World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(Research Article)

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Specific diversity and abundance of communities of microcrustaceans and rotifers in two ponds, Mokolo and Mopa in the city of (Bertoua, Cameroon)

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World Journal of Advanced Research and Reviews, 2022, 16(02), 625–635

Publication history: Received on 19 September 2022; revised on 06 November 2022; accepted on 09 November 2022

Article DOI: https://doi.org/10.30574/wjarr.2022.16.2.1084

Abstract

One of the major challenges of aquatic ecology is to understand how anthropization affects biodiversity and what the consequences on the functioning of hydrosystems. Physicochemical and zoolanktonic variables studied in two ponds (Mokolo and Mopa) in the city of Bertoua, with two sampling stations (surface and depth) per pond and data collected monthly from March 2016 to April 2017 (14 months) allowed us to appreciate the spatial and seasonal dynamics of zooplankton in relation to anthropogenic disturbances. Abiotic variables of the ponds show that they are highly anthropized with relatively high temperatures (> 23 °C), low water transparency (< 70 cm) despite the shallow depth of the ponds (< 170 cm), average oxygenation (> 50%) with hypoxia (< 35%) recorded in the rainy season, high mineralization of the waters, high levels of nutrients, organic matter and photosynthetic pigments (> 30 µg/L). These characteristics allow to classify these water bodies in the category of hypereutrophic ponds. Biological data show fairly diverse ponds with 63 species identified in Mokolo Pond representing 17.89% of the total abundance. In Mopa Pond, 75 species were identified representing 21.30% of the total abundance. This study allowed us to deduce that the structure and dynamics of microcrustaceans communities are under the control of different processes that interact simultaneously. It is mainly influenced by the season, predation and by the depth of sampling, the month and the station having no influence on this distribution.

Keywords: Abundance; Bertoua Ponds; Cameroon; Spatio-temporal variation; Specific diversity; Microcrustaceans

1. Introduction

Water is a natural resource essential to all life on earth. It is unevenly distributed and covers the ¾ of the earth's surface [1]. Despite this apparent abundance, less than 1% of this water is available for human needs. The rest is either too salty, located in inaccessible underground reserves, or frozen in the polar ice caps [2]. The water exploited by man for his needs is freshwater, which represents about 0.6% of the planet's water, i.e. 8 million km^3 distributed in rivers, lakes, groundwater and ponds [3].

A pond is a shallow (1-2 m), stagnant, artificial body of water, more or less completely drainable at a variable frequency [4]. Generally created by man, ponds come in a variety of forms and have ecological and economic interests. Like all aquatic environments, they are characterized by interlinked food chains forming a food web. These ecosystems host numerous biological communities (fish, macroinvertebrates, zooplankton, phytoplankton, etc.) that maintain close relationships with each other and with their environment [5,6]. Some of these organisms, such as zooplankton, are directly consumed by the young stages of different fish species. Today, ponds all over the world are in crisis due to continuous growth and pressure from human activities [7]. They are receptacles for various domestic, agricultural and industrial effluents [3], which results in a degradation of the quality of their water and an acceleration of their

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eutrophication that will eventually cause their rapid disappearance. However, it is still possible to establish protection programs for those water bodies that are not yet engaged in at least a significant pollution phenomenon. To do so, preliminary studies must first be carried out to determine their physicochemical and biological state in order to propose adequate measures for their management. The present work aims to contribute to the understanding of the mechanisms governing the distribution of zooplankton communities in two ponds (Mokolo and Mopa) in the city of Bertoua in relation to some abiotic parameters.

2. Material and methods

2.1. Presentation of the study area

2.1.1. Bertoua city

The city of Bertoua, capital of the East region of Cameroon situated an altitude between 400 and 900m (Figure 1) [8], is located between 04°36.065'and 04°03.408' North latitude and between 013°40.'759' and 013°40.188' East longitude. The temperature is elevated throughout the year, attaining a maximum of 30° C, with an average between 23° C and 25° C. Precipitation in the region is relatively abundant (1500 to 2000 mm of rainfall per year).

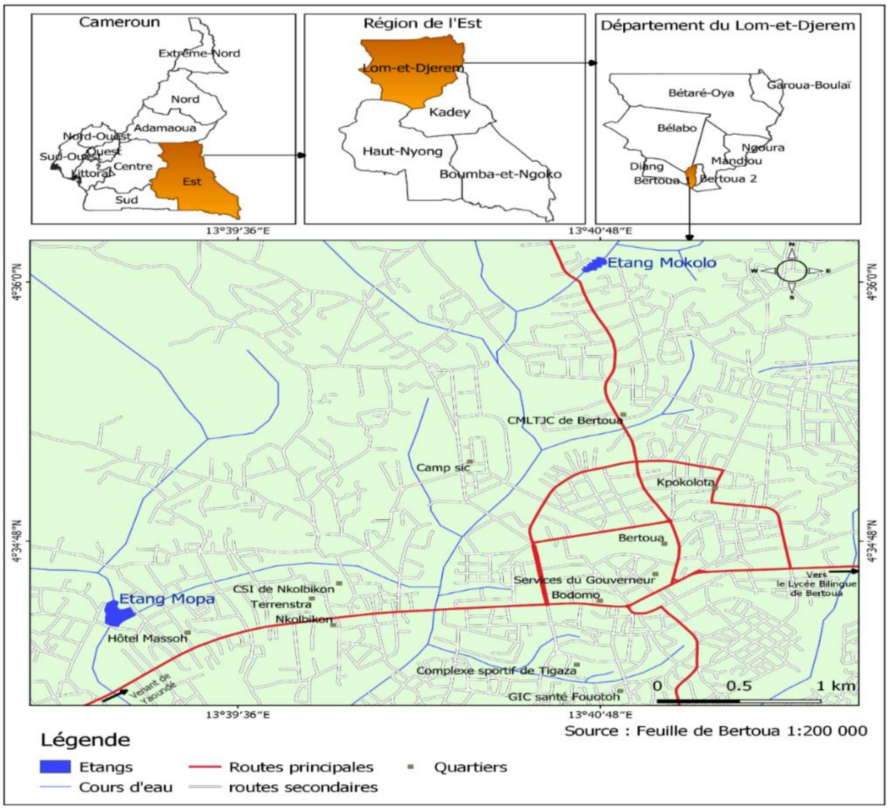

Figure 1 Study area showing the location of the two Bertoua ponds (Mokolo and Mopa)

2.1.2. Sampling stations

The sampling stations were chosen according to accessibility, the interest of the populations for these water points, the location in relation to the surface sources of pollution (Mokolo and Mopa ponds)

Mokolo Pond is a dam pond located in the Mokolo district at the Northern end of the city of Bertoua. It is a pond with very little or no maintenance, abandoned to itself with. This pond is characterized by strong vegetation, trees and shrubs and many floating aquatic plants that proliferate along the banks all around the pond (Figure 2a). The anthropization here is quite strong and the sources of pollution come mainly from a farm located upstream of the pond, domestic wastewater and plantations located in the watershed.

Mopa Pond is a dam pond located in the Nkolbikon district on the outskirts of the city of Bertoua. It is an abandoned pond, not maintained, characterized by many plants mainly the species Nymphaea lotus and Pistia stratiotes which cover the water surface hinding a better penetration of light (Figure 2b). The main sources of pollution in the pond are the strong macrophytic vegetation, trees and shrubs that surround the pond, as well as the plantations and dwellings located in the watershed.

Figure 2 Presentation of the two study sites (**A-**Mokolo pond and **B-**Mopa pond)

2.2. Data Collection

Sampling was carried out from March 2016 to April 2017 followed a monthly frequency [9] at surface and 1 m depth sampling for physicochemistry and biology. The movements on the ponds were possible using an inflatable Zodiac MR II.

2.2.1. Physicochemical analysis

Samples for surface physicochemical analyzes were collected directly at the surface using polyethylene vials, while at 1 m depth, these samples were collected using a 6 L Van Dorn bottle. The physicochemical parameters measured in the field during this study were temperature measured using a 1/100th degree mercury column thermometer, transparency (Zs) measured using a 30 cm diameter Secchi disc, depth measured using a weighted and graduated rope and dissolved oxygen measured using a HACH HQ14d oxymeter. The parameters measured in the laboratory included the nutrient salts (NO^{3-}, NO^{2-}, NH^{4+}, $PO3^{4-}$) measured using the colorimetric method with the HACH/DR 2010 spectrophotometer, the BOD5 measured by respirometry using a LIEBHERR brand BOD meter and the chlorophyll “a”, “b”, “c” content measured by the Lorenzen spectrophotometric method. To characterize the trophic state of the ponds, the system developed by the O.C.D.E. [10] and widely used internationally (Table 1), has been used.

2.2.2. Zooplankton analysis

Table 1 Limit values of the trophic water classification system according to O.C.D.E

Trophic class		**Phosphorous total (µg/l)**	**Chlorophyll *a* (µg/l)**	**Transparency (m)**
Main class	**Secondary class**	**Average**	**Average**	**Average**
Ultra-oligotrophic		< 4	< 1	> 12
Oligotrophic		4 - 10	1 - 3	12 - 5
	Oligo- mesotrophic	7 - 13	2,5 - 3,5	6 - 4
Mesotrophic		10 - 30	3 - 8	5 - 2,5
	Meso-eutrophic	20 - 35	6,5 - 10	3 – 2
Eutrophic		30 - 100	8 - 25	2,5 – 1
Hyper-eutrophic		> 100	> 25	< 1

Samples for biological analysis were taken from the surface to 1 m depth using a 10 L bucket and filtered through a 64 µm porosity 10 cm diameter sieve. The process was repeated five times in order to reach a filtered water volume of 50 L. The 200 mL of filtrate collected, 100 mL was fixed in the field with 5% formalin and was used for identification and counting, the second half (unfixed) was used for observations on living organisms and also for counting formalin-sensitive species (cladocerans, rotifers). Back in the laboratory, the physico-chemical variables were measured and the zooplankton microfauna identified, each time using a specific protocol.

We identified and counted rotifers, cladocerans and copepod taxa under a WILD M5 binocular microscope and an OLYMPUS CK2 UL WCD 0.30 microscope, using the taxonomic keys of [11,12,13]. Counts were done on 10mL subsamples for each composite sample, through duplicate counting in 30mm diameter Petri dishes crisscrossed into small 3mm squares. At least 100 individuals were counted each time per sample, if this was not the case, counting continued until the sample is all used up. The density of the individuals in the sample was calculated using the following formula:

$$D = (n \times 1000) / V \quad \text{……………..} (1)$$

Where;
D = density (expressed in individuals per liter),
n = number of individuals present in the volume of water analyzed under the microscope
V = volume of water analyzed (in ml).

The diversity index of [15] was calculated using the formula:

$$H' = -\Sigma\, [(ni / N) \times \log_2 (ni / N)] \text{……………} (2)$$

Where;
H' represents the specific diversity, in bits/individual,
Σ = sum of the results obtained for each of the species present,
ni = number of individuals of species i,
N= total number of individuals considering all species.

The Sörensen similarity index was calculated from the formula

$$(S = (2c / (a + b)) \times 100) \text{…………………..} (3)$$

Where;
a = number of species present in the first station,
b = number of species present in the second station
c = number of species common to both stations.
Piélou's equitability index (J) was calculated using the formula:

$$J = H' / \log_2 S \text{………………..} (4)$$

Where;
H' = index of [15],
$\log_2$ = logarithm in base 2 and
S= number of species present.

The index J varies from 0 (dominance of a single species) to 1 (equipartition of individuals in the stands).

Since the zooplankton densities obtained do not follow a normal distribution law, the non-parametric Kruskal-Wallis test allowed to compare these densities along the months of sampling. The Mann Whitney test allowed to compare these densities two by two. These tests were calculated using SPSS 20.0 software. The correlation was calculated between the densities of the organisms and the physicochemical variables. It allowed to establish probable interrelationships between the different variables.

3. Results and discussion

3.1. Physicochemical characterization of the media

The values of physicochemical parameters are listed in table 2. The ponds studied have relatively high temperatures, low water transparency and shallow depth, medium oxygenation, high levels of nutrients, organic matter and chlorophyll “a” (Table 2).

Table 2 Physicochemical parameters results (Legend: Ave = Average; Mo=Mokolo ; Mp= Mopa)

Parameters		**Ponds Mokolo**		**Ponds Mopa**	
		Surface	**Depth**	**Surface**	**Depth**
Temperature (°C)	Ave ± σ	24.7±0.3	24.2±0.3	29.4±0.5	27.7±0.3
Transparency (cm)	Ave ± σ	65.93 ± 15.73		72.50 ± 20.55	
pH (UC)	Ave ± σ	6.69±0.2	6.37±0.2	6.36±0.2	6.27±0.2
Dissolved Oxygen (%)	Ave ± σ	62.82±3.3	59.12±2.9	63.1±3.3	60.30±0.3
Electrical Conductivity (µS/cm)	Ave ± σ	45.08±3.6	49.34±3.3	45.51±4.3	42.04±2.6
Suspended solids (mg/L)	Ave ± σ	18.28±3,8	27.85±5.8	17.35±5.16	31.78±10.4
Nitrates (mg/L NO_3^-)	Ave ± σ	1.22±0.3	1.92±0.6	1.12±0.3	0.98±0.3
Nitrites (mg/L NO_2^-)	Ave ± σ	0.002±0.008	0.004±0.001	0.016±0.006	0.014±0.007
Ammonium (mg/L NH_4^+)	Ave ± σ	0.65±0.2	1.10±0.2	1.07±0.3	1.33±0.3
Phosphates (mg/L PO_4^{3-})	Ave ± σ	4.29±0.8	8.91±0.9	3.41±0.8	5.45±0.8
Chlorophyll “a” (µg/L)	Ave ± σ	30.6 ± 10.5	26.17±5.3	40.23 ± 7.1	39.67±7.4
DBO_5 (mg/L)	Ave ± σ	34.28±12.1	28.92±6.5	32.14±12.2	32.5±12.4

The physicochemical parameters measured in this study didn’t vary significantly ($P > 0.05$) from the surface to the depth showing a homogeneous quality of water. The temperature average values recorded in Mokolo (24.46˚C) and Mopa (28.57˚C) ponds are relatively high and depend strongly on the amount of sunlight. [14] affirms that the temperature of surface waters depends closely on the amount of sunshine and exchanges with the atmosphere. Dissolved carbon dioxide evolves in the opposite of oxygenation and the observed fluctuations in levels are undoubtedly linked to CO2 using for photosynthesis and to the activity of aerobic bacteria that degrade fermentable organic matter, consuming dissolved oxygen while releasing carbon dioxide. The high contents of nitrogenous elements in ponds are due to inputs of organic matter and nitrogenous metabolic waste from human activity, mainly from residential areas or from agricultural activities in the watershed of ponds. The high ammonium contents could be explained by the significant decomposition of organic matter accompanied by a high consumption of dissolved oxygen, favouring its production by ammonification [15]. High levels of orthophosphates in ponds show advanced trophic status. The high levels of chlorophyll “a” in ponds may be due to the high levels of nutrients (nitrogen and phosphorus) that can boost algal productivity.

3.2. Status trophic

The parameter values for determining the trophic status of the Mokolo Pond give an average of orthophosphate content of 64.59 µg/L, an average of chlorophyll “a” content of 131.18 µg/L, an average value of transparency of 66.00cm. These parameters for trophic status in Mopa Pond have an average of orthophosphate content of 64.15 µg/L, an average of chlorophyll “a” content of 134.54 µg/L, an average value of transparency of 64.63 cm. The two ponds studied have a very high content of orthophosphate and chlorophyll “a” with a very low transparency. According to the criteria established by the O.C.D.E. all these ponds are hypereutrophic.

3.3. Zooplankton Dynamics of Ponds

3.3.1. Distribution of zooplankton Taxonomic Units in Ponds

The analysis of the microcrustaceans and rotiferans fauna of the two bodies of water has shown that it is made up of 63 species representing (17.89%) in the Mokolo pond belonging to 25 families; 75 species (21.30%) belonging to 24 families in the Mopa pond. Of the three zooplankton groups collected in the ponds, rotifers constitute the most abundant group. Indeed, rotifers represent 92 ind/L (53.80%), 647 ind/L (65.22%) respectively at Mokolo and Mopa pond. Next come the cladocerans with 59 ind/L (34.50%), 256 ind/L (25.81%) at Mokolo and Mopa ponds. And finally the copepods are 20 ind/L (11.70%), 89 ind/L (8.97%) respectively at the Mokolo and Mopa pond.

3.3.2. Structure of zooplankton Groups

Thirty-six species of Rotifers belonging to eighteen families were collected in the Mokolo pond (Table 3). The Lecanidae family was the most represented, followed by the Brachionidae, then the Philodinidae and Asplanchnidae. The least represented are those of the Epiphanidae, Proalidae, Synchaetidae, Mytilinidae, Scaridiidae, Collothecidae, Trichotriidae, Trichocercidae, Philodinidae, Notommatidae, Gastropodidae, Euchlanidae and Habrotrochidae. The Cladocera are grouped into six families, nineteen species of which the most represented belong to the Chydoridae family (07 species) (Table 3), followed by those of the Moinidae, Daphnidae, Macrothricidae, Sididae and the IIyocriptidae. Copepods belong to the family Cyclopidae. Thirty-six species of Rotifers belonging to 17 families have been listed in the Mopa pond (Table 3). That of the Lecanidae is the most represented, followed by Brachionidae, Notommatidae, Philodinidae and Asplanchnidae. The least represented are: Trichocercidae, Euchlanidae, Collothecidae, Scaridiidae, Dicranophoridae, Mytilinidae, Synchaetidae, Proalidae, Epiphanidae, Lepadellidae and Trichotriidae. Twenty-nine species of Cladocera belong to six families, the richest of which is the Chydoridae (Table 3); followed by Daphnidae, Sididae, Moinidae, Macrothricidae, and Sididae. Finally, copepods belong to the family of Cyclopidae.

In the two bodies of water, 7 species are more than 50% frequent. Among these, *Asplanchna herricki* followed by *Asplanchna priodonta* then *Platyias quadricornis, Habrotrocha* sp., *Plationus patulus, Brachionus quadridentatus* and *Rotaria rotatoria* are more contributory in terms of abundance. Whatever the body of water, when cladocerans are present, it is almost always *Moina micrura* followed by *Diaphanosoma brachyurum*, *Moina* sp. and or *Moinadaphnia macleayi* in terms of abundance. Copepods are in almost all (90 to 100%) represented by that of *Thermocyclops crassus*. In other words, in the Mokolo pond, *Thermocyclops crassus* was present but in very low quantity, as well as at the Mopa pond.

Table 3 Appearance frequency (Number of samples containing the specie/total number of samples) x 100) and list of rotiferans, cladocerans and copepod sampled in Bertoua

Groups	Order	Family	Genus/Species	Mokolo	Mopa
Rotifera	Bdelloïdea (Dugès, 1834)	Habrotrochidae (Bryce, 1910)	*Habrotrocha* sp.	***	***
		Philodinidae (Bryce, 1910)	*Rotaria neptuna* (Ehrenberg,1832)	**	*
			Rotaria rotatoria (Pallas, 1766)	**	***
			Rotaria citrina (Ehrenberg,1838)	/	*
	Ploïma (Hudson et Gosse, 1886)	Asplanchnidae (Harring et Myers, 1926)	*Asplanchna herricki* (Guerne, 1888)	***	****
			Asplanchna priodonta (Gosse, 1850)	***	****
		Brachionidae (Wesenberg – lund, 1899)	*Brachionus calyciflorus* (Pallas, 1851)	*	*
			Brachionus caudatus (Barrois et Daday, 1894)	/	*
			Brachionus falcatus (Zacharias, 1898)	/	*
			Brachionus quadridentatus (Hermann, 1783)	**	**
			Kellicottia longispina (Kellicott, 1879)	*	/

Groups	Order	Family	Genus/Species	Mokolo	Mopa
			Plationus patulus (OF. Müller, 1786, Bryce, 1931)	**	***
			Platyias quadricornis (Ehrenberg, 1832, Bryce, 1931)	***	**
		Dicranophoridae (Remane, 1933)	*Dicranophorus grandis* (Ehrenberg, 1832)	*	*
		Epiphanidae (Bartos, 1959)	*Epiphanes macrourus* (Barrois et Daday, 1894)	*	**
			Euchlanis callysta (Myers,1930)	*	*
			Euchlanis meneta (Myers,1930)	*	/
			Euchlanis proxima (Myers,1930)	*	/
		Gastropodidae (Remane , 1933)	*Gastropus hyptopus* (Ehrenberg, 1838)	*	/
		Lecanidae (Bartos, 1959)	*Lecane bulla bulla* (Gosse, 1886)	**	**
			Lecane closterocerca (Schmarda, 1859)	/	*
			Lecane curvicornis (Murray, 1930)	*	**
			Lecane leontina (Turner, 1892)	*	*
			Lecane luna (O.F. Müller, 1776)	*	*
			Lecane lunaris (Ehrenberg, 1832)	*	*
			Lecane papuana (Murray, 1913)	*	*
			Lecane quadridentata (Ehrenberg, 1830)	*	*
			Lecane ungulata (Hauer, 1939)	*	/
		Lepadellidae (Harring, 1913)	*Lepadella ovalis* (O.F. Müller, 1786, Bryce 1931)	/	*
			Mytilina bisulcata (Luckcs, 1912)	*	/
			Mytilina ventralis (Ehrenberg,1832)	/	*
			Cephalodella ventripes (Dixon-Nutall,1901)	**	*
		Notommatidae (Remane, 1933)	*Cephalodella* sp.	*	*
			Notommata pseudocerberus (Beauchamp, 1908)	/	*
			Notommata sp.	/	*
			Philodinavus paradoxus (Murray,1905)	*	/
		Philodinidae (Harring, 1913)	*Proales* sp.	*	*
		Proalidae (Bartos, 1953)	*Scaridium longicaudum* (O.F. Müller, 1786)	*	*

Groups	Order	Family	Genus/Species	Mokolo	Mopa
		Scaridiidae (Manfredi, 1927)	*Polyarthra vulgaris* (Carlin, 1943)	*	**
			Ascomorphella sp.	*	/
		Trichocercidae (Remane, 1933)	*Trichocerca bicristata* (Gosse, 1887)	*	*
			Trichocerca flagellata (Hauer, 1937)	/	*
			Trichotria curta (Skorikow, 1914)	/	*
		Trichotriidae (Bartos, 1959)	*Trichotria tetractis* (Ehrenberg, 1830)	*	/
			Collotheca sp.	*	*
	Collothecacea (Remane, 1933)	Collothecidae (Bartos, 1959)	*Conochilus* sp.	*	/
		Hexarthridae (Bartos,1959)	*Acroperus harpae* (Baird,1835)	*	/
Cladocera	Daphniiformes (Milene-Edwards, 1840)	Chydoridae (Stebbing, 1902)	*Alona pulchella* (King, 1853)	/	*
			Alona sp.	*	**
			Alona rectangular (Sars 1861)	*	*
			Alona monocantha (Sars,1901)	*	*
			Chydorus angustirostris (Frey, 1987)	*	/
			Chydorus barroisi (Richard, 1894)	/	**
			Chydorus eurynotus (Sars, 1901)	*	**
			Chydorus latus (Sars, 1862)	/	*
			Chydorus sp.	**	**
			Chydorus sphaericus (Muller,1785)	/	*
			Dunhevedia sp.	/	*
			Kurzia sp.	/	*
			Pleuroxus chappuisi (Brehm, 1934)	/	*
			Pleuroxus denticulatus (Birge,1879)	*	/
			Pleuroxus trigonellus (Muller, 1785)	/	*
			Oxyurella singalensis (Daday, 1898)	/	*
		Daphniidae (Strauss, 1820)	*Ceriodaphnia pulchella* (Sars, 1862)	*	*
			Ceriodaphnia sp.	*	*
			Ceriodaphnia quadrangula (Muller 1785)	*	*
			Simocephalus expinosus (Koch, 1841)	*	/
			Simocephalus serrulatus (Koch, 1841)	/	*
			Scapholeberis kingi (Sars, 1903)	/	*
		Ilyocryptidae (Smirnov, 1992)	*Ilyocryptus spinifer* (Herrick, 1882)	*	/
		Macrothricidae	*Macrothrix* sp.	*	*

Groups	Order	Family	Genus/Species	Mokolo	Mopa
		(Norman et Brady, 1867)	*Macrothrix goeldii* (Richard,1897)	*	/
			Moina micrura (Kurz, 1874)	**	**
		Moinidae (Goulden, 1968)	*Moinadaphnia macleayi* (King,1853)	*	****
			Moina sp.	*	**
			Diaphanosoma brachyurum (Liévin,1848)	/	**
		Sididae (Bairds, 1850)	*Diaphanosoma* sp.	*	*
			Pseudosida bidentata (Herrick, 1884)	/	**
Copepoda	Cyclopoïda (G.O. Sars, 1885)	Cyclopidae (Dana, 1853)	*Thermocyclops* sp.	*	*
			Microcyclops varicans (Sars,1863)	*	/
			Microcyclops sp.	*	**
			Thermocyclops crassus (Fisher, 1853)	**	**

The asterisks (*) represent the occurrences of each taxon in the corresponding pond during the whole study period and are coded as follows: (*) = rare taxa; (**) = incidental taxa; (***) = constant taxa; (****) = regular taxa; (*****) = ubiquitous taxa; Empty cells correspond to the non-representativeness of a species in the corresponding pond during the whole study period.

Biologically, this study shows that relatively diverse populations of Lecanidae, Brachionidae and cladocerans occur in Bertoua ponds, with 15 species and subspecies of Lecanidae, 10 species and subspecies of Brachionidae and 19 species and subspecies of cladocerans (Table 3). These microorganisms are mostly filter feeders of small organic particles (fresh algal detritus and bacteria) (16). Their presence in Bertoua can therefore be related to the relatively high algal biomass blooms in this pond (17). In terms of relative abundance, rotifers appeared more important than cladocerans. This trend is consistent with those already reported by other authors in reservoirs located in tropical environments (18). Two main factors have been suggested to explain this numerical dominant of rotifers in these ponds: their opportunistic nature, which allows them to better resist variations in environmental conditions (19), and their greater competitiveness in these environments, not only because of their feeding plasticity with respect to the available resources, but also because of their small size, which makes them less vulnerable to predation pressure (20). Rotifers are the most important animal group in freshwater belonging to the ecological niche of small filter feeders (21). Rotifers are able to ingest small particles such as bacteria and organic detritus that are often abundant in eutrophic environments. As a result, according to (22), a high representation of rotifers in aquatic environments can be considered as a biological indicator of a high trophic level. This seems to be confirmed because the presence of the genus *Brachionus* is frequent in tropical waters (23).

3.3.3. Data Analysis

Overall, the diversity index of (24) (Table 3) shows high values in the ponds a diverse stand as a whole. This is better appreciated with the index (25) which shows the balance of the ecosystem and the good distribution of species in the ponds. The different environments (Mokolo, Mopa) therefore contain a relatively equal number of species whose distribution is globally equitable as shown by the values of the Piélou equitability index which, in general, are higher than 0.70. (26) and (27) have established a relationship between specific diversity and the degree of stability of a community. For them, specific diversity generally reflects a high degree of stability within the population, since variations in a species have little influence on the population. (28) also indicates that values of the Shannon and Weaver index greater than 2.50 bits/ind reflect a better distribution and structuring of organisms. In this regard, (29) emphasizes that marshes, by their diversity of habitats, the abundance of food resources and the tranquility of the environment constitute an ideal living environment where a rich and varied fauna develops.

Sörensen's similarity index values (Table 4) of zooplankton communities were greater than 60% between the different water bodies. The relatively strong similarities between the zooplanktonic communities of the different ponds could be explained by the fact that these water bodies drain watersheds with roughly similar characteristics. Indeed, the watersheds of the studied water bodies are all subject to a high level of organic pollution, essentially from domestic and urban effluents from the more or less populated areas crossed by these water bodies.

Table 4 Variability of Specific wealth, Shannon and weaver, Piélou and Sörensen diversity indices during the study

Ponds	Specific wealth	Shannon and Weaver's diversity index	Piélou's equitability index	Sörensen similarity index
Mokolo	13.92±1.9	3.27±0.2	0.78±0.03	64%
Mopa	22.00±1.9	3.04±0.1	0.70±0.04	74%

4. Conclusion

The physico-chemical analyses carried out on the different hydrosystems have revealed that their waters present a strong organic pollution due to the domestic wastewater discharges coming from the houses located in its catchment area. The taxonomic composition of the zooplankton shows that it is essentially the species indicative of eutrophic and hypereutrophic environments that proliferate abundantly in the water bodies. However, it appears that a high organic matter load and the presence of macrophytes are responsible for the structure of the zooplankton populations in these water bodies.

Compliance with ethical standards

Acknowledgement

The authors thank the Direction of Central Africa and Great Lakes Region (DCAGLR) of "Agence Universitaire de la Francophonie" (AUF) for the mobility grant from Cameroun to Canada and the Inter-University Research group in Limnology and Aquatic Environment (GRIL) of the University of Quebec in Montréal (Canada).

Disclosure of conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this document.

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