject to agricultural pollution due to pesticides, fertilizers and livestock residues. The long-term result is deterioration in water quality, reduction in diversity and even the disappearance of water bodies [2]. These modifications affectsignificantly the food webs [3].

For thousands years and especially during the last decade, water engineering has been conducted to ensure a reliable supply of water, limit flood damage, and to avoid or clean up pollution [4]. In the absence of scientific criteria, water quality was assessed using simple criteria. Knowing its origin, a simple visual estimate of its color was enough to declare that the water was drinkable. The physico-chemical criteria of water need to be supplemented by the characterization of biological community indicators to determine the quality of the environment [5]. The use of diversity indices can then be an approach for estimating the biological and ecological quality of an ecosystem through the structure of the community. It can also provide information on pollution levelsin an environment [6, 7].

Both zooplanktonand macroinvertebrates constitute a tool for biological monitoring of aquatic environments. It is one of the first links in the food chain in aquatic environments [8]. Depending on their lifestyle, their reactions to various disturbances as well as the modification of the composition of the water, zooplankton have become an excellent indicator of climate change [9]. It can be used to study the disturbances that can occur in an aquatic ecosystem [10]. Zooplankton holds a key place in food webs, link primary producers and secondary consumers[11] and serve as an important food source for aquatic organisms, especially fish[12]. Planktivorous fish are in turn hunted by predatory fish. The chain continues until human nutritional needs are met. These organisms are also used for the study of ecological interactions[13].

Regarding the management of aquatic ecosystems, without measuring physico-chemical parameters each time, zooplankton species can be used as a biological indicator of pollution and eutrophication [8, 14].

The study of zooplankton helps in the developmentof an effective strategy for managing fishery resources [15]. The alteration of food states in the water column leads to profound changes in the structure of zooplankton communities. It is made up of organisms that are very sensitive to the variations in their environment conditions, withthe relatively short period of time [14, 16]. Some species are largely tolerant to certain environmental conditions and are therefore used as indicators of water pollution [17].

The study of taxonomy, distribution and biology of species is an essential tool for the further development of research, but the inventory of aquatic species remains an unfinished task. In tropical regions, the fauna and flora are poorly known. An estimated of 90% of microorganisms present in the environment have not yet been well described [18].Burundi has adopted in its commitments through the water code, the establishment of legislation in favor of the environment and biodiversity in general and the limitation of water pollution, in particular those of the Lake Tanganyika[19]. Burundi has many

lakes that are subject to anthropogenic pressures. Lake Dogodogo is one of the aquatic systems of Burundi located in the northwest of the country in the province of Cibitoke. As per our knowledge, no study has been conducted on its biotic and abiotic components. Lake Dogodogo is a shallow Lake surrounded mostly by fields of rice, maize, and cassava. Thus, its waters receive different types of agricultural fertilizers from the amendment of crops and pesticides. These substances discharged into the lake change the chemical composition of the water and the animal community'scomposition living thereresulting in degradation of biodiversity in general and zooplankton in particular.The overall objective of the study was to assess zooplankton diversity and water quality of Lake Dogodogousing zooplankton diversity indices for the sustainable management of this fishery resource, which is very important for the surrounding populations, and finallyto have a database for decisions makers and researchers.

2. MATERIAL AND METHODS

2.1. Study area

Lake Dogodogo is located in northwest of Burundi,Cibitoke Province, in the Imbo plain. It is situated between 2° 50' 23.00" South latitude and 29° 05' 52.00" East longitude and 910m of altitude. It is a young reservoir located at 67 km far away from Bujumbura City and in the southern part,at 4 km far away from the chief town of Rugombo commune, along the National Road 5, in right side. This region is the westernmost and has the lowest altitude in Burundi [20].

The Lake occupies an area of 80 hectares with the largest pond havingmarshy valleys covering nearly 450 hectares. It is characterized by aquatic vegetation formed by water lilies and has a remarkable algal flora and some fish species. The edges of the lake are invaded by *Phragmitesmauritianus* and *Typhadomingensis* and tall grasses sailing on its water in an unexpected and mysterious way. Lake Dogodogobiodiversity also includes aquatic birds such as ducks [21] andits soil is sandy clay.

2.2. Sampling stations

A total of six stations were selected depending on their characteristics (Figure. 1) and four stations among them (St1, St2, St3 and St4) were selected in the littoral zone while the two remaining others (St5 and St6) were taken from the pelagic zone. The first station St1 with coordinates (S 2.84191^{o}, E 29.09506^{o}, altitude: 912 m)is located in front of the water outlet of the lake through the discharge canal towards Rusizi River. It is chosen to reflect the water quality of the lake at the outlet. The second station St2 with coordinates (S 2.84312^{o}, E 29.09919^{o}, altitude: 913 m) is located to the right side of the station St1near the rice fields and was selected to show the impact of irrigation water on zooplankton diversity.

The Stations St3 and St4 respectively with coordinates (S 2.83797^{o}, E 29.09956^{o}, altitude: 914 m) and (S 2.83543^{o}, E 29.09529^{o}, altitude: 910 m) are located at a few meters far away from the mouth of the irrigation canal from the rice fields. Station St4 is located at the left side of St3 and was chosen near the landing area for small fishing boats. Both Stations St 3 and St 4 were chosen to assess the influence of the nutrient supply in water on zooplankton composition.

The St5 with coordinates (S 2.83949^{o}, E 29.09763^{o}, altitude: 913 m) and station St6 with coordinates (2.83689^{o}, E 29.09626^{o}, altitude: 912m) are located in the middle of the lake, especially in the pelagic zone. These two stations were chosen to characterize pelagic zooplankton diversity.

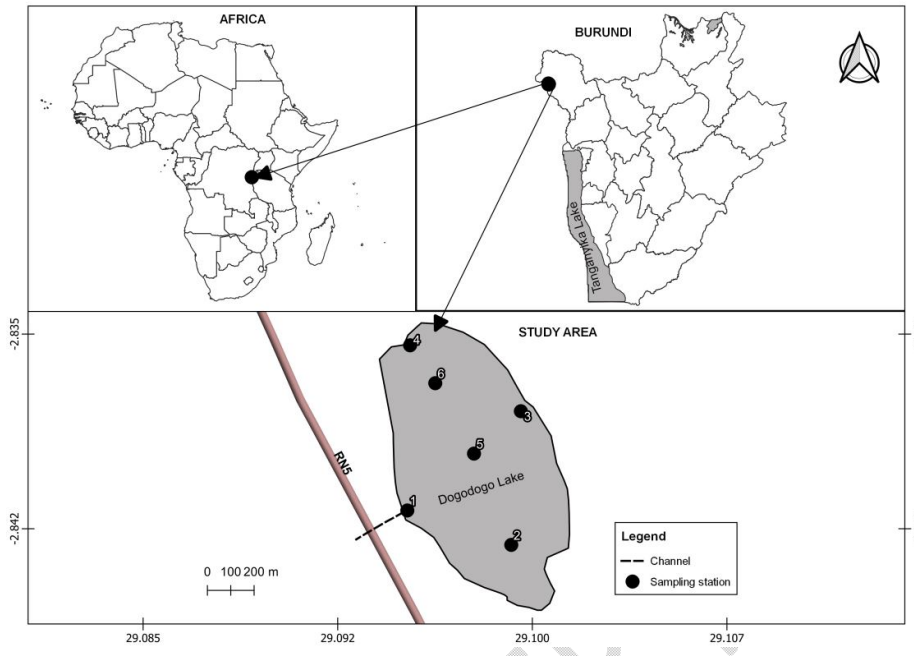

Figure 1: Location of LakeDogodogo and sampling stations

2.3. Sampling

The zooplankton sampling was carried out twice a month over a four-month period, from 4thApril to 25thJuly 2021. Sampling was done between 8 A.Mand 11 A.M each time. The samples were taken vertically using plankton net with a 50 µm of mesh size, 26 cm in diameter and 0.5m depth. At each sampling, the plankton net was immersed and then raised up to the surface. The water retained in the tap was allowed to flow and then collected. The zooplankton concentrate was then collected and preserved in a bottleby adding 5ml of 5% formalin solution [17,22,23].

At each station, sampling was repeated three successive times to constitute a composite sample. Six bottles labeled according to the order of the stations were used to preserve the samplesand then sent to the laboratory for microscopic analysis.

2.4. Observation, identification and enumeration of zooplankton

In the laboratory of Limnology, each zooplankton sample was concentrated to a volume of 50 ml. Zooplankton species were identified by microscopic observation usingWF 10 X-18 MM optical microscope. This species identification operation was based on the specific morphological characters observable using different determination keys [24, 25, 26, 27, 28]. The individuals of each identified species were also counted using a Burker Turk enumerationcell(Buhungu et al., 2019) [17]and the counting effort wasfixed at 400 individuals for each inventoried species. Thus, the count rate varied

according to species abundance up to 100% of sample for rare species. An extrapolation was then made on total volume of sample, on the one hand, and the volume of filtered water, on the other hand, to assess the densities per liter of the Lake water. The density was calculated using the following relation:

$$\mathbf{D} = \frac{\mathbf{1000} * (\mathbf{ni} * \frac{\mathbf{50}}{\mathbf{AR}})}{\mathbf{V}}$$

Where: **D:** The density (expressed in individuals per liter);

ni: The number of individuals recorded for species i;

AR: sample analysis rate corresponding to ni;

V:volume of filteredLake Water (ml)[17, 29].

2.5. Determination of Diversity Indices

i. **Simpson's abundance index** was used to assess the imbalance in terms ofindividual within the population. It is given by the formula: $D = \Sigma (ni / N)^2$,

Where: **ni**: The number of species i,

N: The total number of individuals considering all the species.

If the calculated value is closer to 100%, there is dominance of individuals of a few taxa [23].

ii. **Shannon-Weaver diversity index** establishes the link between the number of species and the number of individuals in the same ecosystem or the same community [15]. It wascalculatedaccording to the following formula:

$$\mathbf{H'} = -\sum \left(\frac{\mathbf{ni}}{\mathbf{N}}\right) \mathbf{log_2} \left(\frac{\mathbf{ni}}{\mathbf{N}}\right)$$

Where: **H':** The value of the Shannon diversity index,

Σ: The sum of the results obtained for each of the species present,

ni: The number of species i,

N: The total number of individuals of all species,

$\log_2$: The logarithm of base 2.

This index helps knowing the diversity of the species that make up the stands of a given environment (Adandedjanet al., 2017) [23].

iii. **Evenness index** was calculated using the formula of Piélou [30]:

$$\mathbf{J} = \mathbf{H'} / \mathbf{log_2}\, \mathbf{S}$$

Where: **H':** The Shannon-Weaver species diversity index;

$\log_2$ S: H'max,

S: The total number of species in the sample,

J: ThePiélou evenness index.

On one hand, the evenness index is derived from the specific diversity index and consists of comparing the diversity H' to its maximum value ($\log_2 N$). At the other hand, the evenness index helps in comparing the measured diversity to the theoretical maximum diversity [15].

iv. **Margalef species richness index** was used to assess the biological diversity of the different stations. This Indexis used to estimate the absolute species richness. Its value isobtained by the following formula:

$$RMg = S - 1 / \log (N)$$

Where: **N:** The number of individuals and

S: The total number of species[31].

The Margalef species richness index is the simplest way to measure biodiversity. It counts the number of different species in a given area[32].

2.6. Statisticalanalysis

The Statistical analyzes were performed using IBM SPSS Statistics version 22 and Canoco 5 software and those analyzes includes:One way Analysis of Variance (ANOVA-1)used to test the significance (at p=.05)of the differences between the mean data found forthe species identified at the different stations while a Principal Component Analysis (PCA) was applied to all the biotic parametersfor establishing the relationship between the biotic parameters andstudy stations, and to better understand their spatial distribution.

3. RESULTS

3.1. Species composition of zooplankton

A total of 30 zooplankton species belonging to three groups of zooplankton have been identified in Lake Dogodogo. Indeed, the rotifers group comprises of 19species (63.33%), copepods group contains 9species (30%) whereas cladocerans group contains only 2species (6.66%). These different species are distributed into 8 families and 16 genera. The most diversified families are Brachionidae with 8 species divided into 4 genera followed by the Cyclopidaewith 8 species and the Filinidae family with 4 species. The Trichocercidae, Asplanchnidae and Moinidae families are each represented by two species, while the rest of the families are monospecificlike the family of Lecanidae and Synchaetidae.The number of species varies from station to another and the highest species richness was observed at station 4 with 30species while 25 species were found at station 5.Among the 30species listed above, only seven species were not identified in all the stations: four species of rotifers, one species of copepods and two species of cladocerans. These are *Brachionuscalyciflorus*, *Brachionusplicatilus*, *Brachionusquadridentatus*, *Keratellasp*, *Macrocyclopsalbidus*, *Moinamacrocopa* and *Moinamicrura* (Table 1).

Table 1: Densities (mean, standard deviation) of species identified at different stations, comparison with one way ANOVA at (p= .05) Tukey's pairwise comparisons

Groups	Families	Speciess	St1	St2	St3	St4	St5	St6	mean± SD	Sig
Rotifers	Brachionidae	*Brachionusfalcatus*	69.05	92.73	227.90	206.21	368.01	206.58	195.07±107.32	S
		Brachionuscalyciflorus	2.24	2.24	1.55	0.36	0.00	0.00	1.06±1.07	S
		Brachionusplicatilus	0.00	0.00	0.00	0.18	0.00	0.23	0.06±0.10	S
		Brachionusangularis	237.65	128.40	357.82	249.79	495.35	595.11	344.02±174.82	NS
		Brachionusquadridentatus	0.00	0.18	0.00	0.18	0.00	1.37	0.28±0.53	S
		Brachionusmanjacavas	3.92	6.57	9.22	9.67	9.90	6.43	7.61±2.37	NS
		Keratellatropica	7.62	1.37	1.87	2.24	7.07	4.01	4.03±2.72	S
		Keratellasp	7.66	1.37	0.64	0.46	2.24	0.00	2.06±2.85	S
		Anuraeopsisfissa	1.78	2.51	1.46	2.65	0.73	6.89	2.66±2.18	S

	Trichocercidae	*Trichocerasimilis*	2.69	1.96	9.99	37.38	5.84	39.05	16.15±17.33	S
		Trichoceraelongata	14.01	9.72	16.15	9.17	11.91	17.11	13.00±3.29	NS
	Synchaetidae	*Poyarthra vulgaris*	76.79	74.23	134.70	98.58	156.49	229.98	128.46±59.38	NS
	Lecanidae	*Lecanemira*	0.46	0.87	0.23	2.55	1.09	1.28	1.08±0.82	NS
	Asplanchnidae	*Asplanchnagirodi*	1.00	3.42	1.55	2.92	3.79	4.70	2.89±1.39	S
		Asplanchnasp	6.66	6.57	10.25	21.76	7.12	7.30	9.94±5.94	NS
	Filinidae	*Filiniaterminalis*	55.98	29.61	73.99	18.57	59.85	51.37	48.22±20.47	S
		Filiniaopoliensis	26.46	1.96	3.79	2.01	29.20	34.58	16.33±15.29	NS
		Filinialongiseta	19.16	5.52	29.66	4.97	27.83	15.19	17.05±10.60	NS
	Philodinidae	*Rotariasp*	4.20	3.65	3.65	3.24	3.01	3.97	3.61±0.44	NS
Copepods	Cyclopoidae	*Macrocyclopsalbidus*	0.14	0.32	0.96	0.14	0.00	0.59	0.35±0.35	S
		Cyclops sp	0.23	0.00	1.19	3.10	1.41	2.92	1.47±1.30	S
		Diacyclopsthomasi	1.78	1.05	5.70	1.55	12.86	7.85	5.13±4.65	S
		Termocyclopsleukarti	22.35	12.82	23.36	15.08	103.27	97.57	45.74±42.58	S
		Thermocyclopscrassus	0.55	0.55	1.87	0.41	16.33	12.68	5.39±7.16	NS
		Acanthocyclopssp	0.41	2.83	1.78	0.78	0.96	2.65	1.56±1.01	NS
		Eucyclopsmacrurus	2.83	1.14	3.24	0.91	15.05	8.67	5.30±5.53	S
		Eucyclopsserrulatus	4.79	1.55	9.40	1.41	20.76	10.99	8.15±7.33	S
		Nauplii sp.	140.98	126.03	180.50	126.88	269.40	348.68	198.74±91.20	NS
Cladocerans	Moinidae	*Moinamicrura*	0.09	0.00	0.00	0.14	0.68	0.09	0.16±0.25	NS
		Moinamacrocopa	0.00	0.09	0.00	0.05	0.00	0.05	0.03±0.03	S

NS : non significance with (p> .05) ; S : significance with (p<.05) ; Sig : Significativity ; SD : Standard Deviation

Species such as: *Brachionusfalcatus*, *Brachionuscalyciflorus*, *Brachionusplicatilus*, *Brachionusquadridentatus*, *Keratellatropica*, *Keratellasp*, *Anuraeopsisfissa*, *Trichocerasimilis*, *Asplanchnagirodi*, *Filinaterminalis*, *Macrocyclopsalbidus*, *Cyclops sp*, *Diacyclopsthomasi*, *Termocyclopsleukarti*, *Eucyclopsmacrurus*, *Eucyclopsserratus*, *Moinamacrocopa* varied significantly (p<.05). While *Brachionusangularis*, *Brachionusmanjavacas*, *Trichoceraelongata*, *Polyarthra vulgaris*, *Lecanemira*, *Asplanchnasp*, *Filinaopoliensis*, *Filinalongiseta*, *Rotariasp*, *Thermocyclopscrasus*, *Acanthocyclopssp*, *Naupliisp*, *Moinamicrura*did not vary significantly (p >.05).

3.2. Temporal variation of identifiedspecies

The study showed that April had the highest density for all the identified species and in all stations except the species *Brachionusangularis* whose highest density was recorded in May and July. The months of June and July were characterized by a lower density for almost all species. *Brachionusangularis*, *Brachionusfalcatus*, *Polyarthra vulgaris* and *Nauplii* species show high densities in all months and were dominant in the zooplankton population found inLake Dogodogo (Figure 2).

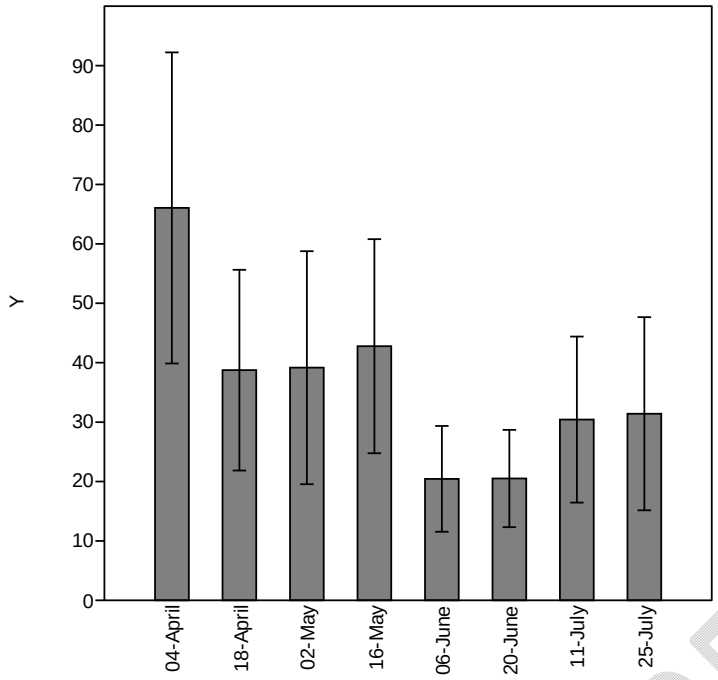

Figure 2: Temporal variation in total zooplanktonidentified

3.3. Spatio-temporal variation in the abundance of different zooplankton groups

The composition of zooplankton has fluctuated considerably over time. The highest density was recorded at station St6 while the lowest density is recorded at station St2 for both rotifers and copepods. The rainy season (April-May) recorded the highest abundances than the dry season (June-July). Rotifers remained the most abundant over time except for the samples collected on 20thJune where copepods were higher than rotifers. As for water fleas, they remained weakly abundant in space than in time (Figure 3).

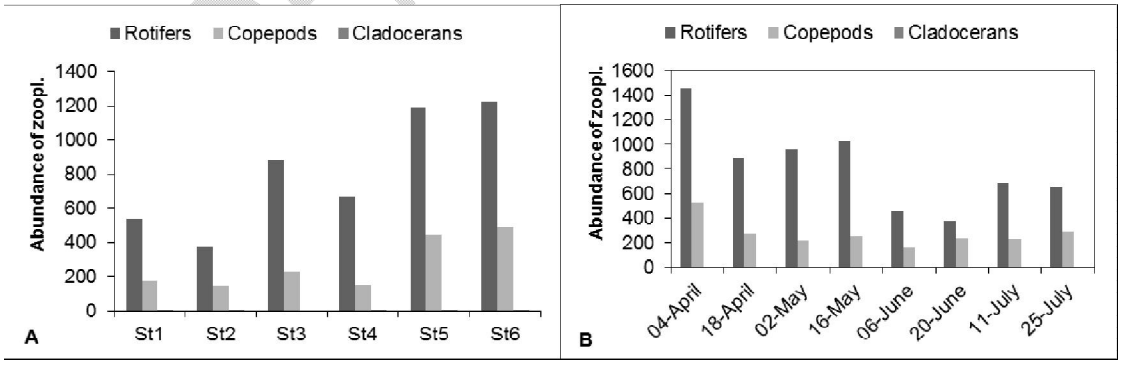

Figure 3: Spatial (**A**) and Temporal(**B**) variation in the abundance of zooplanktonic groups

3.4. Spatio-temporal variation of zooplankton diversity

The spatio-temporal variation of the diversity indices of Shannon, Piélou equitability, Simpson and Margalef were given. The highest value of the Shannon diversity index was recorded on 4th Aprilat station St 1 while the lowest value was recorded on 25thJuly at the same station. Regarding the Piélou

equitability index, the highest and lowest values were recorded respectively on 11thJuly and 25 th July at the first station.

The highest and lowest values of the Simpson index were noted respectively on 25 thJuly and16 th May at station St 1. For Margalef diversity index, the highest value was recorded on 20th June while the smallest was recorded on 11th July at station 1 (Table 2).

Table 2: Spatio-temporal variation of Shannon, Piélou, Simpson and Margalef indices

Stations	Dates	04-April	18-April	02-May	16-May	06-June	20-June	11-July	25-July	mean
St1	H'	3.23	2.93	2.86	2.96	1.9	2.62	2.97	1.74	2.65
	J	0.73	0.64	0.66	0.71	0.48	0.31	0.8	0.42	0.59
	D	0.14	0.17	0.17	0.01	0.42	0.27	0.15	0.49	0.23
	RMG	6.7	6.48	7.89	6.55	5.74	8.74	4.14	5.45	6.46
St2	H'	2.8	2.44	2.53	3.08	2.24	2.61	2.05	1.8	2.44
	J	0.61	0.61	0.58	0.73	0.57	0.59	0.51	0.5	0.59
	D	0.19	0.29	0.25	0.14	0.28	0.26	0.34	0.44	0.27
	RMG	7.31	6.18	6.63	6.88	6.51	8.79	5.51	5.25	6.63
St3	H'	2.89	1.73	1.96	2.58	2.56	2.43	2.45	2.6	2.40
	J	0.64	0.4	0.5	0.62	0.58	0.61	0.56	0.67	0.57
	D	0.2	0.48	0.35	0.21	0.26	0.23	0.3	0.22	0.28
	RMG	6.69	5.91	4.44	5.56	7.05	5.13	6.82	5.44	5.88
St4	H'	2.59	2.75	2.29	2.4	2.52	2.67	2.09	2.11	2.43
	J	0.54	0.66	0.59	0.55	0.63	0.63	0.49	0.54	0.58
	D	0.01	0.2	0.26	0.27	0.25	0.25	0.38	0.34	0.25
	RMG	7.8	6.22	5.63	6.39	5.69	7.58	6.16	4.9	6.30
St5	H'	2.66	2.37	2.44	2.83	2.78	2.8	2.57	2.86	2.66
	J	0.58	0.52	0.56	0.63	0.66	0.67	0.68	0.66	0.62
	D	0.2	0.27	0.29	0.19	0.2	0.17	0.25	0.2	0.22
	RMG	6.56	6.65	5.91	6.41	6.23	5.83	4.57	6.16	6.04
St6	H'	2.62	3.04	2.31	2.55	2.6	2.46	2.66	2.42	2.58
	J	0.57	0.66	0.56	0.58	0.62	0.59	0.68	0.61	0.61
	D	0.22	0.16	0.29	0.25	0.22	0.27	0.23	0.3	0.24
	RMG	6.56	7.4	5	5.88	5.5	5.51	4.31	4.88	5.63

H': Shannon's index, J: Piélou's equitability index, D: Simpson's index, RMG: Margalef's index

3.5. Distribution of zooplankton species in the sampled stations and their similarities

A Principal Component Analysis (PCA) was performed to all the biotic parameters to highlight the relationships between the species and the sampled stations. The two axes explained respectively 40.38% and 27.41% of the global distribution of zooplankton species, a total variation of 63.23%. They provide sufficient information on their distribution in sampling stations. The PCA serves in distinguishing of the stations of the pelagic environment (St 5 and St 6) and those of the coastal area(St1, St 2, St 3 and St 4). The two axes selected the species of copepods like *Eucyclopsserratus*, *Eucyclopsmacrurus*, *Diacyclopsthomasi* and *Termocyclopsleukarti* which are positively correlated to them because of their abundance on the littoral zone. The species *Brachionusangularis* and

Polyarthra vulgaris are negatively correlated to them. The species *Keratellatropica*, *Brachionusquadridentatus*, *Macrocyclopsalbidis* and *Acanthocyclopssp*are weakly represented on the both axes due to their low abundances (Figure 4).

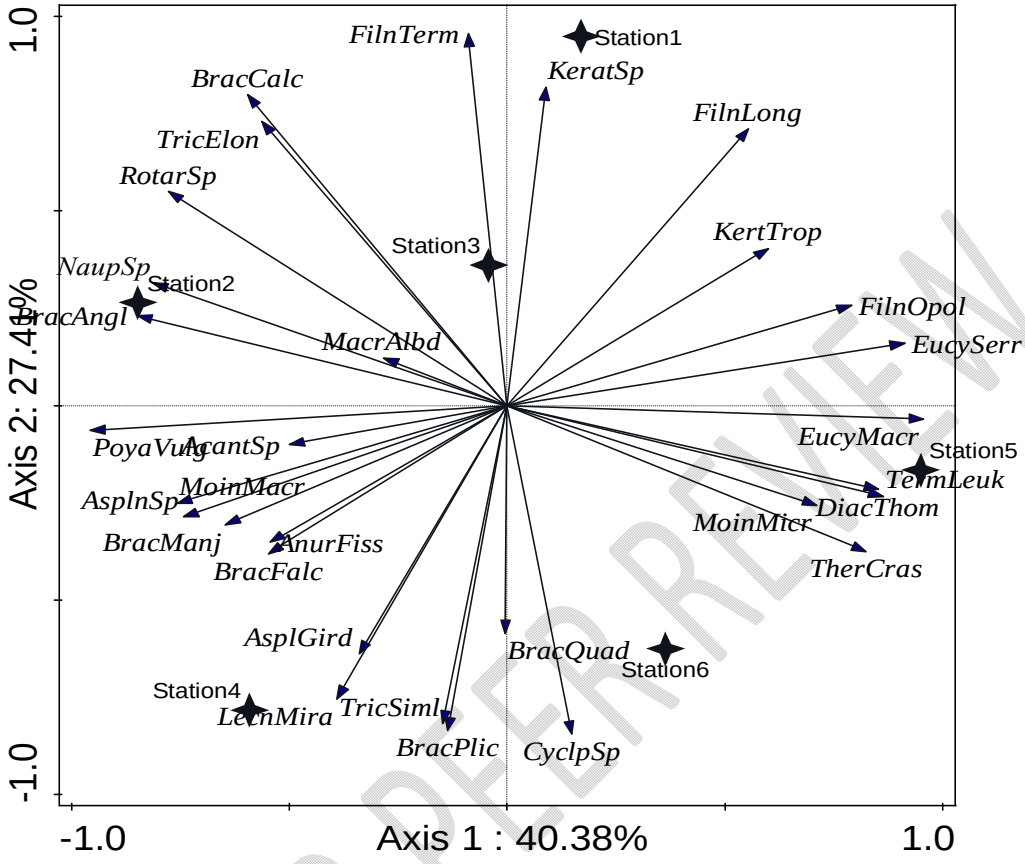

Figure 4: Principal Component Analysis (PCA) of zooplankton species in Lake Dogodogo

An ascending hierarchical classification grouped the stations similar to more than 75% St 1 and St 2, St 3 and St 4 and finally St 5 and St 6 compared to the total zooplankton. This classification also highlighted the coastal stations (St 1, St 2, St 3, St 4) and those of the pelagic zone (St 5, St 6)(Figure5).

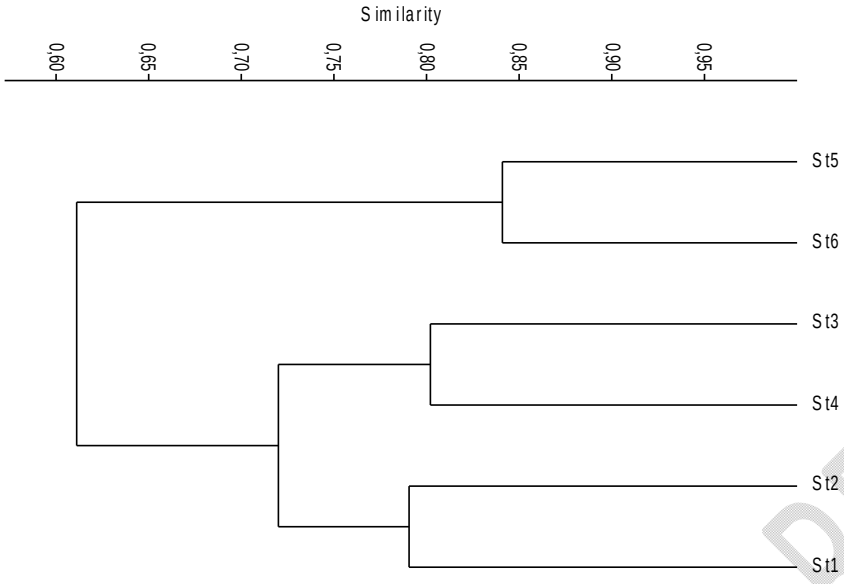

Figure 5: Similaritybetweensampled stations

4. DISCUSSION

4.1. Abundance and variation of zooplankton in Lake Dogodogo

During this study, three groups of zooplankton were identified. These groups are Rotifers, Copepods and Cladocera. The rotifers group was the most dominant followed by copepods and finally cladocerans. Similar results were found by Buhungu[17] in Kinyankonge River in Burundi and Fofana[2] in Kaby Lake in Ivory Coast.

In Lake Dogodogo, the rotifers group appeared to be more important than copepods and cladocerans. According to several authors, rotifers tend to dominate in terms of abundance in aquatic environments. Two main factors are mentioned to explain this numerical superiority of rotifers: (i)their opportunistic nature, which allows them to better resist to variations in environmental conditions, (ii) their greater competitiveness in these environments not only because of their food plasticity towards available resources, but also because of their small size, which makes them less vulnerable to predator pressure [13, 33].In Lake Dogodogo, the zooplankton composition fluctuates over time, the evolution seems to be similar between rotifers and copepods. In general, higher zooplankton densities recorded during the rainy season decrease dramatically during the dry season. The decrease in the population and specific richness of zooplankton in a lake system could be explained by the increase in temperature and acidity as well as the decrease in nutrients [34]. The dominance of rotifers in Lake Dogodogo during two seasons is a characteristic of tropical lakes [2, 23]. Fluctuations in the Shannon,

Piélou and Margalef index revealed certain instability in the structure of the zooplankton community over time.

Indeed, in May, which marks the transition between the wet and dry seasons, the abundance of rotifers has decreased. Species of the Brachionidae and Filinidae families dominate from April to July. These families are generally represented by the largest number of species belonging to the genera Brachionus, Keratella and Anuraeopsis. Thus, whatever the season, the species *Brachionusangularis*, *Brachionusfalcatus*,*Polyarthra vulgaris*, were dominant in the group of rotifers. These results coincide with those found by Tchapgnouo[15] of the Ossa lake complex (Ossa and Mwembè) in Cameroon.

During the dry season when temperatures are highest, the density of zooplankton, especially rotifers is low. This decrease in rotifers would be probably due to the variation in environmental conditions, especially pollution. The copepods population tended to approach that of rotifers. The development of copepods observed in dry periods would be linked in part to their ability to accept and withstand widely varying environmental conditions [26, 35]. This could also be explained by their possibility of surviving in the state of resting stages where certain species of this group can be transported from one environment to another and thus have a wider distribution area [36].

According to Maier [37], the development time of eggs, larvae and copepodid stages is inversely proportional to temperature. The abundance of zooplankton varied from station to station. This variation is attributed to hydrobiological conditions and trophic status [38]. It can be also due to the speed of the low current and the less turbid waters [39] as well as a high transparency of the waters, due to the sedimentation of heavy particles in suspension [22]. Station S3 is characterized by a high density of total zooplankton compared to stations S1 and S2 in the littoral zone. This proliferation of zooplankton in this coastal zone is probably due to the enrichment of the waterwhich could contain nitrates and phosphates from rice crops favorable to the development of phytoplankton grazed by zooplankton.

The study of zooplankton was carried out in the littoral zone on the one hand and in the pelagic zone on the other hand. A non-homogeneous distribution of rotifers and copepods between the littoral zone and the pelagic zone was noted. The pelagic zone represented by stations St 5 and St 6 has a high abundance compared to the littoral zone. This abundance could be explained by the existence of stable waters. Similar results were reported by Onana[33] with essentially pelagic species such as *Anuraeopsisfissa*, *Brachionusangularis*, *Brachionuscalyciflorus*, *Brachionusfalcatus*, *Brachionusleydigi* and *Keratellatropica*. Water fleas did not vary much at the sampled stations. This would be caused by the strong predation pressure towards these Water fleas.

4.2. Assessment of the water quality of Lake Dogodogo

Zooplankton organisms are sensitive and very reactive to variations in environmental conditions [40]. As a result, they are used as bioindicators of water quality [38]. The study revealed a high representativeness of rotifers compared to other zooplankton groups. Thus, the presence or absence of species could be an indicator of water pollution[41]. According to Margalef[42], a high representativeness of rotifers in freshwater aquatic environments can be considered as a biological indicator of a high trophic level [2]. According to Pourriot and Hillbricht-Ilkowsk[25] the presence of

species of the genus Brachionus, indicates hypertrophic water. The zooplankton composition recorded in Lake Dogodogo is similar to the results recorded in other organic pollution environments [33, 43, 44] mainly the waters of tropical environments[45].

A few diversity indices were used to assess the water quality of Lake Dogodogo. According to Simboura[46], the Piélou equitability index can be used to assess the water quality. These authors mentioned the following water classification categories:

The range $0.77 < E < 0.96$ indicates “very good quality water”, $0.46 < E < 0.77$ indicates “good quality water”, $0.30 < E < 0.46$ indicates “average quality water”, $0.21 < E < 0.30$ indicates “low quality water “and $0.09 < E < 0.21$ indicates “very poor quality water” [47]. In the present study, the average values of the Piélou index are in the range of 0.57 to 0.62. These values show that the waters of Lake Dogodogo are classified as “good quality waters”.

Shannon and Simpson indices were also used to assess the water quality [48] according to the following classification categories: $3 < H'$ (or $6 < D$) indicates clean water; $2 < H' < 3$ (or $3 \leq D \leq 6$) indicates low contamination; $1 < H' < 2$ (or $2 \leq D \leq 3$) indicates moderate contamination and $0 < H' < 1$ (or $2 < D$) indicates water with a high level of pollution. In the present study, the mean values of Shannon and Simpson indices fall within the respective ranges of 2.40-2.66 and 0.22-0.28. Only Shannon index indicates that the waters are of “low contamination level” while the Simpson index reveals high pollution. In general, among the three evaluated indices, two of them indicate that the waters of Lake Dogodogo are of low contamination level.

5. CONCLUSION

The study revealed that the zooplankton of Lake Dogodogo is essentially composed of Rotifers, Copepods and Cladocera. The Rotifera group was the most dominant followed by Copepoda and Cladocera. This zooplankton population is dominated by species belonging to the families Brachionidae and Filinidae characteristic of eutrophic conditions. The study also revealed that some identified species are essentially pelagic and indicative of a high trophic level. Some calculated diversity indices showed that the waters of Lake Dogodogo have a low level of contamination and this contamination is of agricultural origin.

To ensure a good future management of Lake Dogodogo, further research could focus on other taxa of animal or plant organisms living in Lake Dogodogo by including physico-chemical parameters over a long period. As a certain pollution threshold is discovered in the lake, some measures must be taken to protect this ecosystem which has a high potential for producing protein resources for human life.

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