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Macroinvertebre and Physico-Chemical Dynamics in the Odza Pond of the Center Region of Cameroon

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ABSTRACT : In Cameroon and more particularly in the Center Region, several studies have been carried out in ponds highlighting the zooplankton which intervenes in the rearing of fry; however, little or almost no data on the study of macroinvertebrates in ponds while they constitute a food source likely to increase fish yields and therefore reduce the costs of fish farmers related to food taste. For this purpose, in order to evaluate the physico-chemical quality of water of Odza the pond in the Central Region, a physico-chemical analysis was carried out from April to September 2020, coupled with that of the distribution of macroinvertebrates. Thus, the sampling of the macro invertebrate is done according to the multi-habitat method and the water samples for the physico-chemistry respecting the usual recommendations.Physico-chemical analysis reveal low oxygen level (25,03 ± 11,53 %), slightly waters (6,83 ± 0,29 UC), is low organic matter(3,47 ± 0,86 mg/L). The Macroinvertébres community of the aquatic ecosystems was averagely diversified and evenly distributed. Macroinertébres sampled belong to 3 classes, 08 orders, 18 families. The statistical analysis revealed a significatives correlations between the biotics and abiotics parameters, then the biology index outstanding a tolerate quality of d'Odza pond water. This study made it possible to determine the state of the water of the Odza pond through the macroinvertebrates that live there. And confirms the possibility of using the latter as an indicator of pollution and a potential source of animal protein for fish farming.

KEYWORDS: physico-chemical, Water quality, Dynamic of invertebrates, Odza pond Yaoundé.

1. INTRODUCTION

At the heart of planetary biodiversity, many questions arise permanently about its future, it reveals a considerable threat to the environment. This calls into question the scientific and technical progress of the 19th century with its improvements that affect waterways, observable in industrialized countries leading to the destruction of ecosystems and endemic species [1]. This situation of ecological stress, particularly in the aquatic environment, leads to a deterioration in water quality, a modification of the structures of the population and, most often, a reduction in biodiversity [2]. In addition, these natural habitats are the most threatened ecosystems on the planet and have experienced a strong decline for many years [3]. These include rivers, lakes, swamps and fish ponds [4].

The ponds are bodies of drainable fresh water which accumulate behind a dyke built in favor of a depression or a pre-existing wetland and whose primary purpose is the production of fish, which constitute one of the main sources of animal protein for humans [5]. This leads us to believe that continental waters as a whole are an essential component of the natural heritage, very important for the well-being of current and future generations [6]. Because there is a very important biocenosis bearing the name of invertebrate divided into two groups: micro-invertebrates and macro-invertebrates [7]

Benthic macroinvertebrates are animal organisms that do not have a skeleton of bone or cartilage, visible to the naked eye such as insects, molluscs and algae that line it, they are the most indicated biological group, because that they are very diverse and constitute a very important part of the fauna of freshwater ecosystems [8]. In addition, they are composed of sedentary organisms, presenting variable sensitivities to different environmental stresses [9]. Moreover, the most important fish food is provided by macroinvertebrates [9].

In Cameroon, these organisms are poorly known despite the work carried out [10], [11] Unfortunately, few data are available on the biodiversity of benthic macroinvertebrates in lentic environments in Cameroon. It is to complete the faunal knowledge of benthic macroinvertebrates and to establish their nutritional roles for fish farming that this study was conducted in the Odza pond in Yaoundé. After a description of the state of each sampling station, the physicochemical analysis of the waters, the taxonomic richness will be discussed, followed by the spatio-temporal dynamics of the taxa.

2. MATERIALS AND METHODS

2.1. Study site

2.1.1. Geographic location

The Central Cameroon region is located between 3°30'-3°58' North latitude and between 11°20'-11°40' East longitude [12]. The average altitude is around 750 m, its relief is generally rugged and the urban area extends over several high hills 25 to 50 m above the plateau [13]. The climate is of the equatorial type with bimodal rainfall characterized by moderate rainfall (1576 mm/year) oscillating between 1500 and 1700 mm per year [14], with temperatures that vary little over time [15].There are four seasons that are unevenly distributed and vary in length from year to year [16].The vegetation is of the secondary dense forest type and the hydrographic network is dense. From a petrographic point of view, the soils present themselves, as in all of southern Cameroon, under three types, including ferralitic soils, hydromorphic soils and poorly evolved soils [17].

The Odza pond is located near the national road N°2 linking Yaoundé to the Gabonese border via Mbalmayo and Ebolowa. Before the creation of this road, the waters of this environment, which had become a pond, flowed and crossed the national, then were used at that time by households. After its implementation, this national favored the installation of this artificial pond; which no longer has a direct impact on households as before, does not present any real differentiation from the classic compartments (outfall, landing stage and outlet) because it is not fed by a watercourse but rather by a water table with an area of approximately 478 m2 and is illustrated by the map of the study area opposite.

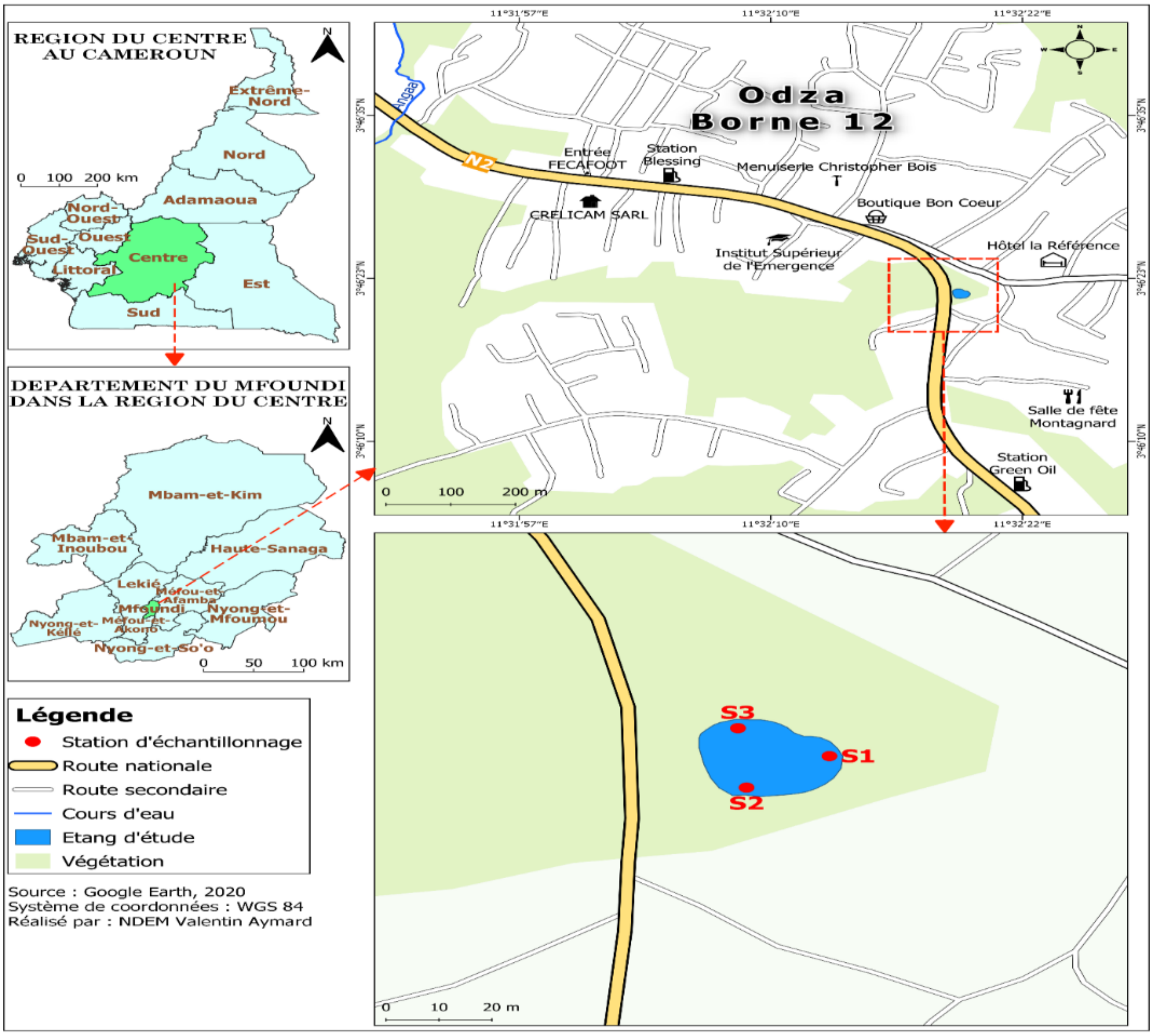


Figure 1: Map of the study area: Sampling station (A). E: 1/50.

2.2. Materials and methods

2.2.1. Physico-chemical

The samples were taken from three points of the pond according to the sources of pollution at a monthly frequency For the analysis to be carried out in the laboratory, the water samples were taken in double-sealed polyethylene bottles of and for six months (April 2020-September 2020). To this end, physico-chemical analysis were carried out both in the field and in the laboratory following the recommendations of [18] and [19].

250 and 1000 ml and then brought back to the laboratory in a refrigerated enclosure. The sampling procedure in the field

and the mode of analysis of each parameter in the laboratory is described in Table 1 below.

a- Temperature

The temperature of this body of water was measured in situ, using a mercury thermometer graduated to 1/10°C after a few seconds of immersion, the rise in mercury indicates the temperature of the water. The results are given in °C.

b- Electrical conductivity

These parameters were measured in the field using a HANNA HI 9829 multiparameter by immersing the electrodes in the samples after calibration. The result is expressed in µS/cm.

c- Suspended solids, and orthophosphates

SS, turbidity and orthophosphates were evaluated in the field using a HANNA HI 9829 multiparameter by immersing the electrodes in the samples after calibration. The results are expressed in mg/L, and in mg/L of PO_4^{3-} respectively.

d- Dissolved oxygen (O_2)

Dissolved oxygen content was measured by Winkler's volumetric method. In the field, in a 125 ml Winkler bottle, 123 ml of sample was mixed with 1 ml of Winkler's reagents and 1 ml of manganese chloride. This resulted in the formation of a white precipitate in the bottle. Back in the laboratory, the precipitate was dissolved by adding 1 ml of concentrated sulfuric acid to the solution (yellow coloring of the solution) and 2 or 3 drops of starch as a colored indicator. 50 ml of solution were then withdrawn and titrated with N/80 sodium thiosulfate. The solution, initially blue, became sample and then boiled on a hot plate. As soon as boiling began, 20 mL of N/80 potassium permanganate ($KMnO_4$) was added. A few minutes later, the whole was cooled with tap water. After cooling, 5 mL of 25% sulfuric acid and 20 mL of Mohr's salt were added to the preparation. The colorless solution thus obtained was titrated with potassium permanganate ($KMnO_4$) N/80 until a persistent pink color appeared. The control is obtained following the same principle using distilled water instead of the sample. The results expressed in mg/L of O_2 were calculated by the formula:

Oxidability (mg/L of O_2) = [(sample burette descent – control burette descent)/2] × 3.95

h- Dissolved carbon dioxide (CO_2)

The CO_2 contents were measured by volumetry. In the field, the CO_2 is fixed by introducing into a 200 mL volumetric flask, 20 mL of NaOH N/20, 2 or 3 drops of phenolphthalein and the water sample up to the gauge mark. The pink colored mixture obtained is transferred to a 250 mL double-sealed polyethylene bottle. In the laboratory, 50 mL of the sample fixed in the field are titrated with hydrochloric acid (HCl) N/10 until the pink color disappears. The control is obtained following the same principle using distilled water instead of the sample. The dissolved CO_2 in mg/L is obtained by the following formula:

Dissolved CO_2 (mg/L) = (control burette drop - burette drop) × 17.6

2.2.2. Sampling of the benthic macroinvertebrates

colorless at the end of the titration. Finally, the results obtained in mg/l of sample, which corresponds to the descent of the burette, were converted into saturation percentages using Mortimer's abacus.

e- Hydrogen Potential (pH)

The pH measurements were made in the field using a SHOTT GERÄTE CG 812 portable pH meter. The direct reading after immersion of the pH electrode in the water sample made it possible to obtain results in conventional units (CU) with an accuracy of 1/10th.

f- Ammonia nitrogen and nitrates

The measurements of the water content in nitrogen forms were made in the laboratory using a HACH DR/2010 brand spectrophotometer. The ammoniacal nitrogen concentrations (expressed in mg/L of NH_4^+) were measured by the Nessler method on 25 mL of raw water sample and the reading was taken at the wavelength λ= 425 nm. The nitrate contents (expressed in mg/L NO_3^-) were measured on 10 mL of sample with nitraver V as reagent respectively, the reading was carried out at the wavelength λ = 507 nm and λ = 500 nm respectively

g- Oxidability

Oxidability was measured by volumetry. In an Erlenmeyer flask, 2 mL of monosodium carbonate was added to 200 mL of the

The benthic macroinvertebrates were harvested using a square-shaped stirrup of 30 cm side, equipped with a conical net of 400 µm mesh opening and 50 cm depth. Sampling was done following the multihabitat approach proposed by [20]. At each study station and each sampling campaign, around twenty blows of the stirrup were carried out for an area of approximately 3 m² along a station whose length is equal to ten times the width of the bed. The kicks were carried out in different microhabitats. Each time, the organisms retained by the cracks were collected using a pair of fine forceps, fixed in 10% formalin and stored in a pillbox. Back in the laboratory, the macroinvertebrate samples were rinsed with plenty of running water to remove the formalin and were stored in pillboxes containing 70° alcohol and identified using Durand's identification keys. [9], [21] and a WILD M5A loupe.

2.2.3. Data analysis and statistical tests

2.2.3.1. Kruskal-Wallis and Mann-Whitney H-test

The Kruskal-Wallis test allowed us to see if the data obtained vary significantly from one sampling station to another and from one month to another, and the Mann Whitney test allowed us to compare these densities between the two stations. These two tests were performed using SPSS version 20.0 software.

2.2.3.2. Spearman rank correlation coefficient

The Spearman rank correlation coefficient makes it possible to establish the degree of dependence between the physico-chemical variables, the biological parameters and between the physicochemical and biological parameters.

2.3.3. Biocenotic indices

2.2.3.4. Global Normalized Biological Index (IBGN) [22]

The IBGN method is based on the simplified study of benthic macroinvertebrate fauna. The index is given by a table involving the nature of the fauna harvested (indicator groups of different sensitivity to disturbances) and its variety. The calculation of the IBGN consists of determining the taxonomic variety (VT), i.e. the total number of taxa identified, regardless of the number of individuals found per taxon, indicator group (GI) or group the most "polluosensitive" marker (GR), that is to say the indicator taxon having a significant presence in the station (at least 3 or 10 individuals depending on the taxa) and possessing the highest possible index. Thus, the IBGN is calculated from a double-entry analysis table, comprising taxonomic variety classes on the abscissa (class 1 to 14) and indicator faunal groups on the ordinate, classified in descending order (index 9 1) sensitivity to pollution.

The IBGN can also be calculated according to the relationship: IBGN = GI + VT-1, with IBGN $\leq$ 21. GI = fauna indicator group; VT = taxonomic variety of the sample

The results obtained will be compared with the values in the table below.

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. Temperature and Suspended Matter (MES),

The water temperature varied between 24.4°C in June at the Odza3 station and 32°C in September at the Odza1 station (Figure 2A) with a thermal amplitude of 7.6°C. On the temporally, the temperature varies significantly ($P<0.05$) from which Mann-Whitney reveals a similarity in temperature between certain months such as April, May and September.

On the spatial level, it is not significant The SS values obtained are between 2mg/L (September, Odza2 station) and 164 mg/L (September at the Odza1 station) The SS levels remained low throughout the 'study. The SS levels fluctuate around an average value of 29.88 ± 37.70 mg/L and the Kruskal-Wallis test is not significant on the spatio-temporal level

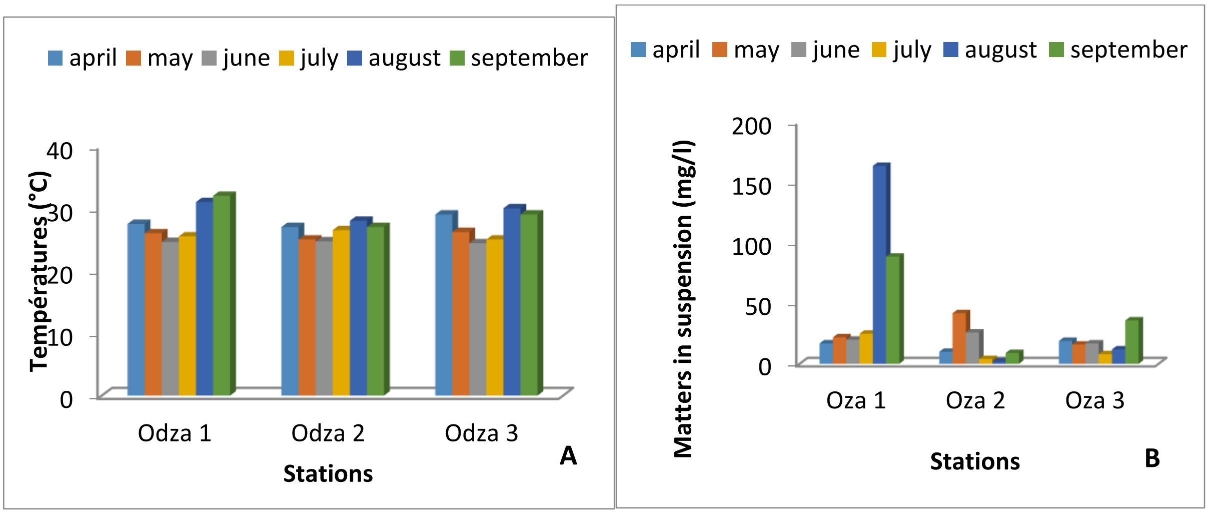


Figure 2: Spatio-temporal variation of temperature (A), matters in suspension (B).

3.1.2. Electrical conductivity and pH

Regarding conductivity, the highest value was obtained in May at the Odza1 station (362 µs/cm) and the lowest value obtained in September at the Odza1 station (136 µs/cm). On the spatio-temporal level, the Kruskal-Wallis test reveals non-significant variations in conductivity ($p > 0.05$). Speaking of pH, the values fluctuate between 6.4 UC (Odza1 station in July) and 7.2 UC (Odza3 station in September). Thus revealing waters oscillating between acid and basicity; this shows on the spatio-temporal level with the Kruskal-Wallis test a non- significant variation ($P=0.05$).

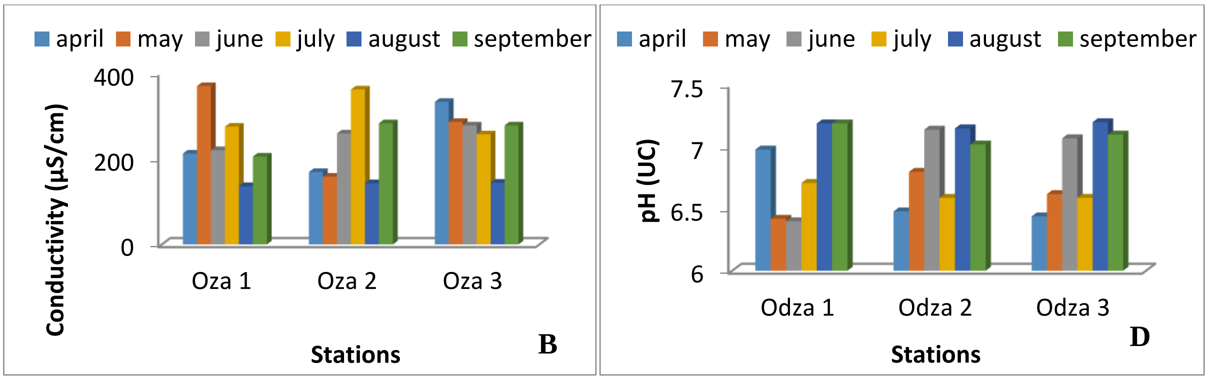


Figure 3: Spatio-temporal variation of conductivity (B), and pH (D) in the Odza pond during the study period.

3.1.3. Oxygen and dissolved CO2

The maximum dissolved oxygen saturation rate (Figure 4A) is obtained in September (61% at the Odza1 station) and the minimum saturation rates in August (12% at the Odza2 These values fluctuate around an average of 25.03 ± 11.53%, testifying to the poor oxygenation of the Odza pond. The Kruskal-Wallis test shows a non-significant spatio-temporal difference. As for dissolved CO2, the highest content is 36.96 mg/L obtained in April and July respectively at the Odza1 and station), April (12% at Odza3 station) and in August (12% at Odza3 station).

Odza2 stations; and the lowest 5.28 mg/L (in May at the Odza2 station). and those with a mean of 26.94 ± 8.45; The Kruskal-Wallis test shows that the dissolved CO2 content does not vary significantly ($p > 0.05$) spatiotemporally.

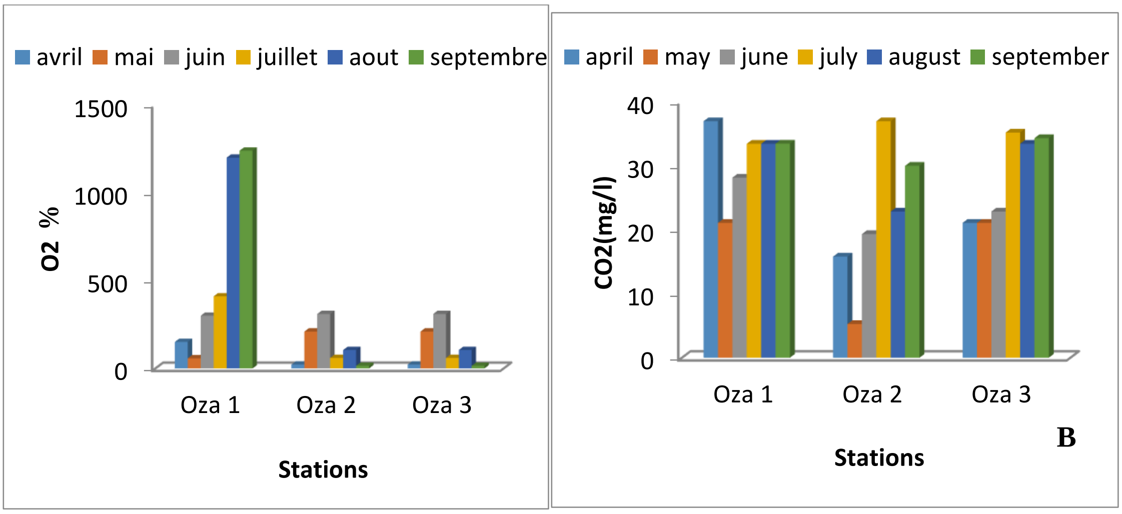


Figure 4: Spatio-temporal variation of O2 (A) and CO2 (B), during the study period in the Odza pond.

The highest ammoniacal nitrogen content is obtained in August (6 mg/L at the Odza3 station) and the lowest is 0.1 mg/L (in April at the Odza2 station), (Figure 5A).
The nitrate levels are high in August at the Odza1 station (8 mg/L) and lower at the Odza3 station in April (0.2 mg/L) the nitrate levels recorded in the pond are generally weak.
The orthophosphate water contents (Figure 5C) show values between 0.009 mg/L (July, Odza2 station) and 0.095mg/L (April, Odza2 station). The orthophosphate levels recorded in the pond are lower than the 0.5 mg/L recommended by [21]Rodier et al. (2009). Overall, the values of nitrates, ammoniacal nitrogen and orthophosphates do not vary significantly from one month and from one station to another ($p > 0.05$).

3.1.4. Ammoniacal nitrogen (NH4+), nitrates (NO3-) and orthophosphates (PO43-)

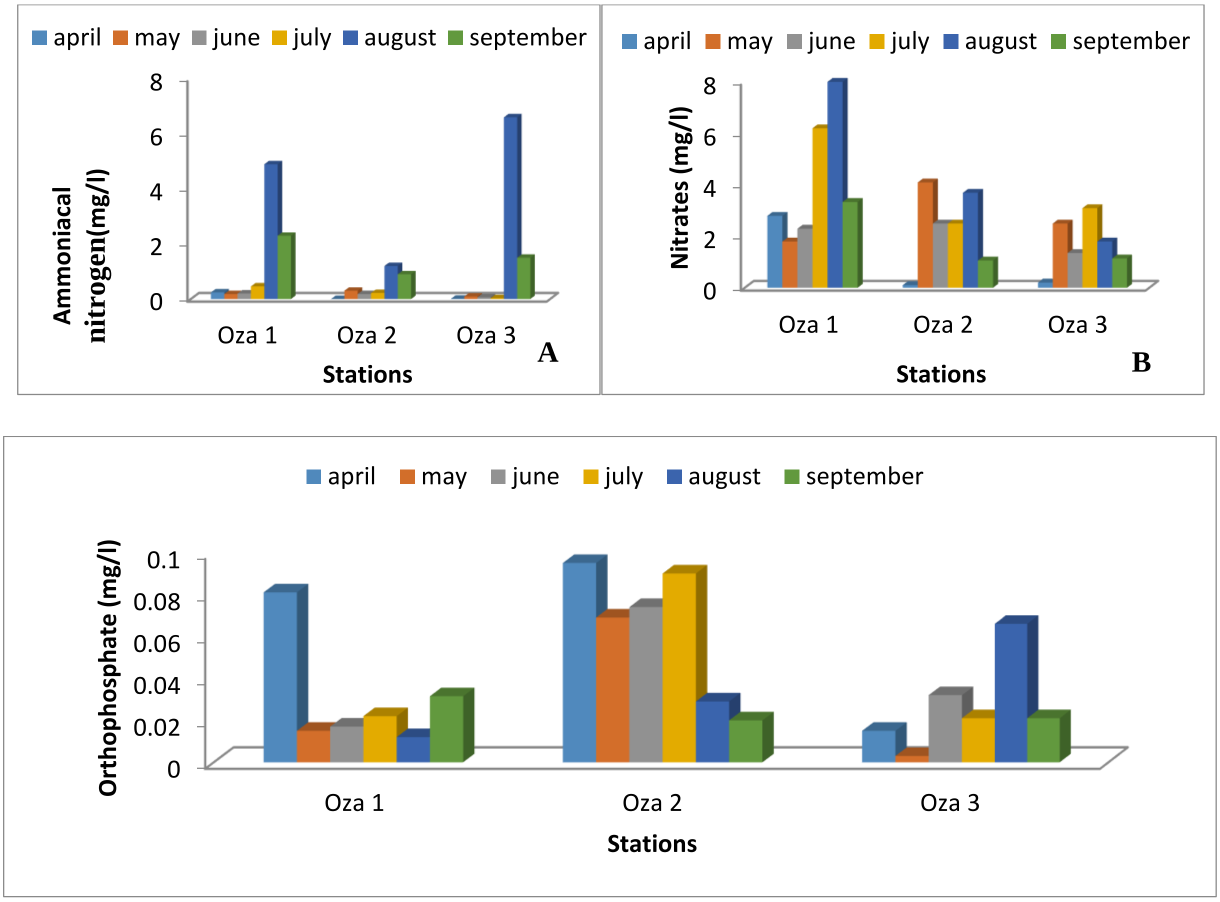


Figure 5: Spatio-temporal variation of ammoniacal nitrogen (A), nitrates (B) and orthophosphates (C) contents in the Odza stream during the study period.

3.1.5. Benthic Macroinvertebrates

3.1.5.1. Taxonomic richness and relative abundance

During the study period, a total of 695 individuals were counted and divided into 03 branches: Arthropods (94.39%), Annelids (3.45%) and Molluscs (2.16%). These organisms belong to 03 classes, 08 orders and 18 families.

The Hexapod class being the most represented with a relative abundance of 94.39%, it has 06 orders, 16 families and more than 14 genera. It is followed by the class of annelids with a relative abundance of 3.45%, including: 01 order, 01 family and 01 genus and finally the class of molluscs represent only 2.16% relative abundance with: 01 order , 01 family and 02 genera (Figure 10A).

Of the 08 orders identified during the study period, Coleoptera dominate with 36.40% relative abundance, followed by Hemiptera, Diptera, Odonata, Phyrngobdllida, Basommatophores, Trichoptera and Ephemeroptera with respective relative abundances of 35.68%, 15.40%, 5.33%, 3.45%, 2.16%, 1% and 0.58% (Figure 10B)

Among the 18 families listed, 05 belong to the order of Hemiptera, 04 to the order of Coleoptera, 03 to the order of Odonata. The orders of Phyrngobdllida, Basommatophores, Trichoptera and Ephemeroptera each have 01 family. (Figure 10C).

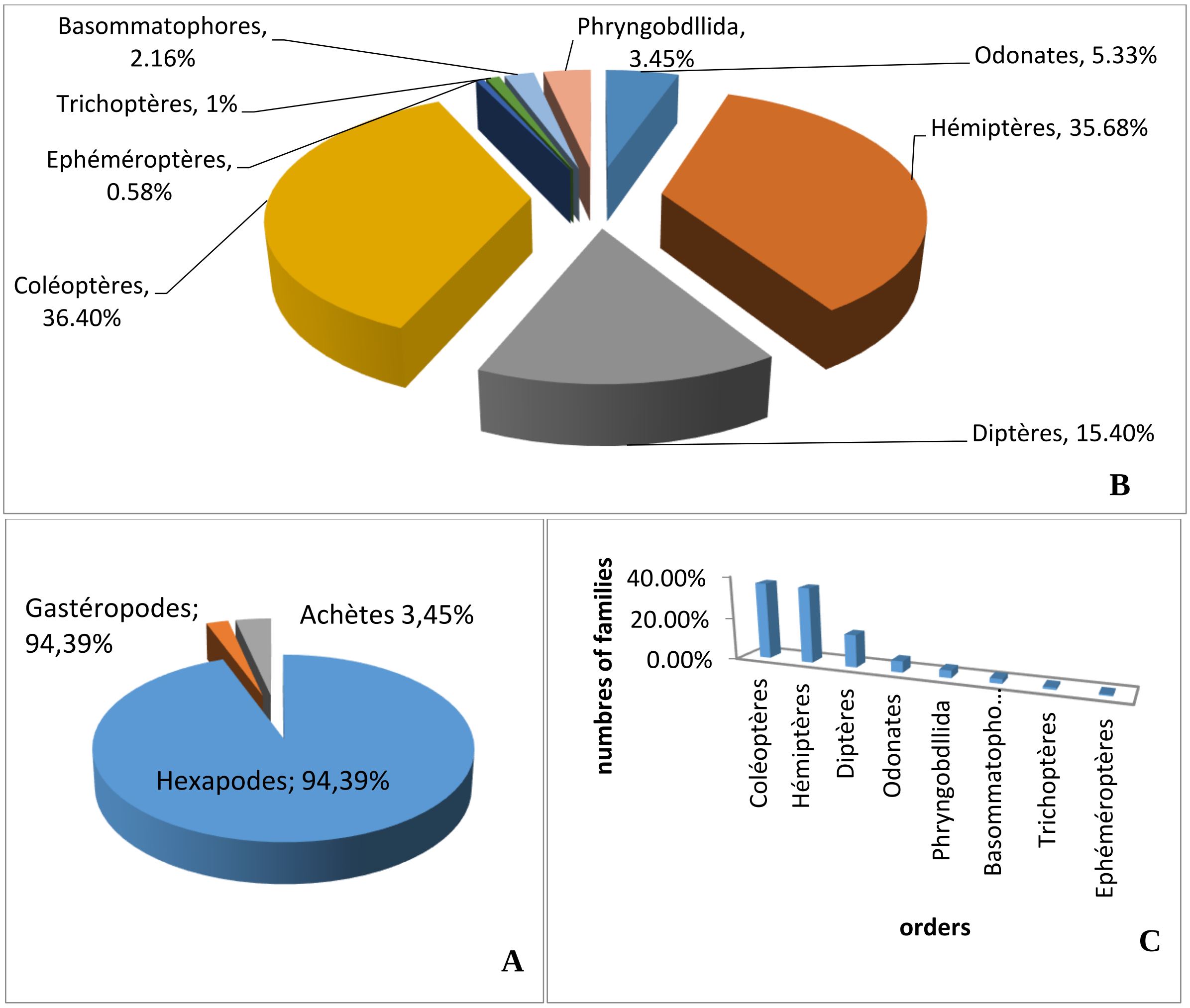


Figure 10: Relative abundance of Orders (B), Classes (A), and Families per order (C) of benthic macroinvertebrates in Odza Pond during the study period.

3.1.5.1. Spatio-temporal variation in the numberof families of macroinvertebrates collected in the Odza pond during the study period.

The total number of families of macroinvertebrates counted is 18. It varies from 14 at the Odza1 station, to 16 and 13 respectively at the Odza2 and Odza3 stations for the reduced to a relative abundance less than or equal to 5.32%, represented by a single individual.

In terms of time, the highest number of families is 11 in April and July and the lowest is 6 families in September. However, respective relative abundances of 36.83%, 24.32% and 38.85 % (Figure 11A). The Hydrophilidae family predominates with a relative abundance of 26.18%, followed by Naucoridae (20.28%), Chironomidae (15.39%) and Dystiscidae (8.77%). Then come 14 other families

the month of May presents 8 families with the highest relative abundance (20.57%) (Figure 11B). However, no significant difference was observed along the river and between the different months ($p > 0.05$).

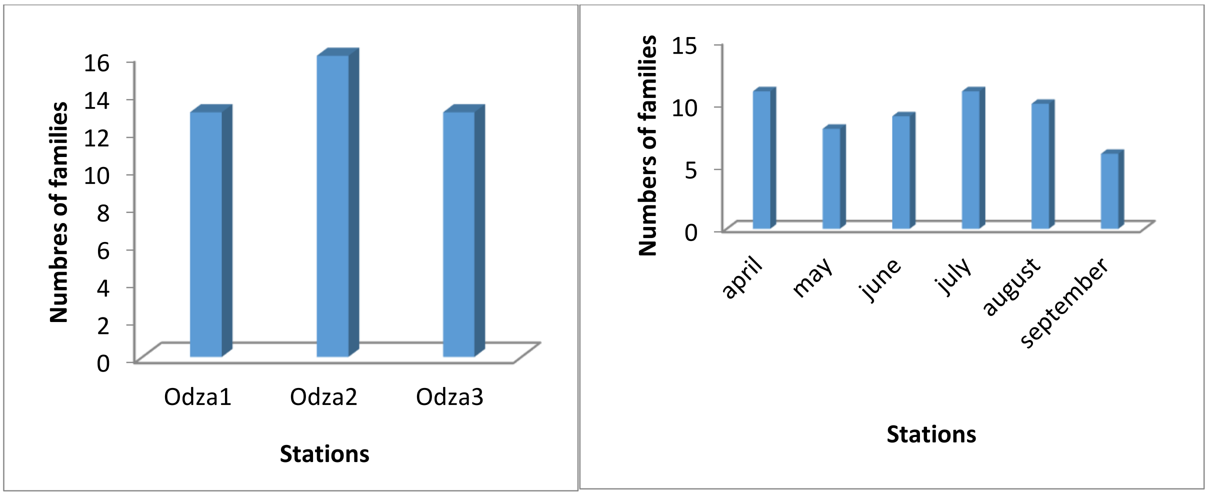


Figure 11: Spatial (A) and temporal (B) variation in the number of families collected in the Odza pond during the study period

Table 2: Correlation between physico-chemical parameters and invertebrates

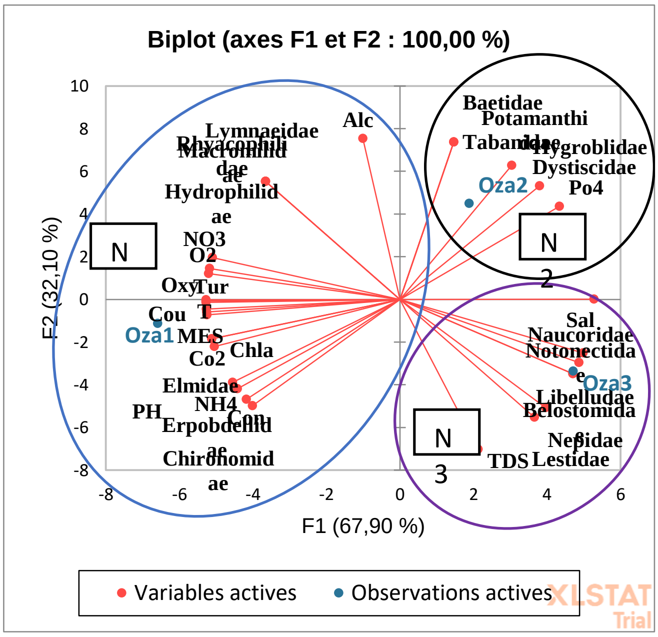
Spearman's "r" correlation test revealed many correlations between certain physico-chemical parameters and biological parameters

Parameters	Species	Corrélations
Temperatures	Belostomatidae	r = 0,630 ; p = 0,005
	Notonectidae	r = -0,070 ; p = 0,084
TDS	Rhyacophilidae	r = 0,516 ; p = 0,028
Turbidity	Belostomatidae	r = 0,542 ; p = 0,020
O2	Hydrophilidae	r = 0,853 ; p = 6,79E-06
Conductivité	Dystiscidae	r = 0,576 ; p = 0,012

3. PRINCIPAL COMPONENT ANALYSIS

Principal Component Analysis (PCA) applied to the different biological and physicochemical variables shows a grouping of parameters around the stations in 3 cores (Figure 12). Core 1 (N1) which includes the Odza1 station shows a predominance of the families Erpobdellidae, Elmidae, Macromilidae, Rhyacophilidae, Hydrophilidae and

Chironomidae which develop affinities for oxidizability, conductivity, suspended solids (SS), ammoniacal nitrogen (NH4), oxygen and pH. Core 2 (N2) which includes the Odza2 station is characterized by the families Baetidae, Potamanthidae, Tabanidae, Hygroblidae and Dysticidae which develop affinities with orthophosphate. As for core 3 (N3), it encompasses the Odza3 station where also predominant pollutant-tolerant taxa (Naucoridae, Belostomatidae, Libellulidae, Notonectidae, Nepidae and Lestidae) develop affinities for TDS and salinity.



4. DISCUSSION

4.1. Physicochemical parameters

During this work, the water temperature of the Odza pond varies little from month to month. This variation would be due to the sunshine conditions and the influence of the surrounding vegetation. In this regard, [23] pointed out that water temperature is strongly influenced by ambient temperature. These results are similar to those obtained by [24] (27.44 and 27.35) in two ponds in the Yaoundé city’s. SS levels remained low throughout the study period. This would testify to a low anthropization of the catchment area of the pond. The high values (164 mg/L) obtained in September would be due to erosion caused by the rains which carried various particles into the pond. In addition, the statistical analysis show a significant and positive correlation between SS and color ($r = 0.6888$; $p < 0.002$) which would reflect the influence of SS on the color of the water. On this subject, [25], the color of the water is influenced by suspended particles from the erosion of mineral and organic particles in the catchment area from natural or anthropogenic sources.

The average pH value shows that the pond waters are slightly acidic. The slightly acid character of water would be, according to [26], influenced by the acid nature of the soils of the region because the pH of the waters depends on the nature of the substrate crossed. These values are similar to the results of [27] obtained respectively in two ponds in Yaoundé (6.83 and 6.82 CU). Nevertheless, this pH remains within the pH range (6.5 - 9.0) recommended by the [28] for the protection of aquatic life.

The percentage of dissolved oxygen saturation (25.03 ± 11.53%) is not included in the range recommended by [29] for fish farming waters (50 to 62.5%) shows poor pond water oxygenation; this character of urban water hypoxia had already been noted by [25]. This would reflect poor photosynthetic activity and an absence of the phenomenon of dissolution from atmospheric oxygen in this pond. In this regard, [30] points out that the air/water interface, oxygen molecules diffuse from air to water or from water to air, depending on the degree of saturation of the oxygen. water into oxygen. He also adds that during the day, plants, algae and certain bacteria use the sun's rays and carbon dioxide (CO_2) to make their food and release oxygen into the water through the phenomenon of photosynthesis.

The orthophosphate levels recorded in the pond are lower than the 0.5 mg/L recommended by [19]. This would result from a very low degradation by bacteria of organic matter coming in particular from waste water rich in organic substances from a toilet and a pigsty upstream of the pond. [19] state that the orthophosphate content in a body of water depends on exogenous inputs. The nitrate levels recorded in the pond are generally low. This would be due to the low load of organic matter in the water and the absence of tributaries upstream of the body of water. The ammonia nitrogen contents observed are

The low values of oxidability with an average value could be due to a strong resilience of the pond although subject to exogenous inputs such as temporary waste from pig excreta and household waste. The results from the physicochemical analyzes generally reflect a good ecological quality of the waters of the Odza pond despite some negative deviations observed at the level of dissolved oxygen. slightly high, this would be due to the low emission of pollution from the toilets and the pigsty.

The electrical conductivity values recorded during the study period would reflect, according to the classification of [19] an average mineralization of the water body. The highest value obtained in April (333 µS/cm) would reflect low mineralization. This could be explained by the low concentration of nutrients in the media (NO_3^-). Indeed [31] points out that nitrate is formed in the presence of oxygen, from dissolved nitrogen (NO_2^- or NO^-), ammoniacal nitrogen (NH_4^+), the latter resulting largely from anaerobic heterotrophic activity. Thus the incomplete oxidation of ammoniacal nitrogen would be at the origin of the reduced nitrate contents and consequently of the weak mineralization [32].

4.1.2. Benthic Macroinvertebrates

The taxonomic richness of benthic macroinvertebrates in the Odza pond is not negligible as it consists of 695 individuals. This could have been larger if the sampling period was longer. The predominance of Hexapods (94.39%) seems to reflect the low anthropized nature of this watershed and the good ecological quality of the waters, because According to [33], [9], [34], most aquatic hexapods are very sensitive to pollution and/or habitat modification and are therefore the first to disappear in a disturbed environment. However, the Diptera (15.40%) which are Hexapods are largely made up of Chironomidae possessing a hemoglobin which allows them to live in highly polluted environments. In addition, Hemiptera (35.39%) have an average tolerance rating, since being good swimmers they can avoid the most degraded areas and they also practice air breathing [35]. Thus, in the pond of Odza, the Hexapods are mainly made up of Coleoptera, Diptera and Hemiptera having a percentage of (50.79%) which is higher than the percentage of Odonata, Coleoptera, Ephemeroptera and Trichoptera (43, 6%) from this pond. According to [35] Dedieu 2011, Hemiptera and Diptera are disturbance-tolerant taxa. Environmental stress has therefore favored the expansion of certain ecological niches occupied by these types of organisms.

The low percentage of Achètes (3.45%) present in this pond brings advantages of arguments according to which our environment is very slightly polluted.

4.1.3. Biocenotic indices

The low values of the Shannon and Weaver index and of the Pielou equitability (J) observed at the Oza 1 station reflect a low diversity of MIBs due to a high abundance of Coleoptera (Hydrophilidae) which group together nearly 35.15 % relative abundance at this station. Moreover, as this index is close to 0 and moves away from Log2 13 (3.70) then, the diversity is low corresponding to non-optimal conditions not allowing the installation of regularly distributed individuals in many species.

Spearman's "r" correlation test revealed many correlations between certain physico-chemical and biological parameters, these are significant and positive correlations between temperature and Belostomatidae (r = 0.630; p = 0.005), then Rhyacophilidae and TDS (r=0.516; p=0.028) and Hydrophilidae and alkalinity (r=0.523; p=0.025). Significant and negative correlations between conductivity and Dystiscidae (r = - 0.542; p = 0.012) and between Potamanthidae and CO2 (r = - 0.621; p = 0.005).

In addition, we have significant and positive correlations between the abundances of macroinvertebrates; this is the correlation between the Macromilidae and the Chironomidae (r = 0.592; p = 0.009), then the Libellulidae and the Nepidae (r = 0.600; p = 0.008) and the Notonectidae and dystiscidae (r = 0.644; p = 0.003).

In addition, the significant and positive correlations between the physicochemical parameters; among many others we have the correlations between color and SS (r = 0.902; p = 3.03E-07) and Turbidity and color (r = 0.902; p = 3.03E-07).

The Principal Component Analysis shows that the two axes which bring together all the information (100%) discriminate the stations into three very distinct nuclei. Core 1 shows waters rich in polluotolerant and polluosensitive taxa (Hydrophilidae) but with a predominance of polluotolerant species of Erpobdellidae and Chironomidae. This predominance of polluting taxa could be justified by the low dissolved oxygen contents obtained in this station as well as a high quantity of carbon dioxide. Core 2 bringing together the Odza2 station highlights the affinities between certain polluotolerant families (Potamanthidae, Tabanidae, Hygroblidae and Dysticidae) and a polluosensitive organism (Tabanidae). These organisms seem to favor water with low orthophosphate values, thus reflecting the beginning of deterioration in water quality. And finally, the Oza3 station shows a presence of pollutant families (Libellulidae) and polluosensitive families (Naucoridae, Belostomatidae, Notonectidae, Nepidae and Lestidae) this could be justified by the fact that these families like water with a low TDS content.

5. CLOSING

At the end of this study, the general objective of which was to assess the physicochemical and dynamic quality of macroinvertebrates in the Odza pond in Yaoundé, Cameroon; while showing the importance of macroinvertebrates in fish nutrition, it appears that these waters are poorly oxygenated, weakly acidic, not very turbid, not very colored reflecting the mesotrophic state of the waters of the Odza pond. These waters have low values of organic pollution indicator parameters (nitrates, orthophosphates and ammoniacal nitrogen), thus reflecting the mesotrophic nature of this environment. Macroinvertebrates have a dominance of the Hydrophillidae family which are polluo-tolerant. All this demonstration shows us a pond of mesotrophic nature. Although this environment being mesotrophic has a size large enough for macroinvertebrates source of protein for fish farming. In addition, several positive and negative correlations are detected between the biotic parameters (Notonectidae, Belostomidae, Hydrophilidae, Rhyacophilidae, Dystiscidae) and abiotic (Temperature, Turbidity, O2) show how a variation of one of the abiotic parameters can allow us to grow or decreased animal protein (macroinvertebrates).

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