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# Combined Zooplankton and Physico-Chemical Approach for Assessing the Water Quality of Lake Ehuikro (Bongouanou, Ivory Coast)

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**Abstract** **Original Research Article**

The present study was conducted on Lake Ehuikro, located in Bongouanou (Côte d'Ivoire), from April 2017 to March 2018, in order to assess its ecological status through the combination of physicochemical parameters and the structure of the zooplankton community. Zooplankton were sampled monthly using a plankton net with a 60 µm mesh size. A total of 33 zooplankton taxa were identified, belonging to 17 families and 25 genera. The zooplankton community was dominated by copepods (48%), followed by rotifers (42%), while cladocerans and other zooplanktonic organisms each represented 5%. Among the rotifers, the Brachionidae (8 taxa) were dominant, whereas among the copepods, the Cyclopidae (5 taxa) prevailed. Conductivity, temperature, oxygen saturation rate, and dissolved oxygen were higher during the major dry season, while phosphorus, nitrate concentrations, and depth were higher during the major rainy season. The results revealed that some physicochemical parameters showed signs of disturbance, likely linked to local anthropogenic activities. Biologically, the dominance of copepods and rotifers indicates a tendency toward mesotrophy.
**Keywords:** Zooplankton biodiversity, Mesotrophy, Seasonal variations, Anthropogenic activities, Ecological status.



## I - INTRODUCTION

Inland aquatic environments, such as lakes, are essential ecosystems for biodiversity, ecosystem services, and water resource provision. To ensure the sustainable management of these the assessment of the ecological quality of these environments has traditionally relied on physicochemical measurements. However, the addition of biological indicators, particularly zooplankton, allows for a more integrated view of ecological health.

In West Africa, several recent studies highlight the relevance of this combined approach. For example, in the Ébrié Lagoon in Côte d'Ivoire, zooplankton communities—particularly Rotifers, Copepods, and Cladocera—vary seasonally and according to physicochemical conditions such as temperature, salinity, conductivity, pH, and dissolved oxygen. Appiah ***et al***, (2018). Similarly, in the coastal rivers of southeastern Ivory Coast, Rotaria sp. has proven to be a reliable indicator of pollution, with the diversity and abundance of zooplankton influenced by environmental factors such as conductivity, water temperature and flow rate (Money ***et al.,*** 2016).

At the regional level, studies conducted in the lagoons of Benin show that seasonal variations in salinity explain 37% of the variance in zooplankton abundance and 23% of that of the most frequent taxa. Chaigneau ***et al.***, (2023). These results confirm the importance of physico-chemical parameters as key drivers of zooplankton dynamics.

Specifically regarding Lake Ehuikro in Bongouanou (Côte d'Ivoire), a study conducted between July 2017 and June 2018 using the Ichthyological Index of Wetlands ("IIZH") revealed that water quality is good during the rainy season and degraded during the dry season, based solely on physico-chemical and ichthyological data. Kouadio ***et al.,*** (2023). Therefore, there remains a pressing need to enrich this assessment by integrating a zooplankton dimension that is still unexplored for this lake.

This research aims to conduct an integrated assessment of the water quality of Lake Ehuikro by combining the analysis of physicochemical parameters (pH, temperature, conductivity, dissolved oxygen, nutrients, etc.) with the study of zooplankton communities. This approach will allow for a better understanding of the ecological pressures the lake experiences seasonally, the detection of potential signs of pollution or trophic imbalances, and the more precise guidance of management and conservation strategies. While vital to the local populations, West African lake environments are subject to increasing pressures related to human activities (domestic, agricultural, and industrial) and climate change.

**I-1 Study Area**

Lake Ehuikro is located in the commune of Bongouanou, in the east-central part of Ivory Coast, in the Moronou region (6°39' N, 4°12' W). Lake Ehuikro is a reservoir lake (Figure 1) Built for drinking water supply, it was constructed in 1973 as part of the national hydraulic program on the sacred Yakpo River. Lake Ehuikro is located between latitudes 6°38'12" and 6°38'40" North and between longitudes 4°09'48" and 4°10'30" West. Its surface area is 733,455 m². The dam's flow is regulated by the flow of the sacred Yakpo River and Lake Kaby. Located 1 km west of the town of Bongouanou, it receives runoff water from the village of Ehuikro, from which it takes its name. The Ehuikro drinking water supply dam is bordered to the south by a poultry farm, a pig farm, and agricultural crops (rubber tree nurseries, corn, tomatoes, and okra). The North, East, and West are occupied by cassava and cocoa plantations and also by tomato, pepper and okra crops. The Ehuikro dam lake is home to other plants such as Mimosa invisa Mart. (Mimosaceae), Cassia siamea Lam. (Babaceae), Polygonum lanigerum R. Br. (Polygonaceae), Nymphaea lotus Linn. (Nymphaeaceae), Rhynchospora corymbosa (L) Britton (Cyperaceae) and Ipomoea aquatica Forssk (Convolvulaceae) (Kouadio *et al.,* 2023).

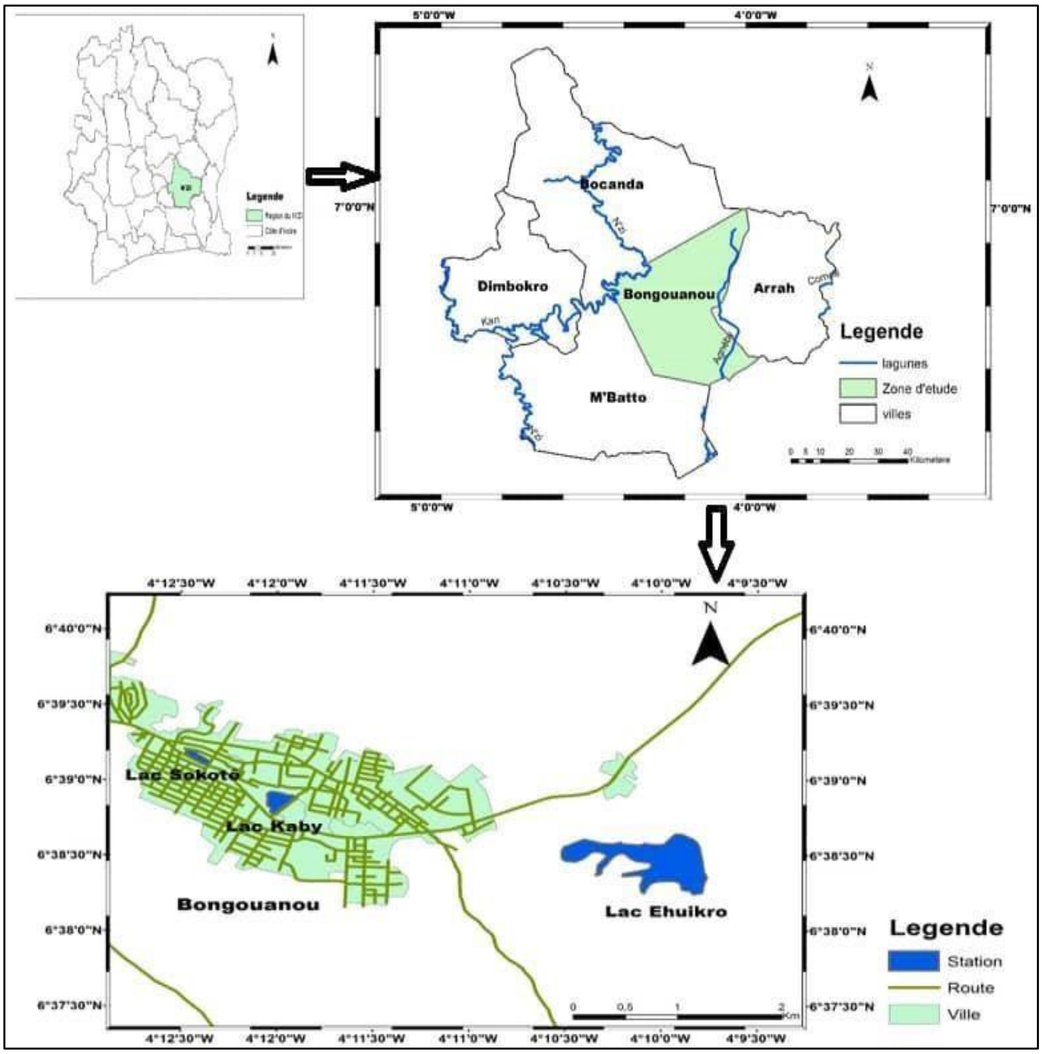



**Figure 1: Geographical location of Lake Ehuikro (Assemien *et al.,* 2013)**

**2-1 Equipment**

**2-1-1 Biological material**

The biological material consists of all the zooplanktonic organisms that were sampled in Ehuikro between April 2017 and March 2018.

**2-1-2 Technical Equipment**

**2-1-3 Materials for studying environmental variables**

The following equipment was used to measure the physicochemical parameters of the study medium. (Figure 2):

- a conductivity meter (Figure 2A) SX713 model for measuring conductivity and dissolved solids content;
- a pH meter (Figure 2B) SX711 model for pH measurement;
- a model oximeter (Figure 2C) SX716 for measuring dissolved oxygen and temperature;
- a Secchi record (Figure 2D)30 cm in diameter for determining water transparency;
- a 10m pole, graduated for measuring water depth.
- a Niskin bottle was used to collect water samples for nutrient analysis.
- 500 ml glass bottles were used as containers for freshly collected water samples.
- a cooler containing ice was used to preserve the water samples.
- a Technicon auto-analyzer (model AA3) was used to measure nutrient salts following the protocol prescribed by
- Strickland and Parsons (1972).

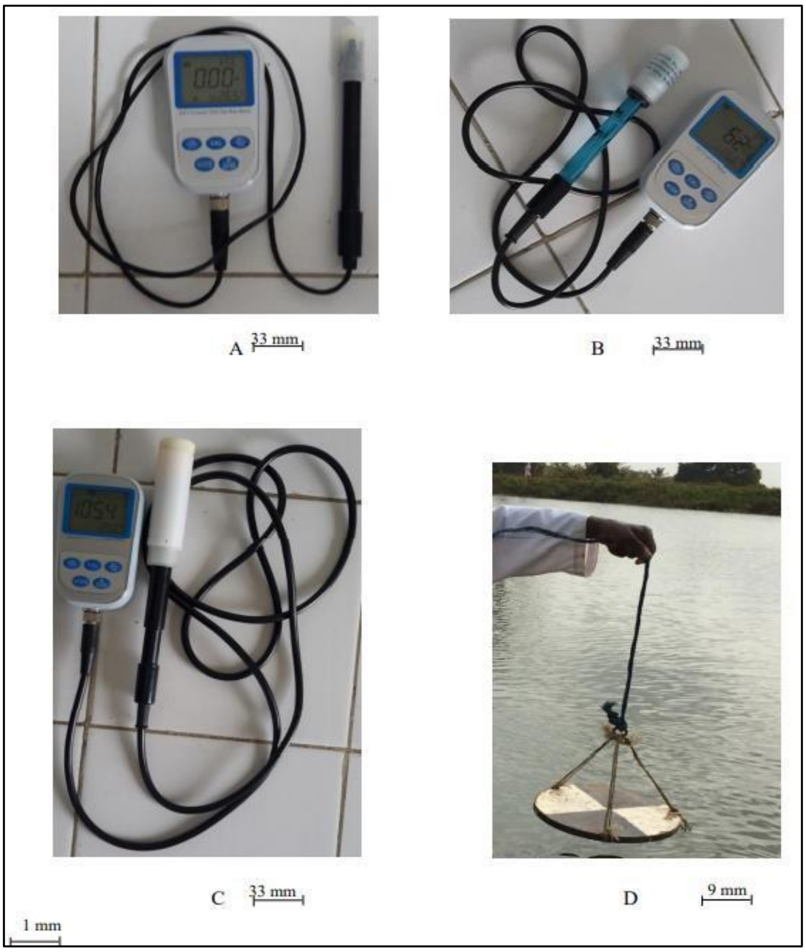



**Figure measure 2: of the Material of features-physics and chemistry**

A =Conductivity meter Model Sx713; B=pH meter Model Sx711; C=Oximeter Model Sx716; D=Secchi disc.

**2-1-4 Zooplankton Collection and Identification Equipment**

**Zooplankton sampling and identification were carried out using the following equipment:**

- a cylindro-conical plankton net with a 30 cm diameter opening, a total length of 1 m and a mesh size of 60 µm(Figure 3);
- a bucket with a capacity of 10 litres.

Zooplankton was preserved in 50-60 ml capacity pill bottles containing formaldehyde buffered with borax at a concentration of 5%.

A Vision ENGINEERING brand binocular loupe (magnification ×160, ×250 and ×400), a Dollfuss tank, a graduated cylinder and 1- and 5-ml Eppendorf pipettes were used for the identification and counting of taxa.

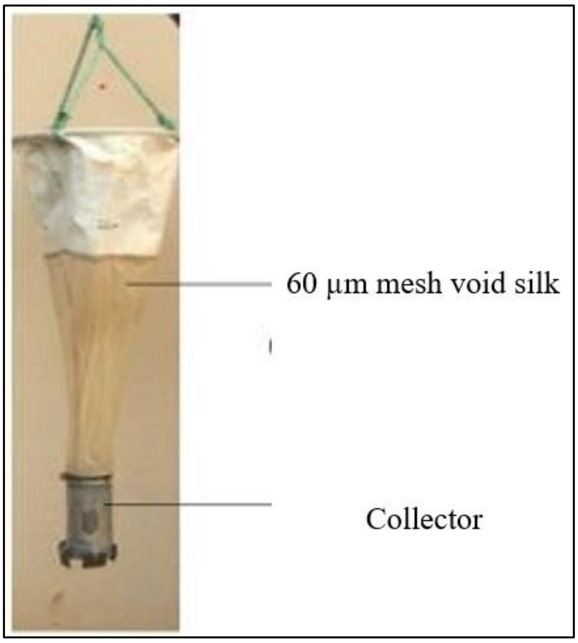



**Figure 3: Plankton net used for zooplankton sampling**

## 2-2METHODS

### 2-2-1 Selection of study stations and sampling periods

Our study focused on the spatial and seasonal variability of zooplankton composition and distribution. It was conducted over an annual cycle (March 2017 to April 2018) with monthly sampling campaigns at three stations. Sampling took place between 7:00 and 9:00 AM. Three sampling stations (figure 11) The sites were chosen across the Ehuikro lake area based on human pressures, habitat diversity, and canopy. However, these choices were also influenced by the ease of access to the sites.

### 2-2-2 Estimation of substrate content and vegetation cover of water

For each site, the average substrate levels as well as the water surface coverage by plants aquatics were expressed as a percentage (%)(Arab ***et al***., 2004). The different types of substrates identified from the sample taken from the bottom of the water using a Van Veen grab.

### 2-2-3 Measurement of environmental variables

The physicochemical characteristics were measured monthly between 7:00 and 9:00 AM. For the measurement of physicochemical variables, the instruments (pH meter, conductivity meter, oximeter) were prepared by inserting the batteries and connecting the probes, then powered on. They were then calibrated with the various calibration solutions. Next, their probes were immersed in water to measure pH, conductivity, and dissolved solids. Selecting the parameter function automatically displayed the parameter value on the screen, which was then recorded.

To determine water transparency, the Secchi disk is submerged until it disappears completely, then raised until it is visible again to the observer. The depth at which it becomes visible again corresponds to the water's transparency.

The water depth was measured using a graduated rod. This rod was submerged in the lake until it reached the bottom. The depth corresponds to the length of the submerged part of the rod.

### 2-2-4 Zooplankton Sampling

Zooplankton was sampled as follows: water was drawn ten times from the environment using a bucket with a capacity of 10 litres and filtered through the 60 µm mesh plankton net at the seven stations.

**The collected sample is placed in a pillbox. The reduced sample is then processed according to the following protocol:**

- to limit the bursting of the Cladoceran valves, 1 to 2 mg of sucrose were added (Haney and Hall, 1973).
- for the staining of zooplanktonic organisms in order to facilitate their observation under a magnifying glass, 2 to 3 drops of neutral red were added.
- for the preservation of zooplanktonic organisms, borax-buffered formaldehyde with a final concentration of 5% was added.

### 2-2-5 Identification and counting of zooplankton

The organisms were identified in the laboratory using the keys of By Manuel (2000) for rotifers, Dussart And Defaye (2001) for copepods, of Kotov ***et al*** (2012) for cladocerans and then counted. The sample is reduced to a volume of 50 or 100 ml in a graduated cylinder according to its zooplankton concentration. It is then homogenized by successive transfers into beakers, and subsampling is carried out using 1- and 5-ml Eppendorf pipettes with wide-bore tips. The subsample is transferred to a Dollfuss tank, the contents of which are examined under a binocular microscope. One or more subsamples are examined until a minimum of 100 individuals per taxon is counted, in order to minimize subsampling error. (Cassie, 1968) and to reduce the coefficient of variation to a maximum of 10%. For the least abundant taxa, the entire sample is explored. The other organisms were identified using the keys of Durand and Lévêque (1981); Tachet ***et al***. (2010). Individuals not identified by the keys are classified in the group of other zooplanktonic organisms.

$$H' = -\sum_{i=1}^{Sobs} P_i \log_2 P_i$$

**2-2-6Methods for studying zooplankton populations**

**2-2-6-1 Taxonomic richness (Rt)**

This is the total number of the various taxa to which the organisms collected at a given sampling station belong. It measures elementary diversity, based directly on the total number of taxa in a site.

This method depends on the sample size and not on the relative density of the different taxa. Therefore, its ecological value is limited. (Travers, 1971). For the qualitative expression of the structure of The ecosystem, two indices considering both density and taxonomic richness: the Shannon index and the regularity index, calculated using the past.exe software. 2.18

**2-2-6-2 Density**

Density is the number of individuals of a tax on present in the sample per unit volume of water. filtered (ind/L). It is obtained from the formula.

D = n / V

Where: n = number of individuals of a tax on present in the sample and V = Volume of filtered water expressed in liters. The volume of water taken with the bucket has a value of 100 liters [10 times the capacity of the bucket (i.e. 10 × 10 liters)].

**2-2-6-3 Percentage of occurrence**

The percentage of occurrence (F) is the ratio between the number of samples (Pi) where a species is observed and the total number of samples (Pt) multiplied by 100. It indicates the degree of ubiquity of the different species.

$$F = \frac{Pi}{Pt} \times 100$$

The classification of taxa based on their percentage of occurrence was done according toDajoz (2000):F ≥ 50%: constant taxon; 25% ≤ F < 50%: accessory taxon; F < 25%: accidental taxon.

**2-2-6-4 Shannon Diversity Index (H')**

The Shannon diversity index (H') is an index that measures the overall diversity of a population (Amanieu and Lasserre, 1982It allows for a comparative study of stands. between stations because it is relatively independent of the sample size (Ramade, 1994).

High Shannon diversity index values correspond to a high diversity in the studied community. H' is zero if and only if the sample consists of a single species, and maximal (on the order of 5) if all species in the community have equivalent densities.

Sobs: total number of taxa observed in all samples; Pi = ni / ∑ ni = relative frequency of taxon i in the population;

∑ ni = total population ; ni = population of taxon i

**2-2-6-5 Regularity Index (Re) or Fairness Index (E)**

The evenness or regularity index (E) is used to study the degree of balance in terms of density between the different taxa of a stand. (Lobry ***et al***., 2003) This measure can be seen as the proportion of the maximum value that the Shannon diversity index H' can reach for a locality, if the Species were distributed in similar proportions. Evenness varies between 0 and 1. It is equal to 0 when one species dominates the population and 1 when all species have the same relative abundance. The expression of evenness is determined by the ratio of the diversity index (H') to its maximum value (H'max).

E = H'/ H'max

H'max: maximum value of H' (H'max = log2 Sobs with Sobs: number of taxa)

**2-2-6-6 Sladecek Index**

According to Sládecek (1983), the gender quotient *Brachionus*/gender *Trichocerca* This allows us to determine the quality of a water body. This quotient can be established for a body of water characterized by slow or fast flow. It can also be applied to individual samples if representatives of at least one of these types are present.

In our study, we calculated the quotient of the sum of the abundance of all species of the genus *Brachionus* on the sum of the abundance of all species of the genus *Trichocerca.* The results obtained were classified according to the grid of Sládecek (1983).

QB/T= Abundance of species of the genus *Brachionus*/Abundance of species of the genus *Trichocerca* when the values of Q

B/T <1.0 then the environment is said to be Oligotrophic.

When the values of QB/T1.0 < QB/T <2.0 then the environment is said to be Mesotrophic. When the values of QB/T2.0 then the environment is said to be Eutrophic.

**2-2-7Statistical Analyses**

**2-2-7-1 Analysis of Variance**

Analysis of variance (ANOVA) is a statistical test for comparing means that allows us to verify the differences or similarities between different samples are examined. In this case, two hypotheses are formulated: a null hypothesis (H0) stating that there is no difference between the means of the samples being compared, and a second hypothesis (H1) stating that there is a significant difference between the means of the samples being compared. The analysis was performed using Statistica 7.1, which provides the p-value. If this p- value is less than 0.05, the null hypothesis (H0) is rejected; otherwise, it is concluded that these differences are not significant.

In this work, ANOVA was used to compare the values of environmental parameters and the abundance of zooplanktonic organisms spatially and seasonally.

Tukey's post hoc test is a non-parametric alternative to Student's t-test. It is used to compare two independent samples and test the null hypothesis (significant at $p < 0.05$) that the different samples being compared come from the same distribution. (Siegel, 1956). The interpretation of the test is partly identical to that of the results of the student's t-test for independent samples. In this study, Tukey's post-hoc test was used to assess the degree of significance of seasonal variations in environmental parameters at the three lakes (Ehuikro, Kaby, and Sokotè).

**2-2-7-2 Redundancy Analysis**

The CANOCO program (Canonical Community Ordination, version 4.5) (Ter-Braak and Smilauer, 2002*)* This method was used to relate the environmental variables of the different habitats studied to the zooplankton taxa collected in these environments. In this program, a Detrended Correspondence Analysis (DCA) is first performed. This allows the gradient length to be determined in standard deviation (SD) units. When the maximum gradient length does not exceed 4SD, a linear method is preferable to a unimodal method. To this end, an environmental variable/station matrix is constructed based on the densities of the different taxa. The densities and values of the environmental factors undergo a log(x+1) transformation to obtain a normal distribution of these data.

The results of this analysis are presented in the form of a diagram where the relative positions of the environmental variables are represented by arrows: the length of the arrow reflects the importance of the environmental variable; its direction indicates how the environmental variable is correlated with the various axes; the angle between the arrows shows the correlations between the variables; the location of the species in relation to the arrows highlights the environmental preferences of each species.

**3.1. Environmental parameters**

**3.1.1. Results**

**3.1.1.1. Physico-chemical characterization of Lake Ehuikro**

**3.1.1.1.1. Spatial variations of physico-chemical parameters**

Ten physicochemical parameters (Dissolved solids content, Temperature, Dissolved oxygen, Rate of Oxygen saturation, pH, conductivity, transparency, depth, nitrate and phosphate content) were monitored monthly during the study period. (Figure 4).

The dissolved solids content varied between 159.88 mg/L (Ehui 2) and 166.09 mg/L (Ehui 1). The conductivity varied between 274.45 mg/L (Ehui 2) and 278.33 mg/L (Ehui 1). The pH values ranged between 7.42 (Ehui 2) and 7.70 (Ehui 3). The average water temperature at the sampling sites ranged from 27.78 °C (Ehui 2) to 28.16 °C (Ehui 1). The oxygen saturation level varied between 58.76% (Ehui 2) and 61.41% (Ehui 3). The dissolved oxygen level ranged from 4.50 mg/L (Ehui 2) to 4.98 mg/L (Ehui 3). 1) The extreme values of phosphorus range from 0.03 mg/L at (Ehui 1) to 0.06 mg/L at (Ehui 3). Nitrate ranges from 0.002 mg/L at (Ehui 1) to 0.004 mg/L at (Ehui 3). Transparency ranges from 0.54 m (Ehui 1) to 0.58 m (Ehui 2), while depth varies from 2.98 m at (Ehui 2) to 3.93 m at (Ehui 1).

Overall, the average values for temperature, conductivity, saturated oxygen content, the Dissolved solids concentration and dissolved oxygen concentration gradually increase from station Ehui 2 (27.78 ± 0.81°C; 274.45 ± 23.94 mS/cm; 57.76 ± 7.62%; 159.88 ± 10 mS/cm; 4.50 mg/L ± 0.7 mg/L, respectively) to station Ehui 1 (28.16 ± 0.17°C; 278.33 ± 13.42 mS/cm; 61.41 ± 10.27%; 166 mg/L ± 12.14 mg/L; 4.98 ± 0.64 mg/L, respectively).

Conversely, the average values of transparency, phosphorus, and nitrate increase from station Ehui 1 (0.54 ± 0.08 cm; 0.03 ± 0.01 mg/L; 0.002 ± 0.001 mg/L, respectively) to station Ehui 3 (0.56 ± 0.09 cm; 0.06 ± 0.009 mg/L; 0.004 ± 0.0008 mg/L). The average hydrogen potential (pH), on the other hand, increases from station Ehui 2. (7.53 ± 0.19) at station Ehui 3 (7.89 ± 0.5). Comparison of the variations of the ten physico-chemical parameters showed significant differences between stations for nitrate (ANOVA, $p < 0.05$).

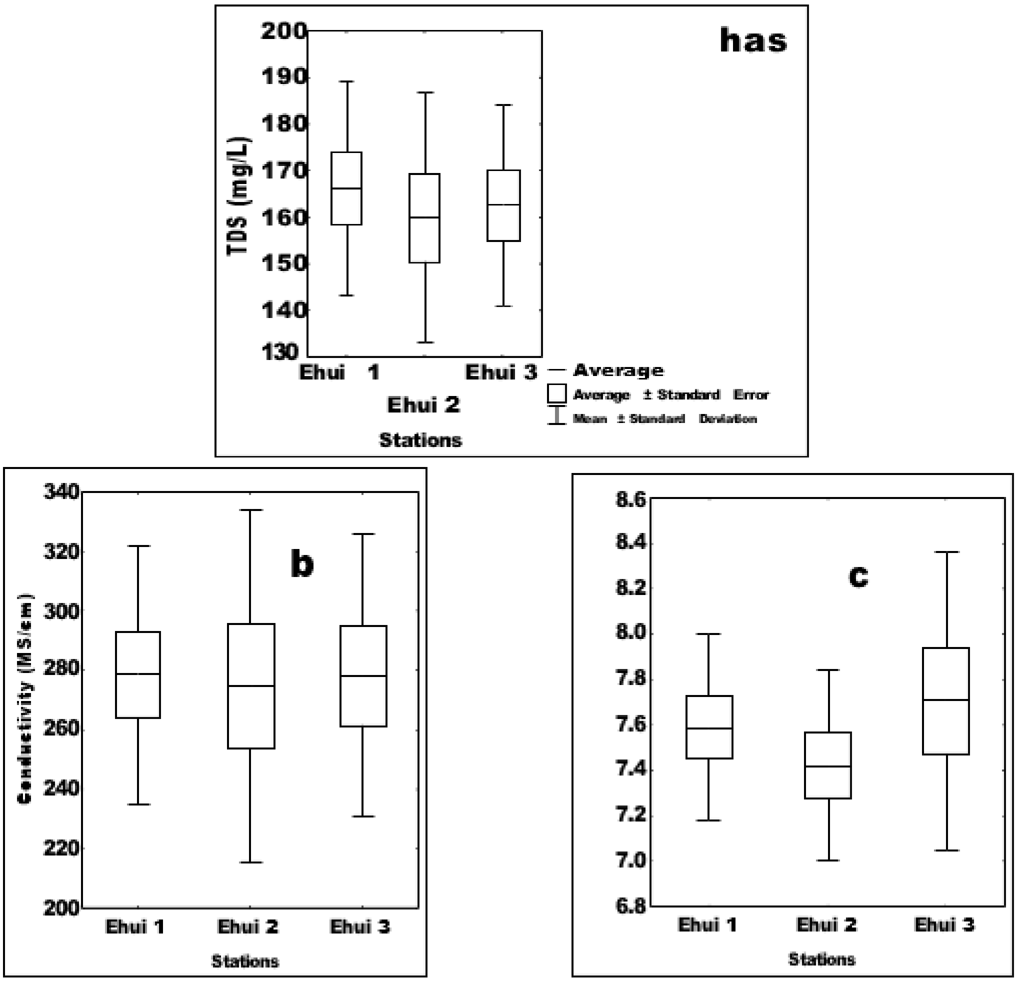
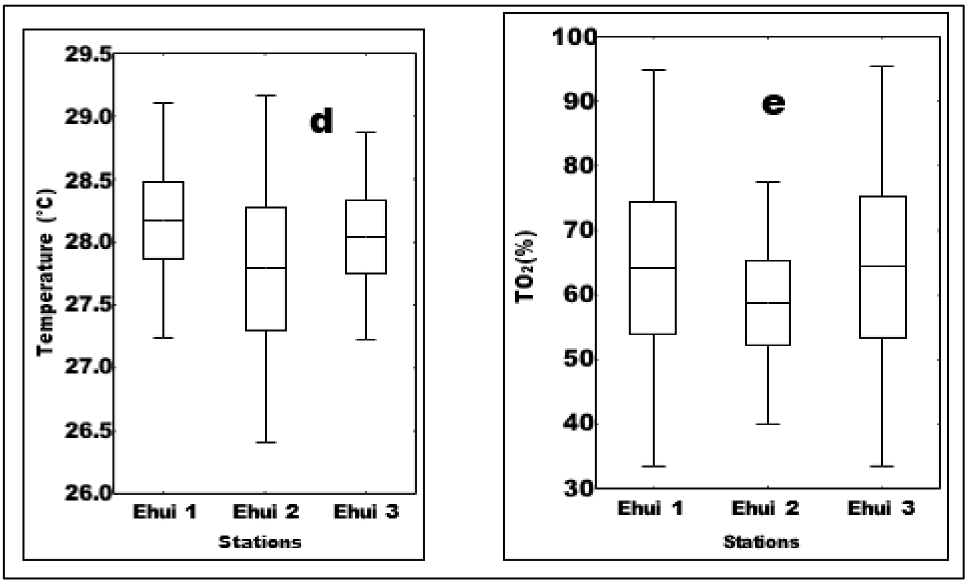



**Figure 4: Spatial variations of physico-chemical parameters measured in Lake Ehuikro (Ivory Coast) between April 2017 and March 2018.has) dissolved solids content; b) conductivity; c) pH;**



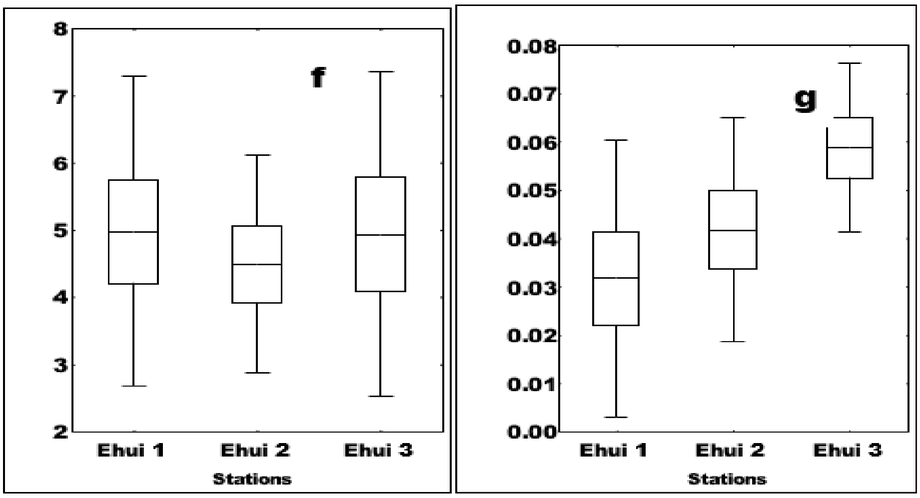



**Figure 5: Spatial variations of physico-chemical parameters measured in Lake Ehuikro (Ivory Coast) between April 2017 and March 2018.d): temperature e): oxygen saturation level; f) dissolved oxygen levels, g) phosphorus level**

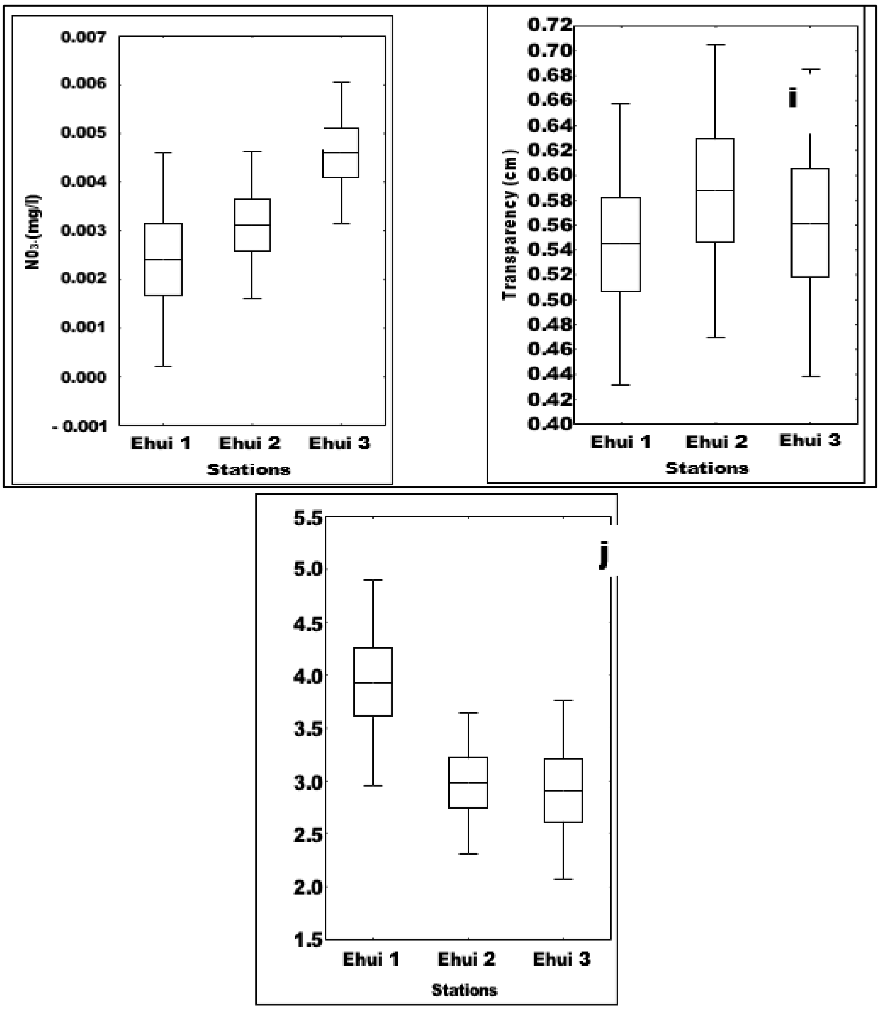



**Figure 6: Spatial variations of physico-chemical parameters measured in Lake Ehuikro (Ivory Coast) between April 2017 and March 2018.h): nitrate level. i): transparency, j): depth.**

**3.1.1.1.1.2 Seasonal variations of physico-chemical parameters**

Conductivity, temperature, oxygen saturation level, and dissolved oxygen level were more raised during the long dry season (Table 1) Phosphorus and nitrate concentrations, as well as depth, were highest during the long rainy season. Dissolved solids levels and transparency peaked during the short dry season. The highest hydrogen potential value was observed during the short rainy season.

The average values for dissolved solids range from 154.13 ± 1.22 mg/L (long dry season) to 181.67 ± 3.78 mg/L (short dry season). Conductivity varies between 250 ± 3.07 Ms/cm (short rainy season) and 297.75 ± 2.66 Ms/cm (long dry season).

The hydrogen potential has the lowest value (7.35 ± 0.13) during the long dry season and the highest

The highest value (8.09 ± 0.55) was recorded during the short rainy season. Regarding temperature, the lowest average was recorded during the long rainy season (27.06 ± 0.67 °C) and the highest during the long dry season (28.45 ± 0.05 °C). The oxygen saturation level showed average values ranging from 42.67 ± 3.77% (short dry season) to 67.93 ± 6.96% (long dry season). Regarding dissolved oxygen levels, the lowest average was recorded during the short dry season (3.07 ± 0.64 mg/l) and the highest during the long dry season (5.24 ± 0.45 mg/l).

The average phosphorus concentration values are between 0.03 ± 0.01 mg/l (small Rainy season) and 0.06 ± 0.01 mg/L (main rainy season). Average nitrate concentration values range from 0.01 ± 0.1 mg/L (main dry season, and short dry and rainy seasons) to 0.02 ± 0.1 mg/L (main rainy season).

In terms of transparency, average values vary between 0.44 ± 0.02 cm (main rainy season) and 0.68 ± 0.05 cm (short dry season). Average depth values range from 2.71 ± 0.36 m (main dry season) to 4.20 ± 0.51 m (main rainy season).

Analysis of variance (ANOVA) revealed significant seasonal differences ($p < 0.05$) for depth, temperature, and transparency. For temperature and depth, the significant differences (Tukey post-hoc test, $p < 0.05$) were found between the long dry season and the long rainy season. For transparency, the significant difference was observed between the dry seasons (GSS and PSS) and the rainy seasons (GSP and PSP) (Tukey post-hoc test, $p < 0.05$).

**Table 1: Values (means ± standard deviation) of physico-chemical parameters measured during the short dry season (SDS), long dry season (LDS), short rainy season (SPS) and long rainy season (LPS) in Lake Ehuikro (Ivory Coast) between April 2017 and March 2018**

| Settings | GSS | GPS | PSS | PSP |
|---|---|---|---|---|
| TDS (mg/L) | 154.13 ± 1.22has | 168.5 ± 8.01has | 181.67 ± 3.78has | 163 ± 2.02has |
| Cond (MS/cm) | 297.75 ± 2.66has | 252.14 ± 11.70has | 274 ± 2has | 250± 3.07has |
| PH | 7.35 ± 0.13has | 7.75 ± 0.01has | 7.53 ± 0.06has | 8.09 ± 0.55has |
| Temperature (°C) | 28.45 ± 0.05has | 27.06 ± 0.67b | 28.24 ± 0.04ab | 27.9 ± 0.07ab |
| Sat TO2(%) | 67.93 ± 6.96has | 61.42 ± 4.81has | 42.67 ± 3.77has | 65.63 ± 2.11has |
| TO2(mg/l) | 5.24 ± 0.45has | 5.08 ± 0.58has | 3.07 ± 0.64has | 4.53 ± 0.36has |
| P034-(mg/l) | 0.04 ± 0.01has | 0.06 ± 0.01has | 0.04 ± 0.01has | 0.03 ± 0.01has |
| N03-(mg/l) | 0.01 ± 0.1has | 0.02 ± 0.1has | 0.01 ± 0.1has | 0.01 ± 0.1has |
| Transp (cm) | 0.62 ± 0.01has | 0.44 ± 0.02b | 0.68 ± 0.05has | 0.52 ± 0.03ab |
| Prof (m) | 2.71 ± 0.36has | 4.20 ± 0.51b | 3.18 ± 0.29ab | 3.43 ± 0.31ab |

TDS = Total Dissolved Solids; Cond = Conductivity; pH = Potential of Hydrogen; Temp = Temperature; Sat TO2= Oxygen saturation level; TO2= Dissolved oxygen level; P03- -4= Phosphate level; NO3-= Rate of nitrate; Transp = Transparency; Prof = Depth.

For a given parameter, values in the same row with different letters (a and b) in exponents show significant differences (ANOVA, p<0.05).

**3.1.1.1.1.4 Substrate canopy closure rate at Lake Ehuikro**

The substrate of Lake Ehuikro is composed of fine and coarse sands, dead wood, and plant debris. a mixture of gravel and mud, sand and gravel (Table 2). Aquatic plants can also be found on the lake.

At Ehui 1, the substrate consists of a mixture of gravel and mud and plant debris, while at Ehui 2, it is primarily a mixture of sand, gravel, and plant debris. At Ehui 3, the substrate is dominated by sand and plant debris. The canopy cover is 20% at Ehui 1 and 0% at Ehui 2 and 3. The aquatic plant cover rate is 16% at Ehui 1, 30% at Ehui 2, and 34% at Ehui 3.

**Table 2: Average values of substrate levels in Lake Ehuikro**

| Stations | MGB (%) | MSG (%) | S (%) | DV (%) |
|---|---|---|---|---|
| E1 | 82 | 0 | 0 | 18 |
| Ehuikro E2 | 0 | 68 | 0 | 32 |
| E3 | 0 | 0 | 67 | 33 |

MGB: Gravel Mud Mixture; MSG: Sand Gravel Mixture; S: Sand; DV: Plant Debris;

**3.2.1.2. Zooplankton population of Lake Ehuikro**

**3.2.1.2.1. Qualitative aspect**

**3.2.1.2.1.1. Taxonomic composition and distribution**

In total, 33 zooplankton taxa were collected from Lake Ehuikro (Table 3) These taxa are divided into four major zooplanktonic groups [Rotifers (21 taxa; 63.64%), Copepods (6 taxa; 18.18%), Cladocera (1 taxa; 3.03%), and the group of other zooplanktonic organisms (5 taxa; 15.15%)]. These 33 taxa are distributed among 17 families and 25 genera, plus taxa whose families and genera remain undetermined.

Among Rotifers, considering the number of taxa, the richest family is the Brachionidae (7 taxa; 33.33%), followed by the Filinidae and Licanidae (three taxa; 14.29%). Eight families (Asplanchnidae, Trichocercidae, Hexarthridae, Gastropodidae, Mytilinidae, Notommatidae, Floscularidae, and Synchaetidae) are monotypic (4.77% each). *Brachionus* constitutes the most important genus in terms of taxonomic richness, with four taxa, followed by the genus *Filinia* and the genre *Lecane* (three taxa).

Among Copepods, the richest family is the Cyclopidae with five taxa (83.33%) followed by the nauplii (16.67%).

Regarding Cladocera, the Sididae (100%) constituted the only family

The distribution of zooplankton taxa in the different stations of Lake Ehuikro shows 27 taxa At Ehui 1, there are 28 taxa, at Ehui 2, and 25 taxa at Ehui 3. Analysis of organism distribution indicates that four taxa are present only at Ehui 1. These are: *Brachionus calyciflorus, Lecane monostyla, Mytilina mucronata* and *Gastropus minor*.

**Table 3: Distribution and occurrence of the different taxa collected in Lake Ehuikro (Ivory Coast) from March 2017 to April 2018.**

| GROUPS | FAMILIES | TAXONS | EHUI 1 | EHUI 2 | EHUI 3 | % OCCURRENCY |
|---|---|---|---|---|---|---|
| ROTIFERS | Brachionidae | *Brachionus angularis* | + | + | + | 86.11 |
| | | *Brachionus calyciflorus* | + | | | 2.77 |
| | | *Brachionus falcatus* | + | + | + | 38.88 |
| | | *Keratella lenzi* | + | + | | 5.55 |
| | | *Keratella tropica* | + | + | + | 7.22 |
| | | *Anuraeopsis navicula* | + | + | | 11.11 |
| | | *Anuraeopsis fissa* | + | + | + | 25 |
| | Filinidae | *Filinia longiseta* | + | + | + | 31.11 |
| | | *Filinia opoliensis* | + | + | + | 44.4 |
| | | *Filinia terminalis* | + | + | + | 33.33 |
| | Licanidae | *Lecane Leontina* | + | + | + | 27.77 |
| | | *Lecane monostyla* | + | | | 2.77 |
| | | *Lecane*sp. | + | + | + | 52.77 |
| | Mytilinidae | *Mytilina mucronata* | + | | | 2.77 |
| | Gastropudae | *Gastropus minor* | + | | | 2.77 |
| | Asplanchnidae | *Asplanchna*sp. | + | + | | 11.11 |
| | Trichocercidae | *Trichocerca*sp. | + | + | + | 19.44 |
| | Notommatidae | *Cephalodella gibba* | + | + | + | 41.66 |
| | Floscularidae | *Lacinularia floculosa* | + | | | 2.77 |
| | Synchaetidae | *Polyarthra vulgaris* | + | + | + | 22.22 |
| | Hexarthridae | *Hexarthra mira* | + | + | + | 25 |
| COPEPODES | Cyclopidae | *Thermocyclops dicipiens* | + | + | + | 77.77 |
| | | *Thermocyclops neglectus* | | + | + | 58.33 |
| | | *Paracyclops affinis* | | + | + | 61.11 |
| | | *Mesocyclops*sp. | + | + | + | 43.22 |
| | | *Halycyclops koensis* | + | + | + | 31.11 |
| | Undetermined | *Nauplia* | + | + | + | 100 |
| CLADOCERES | Sididae | *Diaphanosoma excisum* | | + | + | 53.02 |
| OTHERS | Chironomidae | Chironomidae larvae | | + | + | 52.77 |
| | Cyprididae | Ostracode | + | + | + | 51.11 |
| | Undetermined | Chaoborus larvae | | + | + | 22.22 |
| | Undetermined | Insect larvae | + | + | + | 12.33 |
| | Centropyxidae | Centropyxis | | + | + | 11.11 |
| TOTAL | | 33 | 27 | 28 | 25 | |

**3.2.1.2.1.2. Occurrence of taxa from Lake Ehuikro**

The classification of taxa, based on their percentage of occurrence, resulted in three categories of taxa.(Table 3.1)Nine constant taxa (27.28%) are:*Brachionus angularis, Lecane sp, Thermocyclops dicipiens, Thermocyclops neglectus, Paracyclops affinis,* Nauplus *Diaphanosoma excisum,* Chironomidae larvae,Ostracod.2)Ten accessory taxa (30.30%) which are:*Brachionus falcatus, Anuraeopsis fissa, Filinia* *longiseta, Filinia opoliensis, Filinia terminalis, Lecane leontina, Cephalodella gibba, Hexarthra mira, Mesocyclops sp, Halycyclops koensis*3)Fourteen accidental taxa (42.42%) that are*: Brachionus calyciflorus, Keratella lenzi, Keratella tropica, Anuraeopsis navicula, Lecane monostyla, Mytilina mucronata, Gastropus minor, Asplanchna sp, Trichocerca sp, Lacinularia floculosa, Polyarthra vulgaris,* chaoborus larvae, centropyxis.

**3.2.1.2.1.3 Spatio-temporal variations of the diversity indices of Lake Ehuikro**

The lowest taxonomic richness values were observed in Ehui 1 (8 taxa) and Ehui 3 (13 taxa), and the highest in Ehui 2 (27 taxa). In Ehui 1, the lowest taxonomic richness was observed during the short rainy season (8 taxa), and the highest during the long dry (18 taxa) and rainy (19 taxa) seasons. (Table 4) At Ehui 2, the lowest taxonomic richness (16 taxa) was noted during both the short dry and rainy seasons. The highest (27 taxa) was recorded during both the long dry and rainy seasons. At Ehui 3, the lowest taxonomic richness (13 taxa) was recorded during the short dry season and the highest during the rainy season (25 taxa).

**Spatially, the lowest Shannon index values (1.61 to 2.35 bits/ind) were recorded at Ehui 1 and Ehui**

2. Conversely, the highest values (2.61 to 2.75 bits/ind) were observed at Ehui 2 and Ehui 3. In Ehui 1, the lowest Shannon index value (1.61 bits/ind) was recorded during the short rainy season and the highest (2.56 bits/ind) during the rainy season. In Ehui 2, the lowest Shannon index value (2.35 bits/ ind) was obtained during the short rainy season and the highest (2.72 bits/ind) during the long rainy season. In Ehui 3, the lowest value (2.35 bits/ind) was recorded during the dry season and the highest (2.75 bits/ind) during the heavy rains.

The study of the spatial variation of the regularity index indicates that the lowest values (0.77 to 0.79) were recorded in Ehui 1 and Ehui 2. Conversely, the highest values (0.87 to 0.93) were observed in Ehui 2 and Ehui 3. In Ehui 1, the lowest value of the regularity index (0.77) was obtained during the short rainy season and the highest value (0.90) during the short dry season. In Ehui 2, the lowest value (0.79) of the regularity index was obtained during the long dry season and the highest value (0.87) during the short dry season.

Meanwhile, in Ehui 3, the lowest value (0.84) of the regularity index was obtained during the long dry season and the highest value (0.93) during the rainy season. Comparison of the values of the different diversity indices between seasons does not show significant differences (ANOVA; $p > 0.05$).

Comparison of the different diversity indices between stations shows a significant difference (ANOVA; $p < 0.05$). The significant differences (Tukey post hoc, $p < 0.05$) are found between stations Ehui 1 and Ehui 3, and between stations Ehui 2 and Ehui 3.

**Table 4: Seasonal variations of zooplankton population diversity indices collected in Lake Ehuikro (Ivory Coast) between March 2017 and April 2018**

| | | **Stations** | | |
|---|---|---|---|---|
| **Diversity indices** | | **Ehui 1** | **Ehui 2** | **Ehui 3** |
| Taxonomic Wealth | Long dry season | 18 | 27 | 22 |
| | Long rainy season | 19 | 27 | 25 |
| | Short dry season | 10 | 16 | 13 |
| | short rainy season | 8 | 16 | 16 |
| Shannon Index (bits/ind) | Long dry season | 2.5 | 2.61 | 2.61 |
| | Main rainy season | 2.56 | 2.72 | 2.75 |
| | Short dry season | 2.09 | 2.4 | 2.35 |
| | short rainy season | 1.61 | 2.35 | 2.57 |
| Regularity Index | Long dry season | 0.86 | 0.79 | 0.84 |
| | Main rainy season | 0.87 | 0.83 | 0.85 |
| | Short dry season | 0.9 | 0.87 | 0.91 |
| | short rainy season | 0.77 | 0.85 | 0.93 |

**3.2.1.2.2. Quantitative aspect**

**3.2.1.2.2.1. Abundance of zooplankton population**

**3.2.1.2.2.1.1 Abundance of zooplankton communities in Lake Ehuikro**

The zooplankton community sampled between March 2017 and April 2018 in Lake Ehuikro is Copepods dominate, representing 48% of the total zooplankton density, followed by rotifers at 42%. Cladocerans and other zooplanktonic organisms each account for 5% of the total zooplankton abundance (Figure 7).

The zooplankton community, with an average density of 290.21 individuals/L, is composed in terms of family by the Brachionidae (56%) and Filinidae (18%), which were the most abundant of the rotifer group. In terms of taxa, *Brachionus angularis* (31%) *Keratella tropica* (11%) *Brachionus falcatus*(10%) and *Licane leontina* dominate the rotifer group. The Cyclopidae family (68%) dominated the copepod group. The majority of taxa are the nauplii (32%), *Thermocyclops dicipiens* (27%) and *Termocyclops neglectus* (16%). Cladocera, representing 5% of the total zooplankton, consist of the only species *Diaphanosoma excisum* *(*42ind/L). The group of other zooplanktonic organisms is dominated by Ostracods (26%), insect larvae (25%) and chironomid larvae (23%).

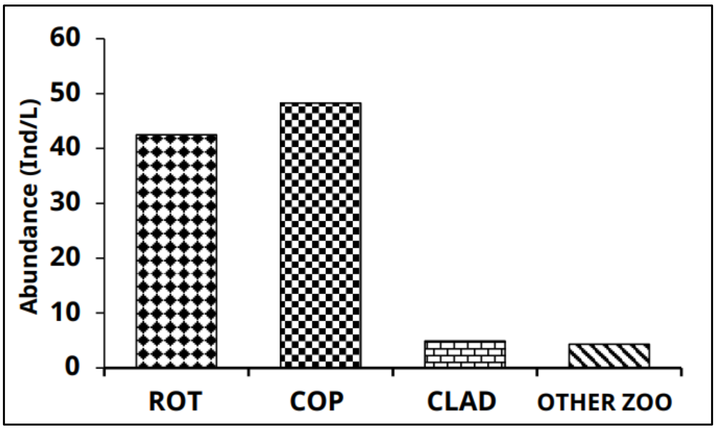



**Figure 7: Variations in the proportions of the main zooplankton groups in the lake Ehuikro (Ivory Coast) between April 2017 and March 2018. ROT = Rotifer; COP = Copepod; CLAD = Cladoceran; OTHER ZOO = Other zooplanktonic organism**

**3.2.1.2.2.1.2 Abundance of zooplankton populations in the different stations of Lake Ehuikro**

Copepods constituted the dominant group across all stations, representing 45 to 47%. Rotifers (38 to 53%), Cladocera (7% to 8%), and other zooplanktonic organisms (5 to 10%) were the least dominant groups.

At station Ehui 1, rotifers (53%) and copepods (47%) were the most abundant. Brachionidae (53%) dominated the rotifer group. *Brachionus angularis* (21%) *Cephalodella giba*(18%), *Keratella tropica* (12%) *Lecane Leontina* (11%) *Polyarthra vulgaris* (8%), *Hexarthra mira* (7%), *Anuaeropmss fisa* (6%), *Brachionus falcatus*(6%) and *Trichocerca chatoni*(5%) constitute the majority of the Rotifer abundance. Copepods are dominated by cyclopidae (70%), *Thermocyclops dicipiens* (25%) *Thermocyclops neglectus* (16%), Mesocyclops sp (15%), *Paracyclops affinis* (9%) and nauplii (31%). Cladocerans and other zooplanktonic organisms are absent (Figure 8).

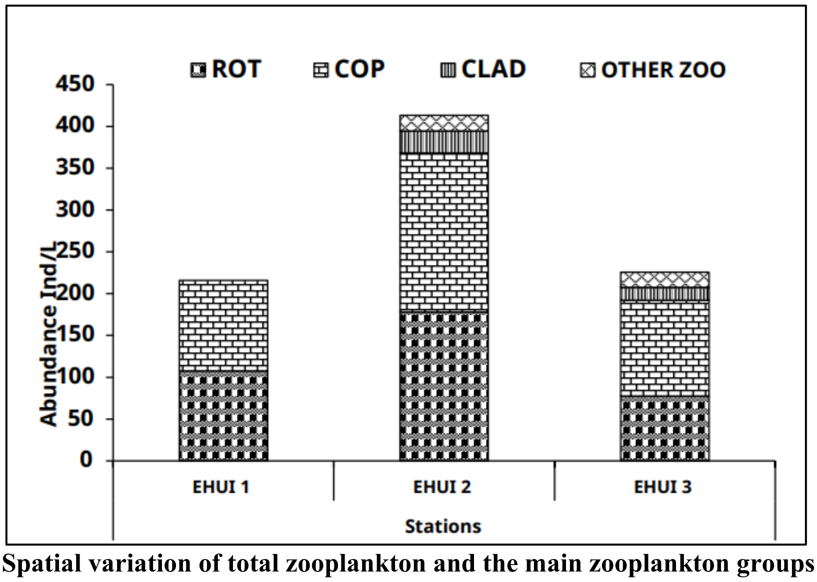



**Figure 8: Spatial variation of total zooplankton and the main zooplankton groups collected in Lake Ehuikro (Ivory Coast) between April 2017 and March 2018. ROT = Rotifer; COP = Copepod; CLAD = Cladoceran; OTHER ZOO = Other zooplankton organism**

At Ehui 2, copepods are the most abundant at 46%, followed by rotifers (43%), cladocerans (6%), and other zooplanktonic organisms (5%). Copepods are dominated by cyclopidae (67%) and nauplii (33%). *Thermocyclops dicipiens* (29%), *Thermocyclops neglectus*(17%)*, Paracyclops affinis* (9%) *Mesocyclops* sp. (8%), and Halycyclops*koensi s* (4%). Rotifers are dominated by the families Brachionidae (45%) and Filinidae (26%). *Brachionus angularis* (23%), Brachionus*falcatus* (12%) *Keratella tropica*(10%*Filinia opoliensis* (9%) *Filinia longeseta* (8%) *Filinia termilalis* (8%) *Lecane Leontina* (8%) and *Polyarthra vulgaris*(7%). *Diaphanosoma exisum*is the only cladoceran taxon (100%). The other zooplankton organisms are dominated by ostracods (30%), insect larvae (25%), chironomid larvae (23%), centropixis (12%), and chaoborus larvae (10%). ANOVA comparison of zooplankton density sampled at this station shows no significant difference between seasons. (P > 0.05) (Figure 8).

At Ehui 3, copepods are the most abundant (45%), followed by rotifers (38%), the other organisms Zooplanktonic (11%) and cladocerans (7%). The Cyclopidae family dominates among copepods with 67%. [Nauplii (33%), *Thermocyclops dicipiens* (25%) *Thermocyclops neglectus* (13%) *Mesocyclops*sp (13%), *Paracyclops affinis*(10%) and *Halycyclops koensis* (6%)]. Among rotifers, the Brachionidae family dominated the population (54%), followed by the Filinidae family (23%). *Brachionus angularis* (33%), *Brachionus falcatus*(12*K%er*) *atella tropica* (10%) *Filinia opolienssis* (9%), *Polyarthra vulgaris* (8%), *Filinia terminalis* (7%) *Lecane Leontina (*7%) and *Filinia longeseta*(6%). *Diaphanosoma excisum*constituted the only taxon of cladocerans (15%). The other zooplanktonic organisms are represented by insect larvae (24%), chironomid larvae (22%), ostracods and chaoborus larvae (21% each), and centropyxis (12%).

Comparison by ANOVA of the density of zooplankton sampled at this station shows no significant difference between seasons. (p > 0.05) (Figure 8).

**3.2.1.2.2.2. Spatio-temporal variations in zooplankton density in Lake Ehuikro**

**3.2.1.2.2.2.1 Total zooplankton**

The density of total zooplankton shows a large spatio-temporal variation. The total abundance of Zooplankton increases from Ehui 1 (228 ind/L) to Ehui 2 (413 ind/L) and decreases to Ehui 3 (229 ind/L) (Figure 9). However, the differences in total zooplankton density between stations are not significant (ANOVA, p > 0.05).

Total zooplankton exhibits the highest densities at Ehui 2 during the major dry seasons (170 ind/L) and rainy (153 ind/L), at Ehui 3 during the major rainy (93 ind/L) and dry (82 ind/L) seasons and at Ehui 1 during the major dry (82 ind/L) and rainy (81 ind/L) seasons. In contrast, the lowest values for total

zooplankton density were obtained during the short dry season at Ehui 1 (20 ind/L); Ehui 3 (24 ind/L), Ehui 2 (37 ind/L) and during the short rainy season at Ehui 3 (28 ind/L); Ehui 1 (34 ind/L) and Ehui 2 (55 ind/L) (Figure 9).

**3.2.1.2.2.2.2 ROTIFERS**

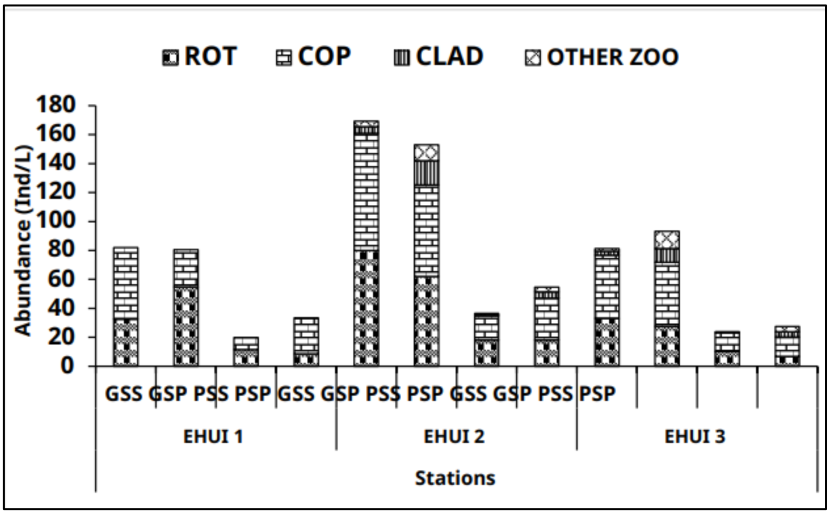



**Figure 9: Spatio-temporal variations in the abundance of the main zooplankton groups collected in Lake**

Rotifers constituted a total abundance of 363 individuals/L, representing 43% of the total zooplankton. Rotifer abundance shows a spatiotemporal variation similar to that of total zooplankton abundance. Indeed, rotifer abundance increases from Ehui 1 (108 individuals/L) to Ehui 2 (178 individuals/L), then decreases at Ehui 3 (77 individuals/L). For rotifer density, we observed a significant difference (ANOVA, p 0.05) only between stations Ehui 2 and Ehui 3. Rotifers generally exhibit high densities during the major dry and rainy seasons at all sampling stations (Figure 9). Regarding rotifer density between seasons, we note a significant difference between the major seasons (dry and rainy) and the minor seasons (dry and rainy) (Anova, p 0.05).

Ehuikro (Ivory Coast) between April 2017 and March 2018. ROT = Rotifer; COP = Copepod; CLAD = Cladoceran; OTHER ZOO = Other zooplankton organism; GSS = Major dry season; GSP = Major rainy season; PSS = Minor dry season; PSP = Minor rainy season.

**3.2.1.2.2.2.3 COPEPODS**

The total abundance of copepods is 413 individuals/L, representing 48% of the total zooplankton.

The abundance of Copepods exhibit a spatio-temporal variation similar to that of total zooplankton abundance. Indeed, copepod abundance increases from Ehui 1 (108 ind/L) to Ehui 2 (190 ind/L), then falls to Ehui 3 (115 ind/L). (Figure 9). Copepods exhibit high densities during the major dry and rainy seasons at all sampling stations. However, ANOVA comparisons of copepod density between seasons show a significant difference ($p < 0.05$) only during the major dry season and the minor (dry and rainy) seasons.

**3.2.1.2.2.2.4 Cladoceran**

Cladocerans have a total abundance of 42 individuals/L, representing 5% of the total zooplankton. The abundance of Cladoceran abundance shows a spatiotemporal variation similar to that of total zooplankton abundance. Indeed, cladoceran abundance increases progressively from Ehui 1 (0 ind/L) to Ehui 2 (27 ind/L), then falls to Ehui 3 (16 ind/L).(Figure 9).

The abundance of Cladocerans between stations shows a significant difference on the one hand between the Station Ehui 1 and station Ehui 2, and on the other hand between station Ehui 1 and station Ehui 3 (ANOVA, $p > 0.05$). Cladocerans generally exhibit high densities during both short and long rainy seasons at all sampling stations. However, the ANOVA comparison of Cladoceran density between seasons shows no significant difference ($p > 0.05$).3.2.1.5.7 Trophic quality of Ehuikro lakes

- **QB/Tof Lake Ehuikro**

The Quotient *Brachionus Trichocerca* (QB/T The pH of Lake Ehuikro during the dry seasons is 1.46. Lake Ehuikro exhibits signs of a mesotrophic environment during the dry season (Figure 10).

The Quotient *Brachionus Trichocerca* (QB/T The water level of Lake Ehuikro during the rainy seasons is 0.88. Lake Ehuikro shows signs of an oligotrophic environment during the rainy season.

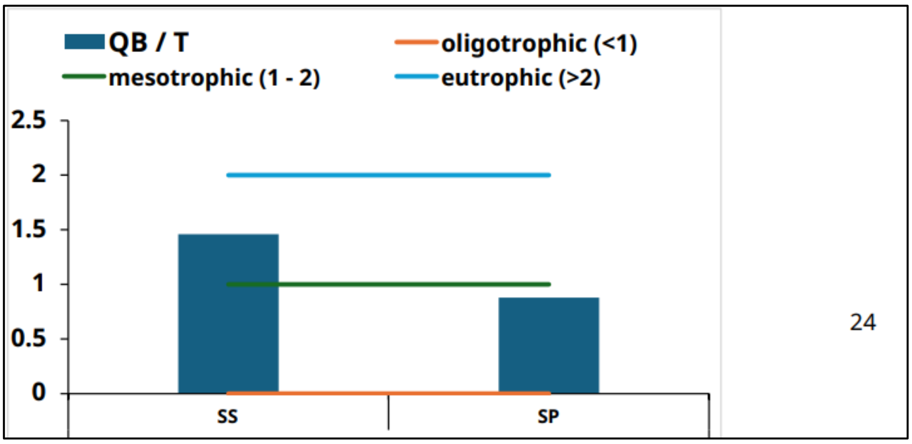



**Figure 10: Trophic state diagram of Lake Ehuikro**

## 3.1.1.4 DISCUSSION

The water temperature of the lakes in the city of Bongouanou fluctuates with an average Annual temperature between 27.06 °C (main rainy season) and 28.45 °C (main dry season). These figures are of the same order of magnitude as those recorded by Kouassi ***et al***. (2007) and Aliko ***et al*** (2010) in the Taabo reservoir; by Yté ***et al*** (1996) in the Buyo reservoir and by Brunel and Bouron (1992) in Lake Kossou. These authors gave temperature values varying between 25°C and 33°C. According to Iltis and Lévêque (1982), The temperature of Ivorian rivers rarely falls below 25°C. Indeed, in tropical zones, during the period February-April (dry season), the air temperature, linked to solar radiation, is at its maximum, while it is at its minimum during the period June-July (rainy season) to August-September (dry season), with overcast skies.( Dufour and Durand, 1982).These seasonal variations are small within the same station (less than 1°C difference) and the observed differences are not significant. Nevertheless, these variations

These variations can be linked, among other things, to the climatic conditions on the days when this parameter was measured. Factors that determine temperature variations in aquatic ecosystems include atmospheric conditions, hydrology, exchanges at the water/sediment interface, geomorphology, and vegetation cover. (Caissie, 2006). The intensity of sunshine would also explain the maximum values of this parameter recorded during the dry season.

pH is a measure of whether water is acidic, basic, or neutral. Measured pH values vary between 7.35 and 8.09, with an annual average of 7.57 for Ehuikro. These results show that the waters of this lake are slightly alkaline. Kouassi ***et al.,*** (2007) noted an average pH of 7.36 in the waters of Lake Taabo. This value is of the same order of magnitude as that obtained in our study. pH values (between 7.33 and 7.61) similar to the annual average recorded at Kossou were noted by Lozo (2011) in Lake Taabo. According Iltis and Lévêque (1982) pH levels are generally very slightly alkaline, with an average of 7.35 in the

Bandama River basin. Seasonal variations in this parameter are thought to be linked to the life cycle of organic matter. The drop in pH observed during the dry season is thought to result from a significant decomposition process of organic matter (Ekou ***et al***., 2011Indeed, the death of a large portion of the lake's aquatic plants occurs periodically. The decomposition of biomass (macrophytes) introduces organic matter into the water, leading to increased oxygen consumption and a reducing environment. Thus, the decomposition process could result in a decrease in the pH. Consequently, in the absence of aquatic plant decomposition, the water's pH would tend to rise.

Spatio-temporal variations in saturated oxygen content (42.67 in the short dry season and 67.93 in the long dry season) are commonly observed in other lacustrine environments such as Lakes Ayamé 1 and 2. Galy-Lacaux *et al.,* (1999); Lake Taabo by Kouassi ***et al***(2007) and Aliko ***et al***(2010); Lake Kossou by Traoré (1996);Canet Pond (Pyrénées-Orientales, France) (Wilke,1998a); Salses-Leucate Lagoon (France)Wilke, 1998b).According to Dufour and Slepoukha (1975) and Dufour and Durand (1982),Several factors could explain these spatio-temporal variations in oxygen content, including exchanges with air-water interfaces (atmosphere, marine and fresh waters) on the one hand, and the phenomena of consumption and production by photosynthesis, *in situ*, on the other hand

Transparency is a measure used to assess the amount of suspended matter in the environment. Our study shows a clear seasonal variation in the transparency of the lake waters of Bongouanou. Maximum transparency values are observed during the dry seasons (low water levels in the lakes), while minimum values are obtained during the rainy seasons (high water levels in the lakes). This seasonal variation is consistent with the results obtained by Kouassi (2013) in the Adzopé reservoir. It also follows the same trend as the variations observed in the Ebrié Lagoon by Dufour and Durand (1982) and in Lake Togo by Millet (1986) Indeed, the stagnant nature of the water promotes the settling of suspended matter, which would result in increased transparency. (Diomandé, 2001). Conversely, during the rainy season, the waters carry mineral and organic particles, thus increasing their turbidity. (Diomandé, 2001).

According to Martin (1987), Phosphate plays a very important role in the development of aquatic plants. It is an important parameter in the fertilization of bodies of water, which plays a role in.

It plays a major role in planktonic growth. This nutrient is a relevant indicator for assessing the trophic level of the waters. (Mama ***et al.***, 2011). According to this author, the majority of phosphorus intake comes from sources point sources: urban or industrial discharges, animal waste from traditional or industrial livestock farms, and runoff from rainfall in the river basin. The values of this compound are much higher than those obtained by Mama ***et al*** (2011) in Lake Nokoué in Benin. This difference could be explained by the drainage of rainwater, rich in phosphorus from the use of fertilizers for fields. Phosphorus is an essential nutrient for plant growth; however, above a certain concentration and when conditions are favorable, it can cause excessive growth of algae and higher aquatic plants. This increase can be followed by an accumulation of plant biomass and detritus, which generally leads to a degradation of water quality.(Ekou ***et al***., 2011). Levels exceeding 0.5 mg/L should be considered an indicator of pollution (Ahonon, 2011).

A total of 33 zooplankton taxa were collected from the waters of Lake Ehuikro. This richness (33 The low number of taxa could be explained by the small size of the lake with average depths of 3.38 m. This could be due to the location of Lake Ehuikro; it is situated at the entrance to the city, surrounded by some agricultural plantations, fields, and farms. This population is richer in species compared to the populations harvested by Addandedjan ***et al.,*** (2017) (31 taxa) in Lake Nokoué and by Yté ***et al.*** (2009) in the waters of three shoals studied in

Gagnoa (31 taxa), divided into 14 Rotifers, 11 Cladocera and 6 Copepods, and less rich in zooplankton communities than the works Tchapgnouo ***et al.,*** (2012), in Lakes Ossa and Mwembè in Cameroon (78 taxa). Several factors (physicochemical characteristics and the size of the environment and sampling equipment) could explain these observations. The present study identified 33 species with a 60 µm mesh, compared to 30 species obtained by Aka ***et al.,*** (1998) with a 20 µm plankton net. The mesh size of the nets could also play a role in the collection of zooplankton.

The high diversity of rotifers in the lake seems to indicate environmental conditions favorable to the development of several species of this zooplankton group. Thus, their high diversity in these environments can be linked to the relatively high algal biomass blooms in the lake environments of Bongouanou. The dominance of rotifers, characteristic of tropical lakes, has already been noted by Bidwell ***et al.,*** (1977); Egborge (1981); Mwebaza ***et al***., (2005). Among Rotifers, the most diverse family is the Brachionidae with 7 species, and the most represented genera are the genera *Brachionus* (3 species) and *Keratella*(2 species). This great diversity of the genus *Brachionus* has also been reported in some freshwater ecosystems in Ivory Coast such as the 49 shallow reservoirs of Ivory Coast (Aka ***et al***., 2000), Gannon and Stemberger (1978). Sladecek (1983), Maemets (1983)), Branco ***et al***., (2007These authors were able to establish a relationship between the high number of species in the genus *Brachionus* and a high trophic level. Furthermore, certain taxa are considered good indicators of eutrophication (*Brachionus plicatilis*, B. *caudatus*, B.*falcatus*, *Keratella tropica, Epiphanes clavulata* And *Moina micrura*) were observed at low densities (1 to 30 individuals/L; i.e., 1 to 25% of the total zooplankton) in the lakes of Bongouanou. The presence of these species in the lake waters of Bongouanou does not necessarily suggest a trend towards eutrophication. However,

Even though they are still relatively few in number, their occurrence (frequent species) should draw our attention to a possible phenomenon of eutrophication of the environment.

The total abundance of zooplankton increases from Ehui 1 (228 ind/L) to Ehui 2 (413 ind/L) and decreases to Ehui 3 (229 ind/L)

This density is higher than those described byMoney ***et al.,*** (2016) in the Aby-Tendo lagoon complex Ehy (151 ind/l) and Etilé ***et al***., (2009) in the Grand-Lahou lagoon complex (101 ind/l). This difference in zooplankton density results from the very different characteristics of these study environments. In terms of density, the zooplankton community is largely dominated by copepods (48% of the total abundance). This quantitative dominance of copepods differs from that observed in other tropical watercourses such as the Omi River in Nigeria (Fafioye and Omoyinmi, 2006Rotifers were found in higher densities in these environments. This data corroborates observations made at Lakes Buyo, Ayamé, and Faé by Yté ***et al*** (1996; 2002), at the level of the small dams in northern Ivory Coast by (Aka, 1998). According to Badsi ***et al.,*** (2010), The high representation of rotifers in aquatic environments can be considered an indicator of a high trophic level. Indeed, rotifers are capable of ingesting small particles such as bacteria and organic detritus, which are often abundant in eutrophic environments. Their high competitiveness in aquatic environments is due not only to their dietary plasticity with respect to available resources, but also to their small size, which makes them less vulnerable to predation pressure. Allan, 1976). According to Villanueva (2004), Such an abundance of Rotifers is related to the intense fishing activity exerted on young zooplankton-eating fish.

In the waters of Lake Ehuikro, the lowest zooplankton abundances were recorded during the dry seasons and the highest during the rainy seasons.

These results could be explained by the increased water column during the rainy seasons, allowing vulnerable organisms to hide from predators. The arrival of nutrient-rich rainwater in the lakes would also explain the high abundance at this time of year. Similar observations have been made bySaint-Jean (1983) in Ivory Coast

According to Amblard and Pinel Alloul (1995), The increase in zooplankton density during dry seasons can be explained by the fact that temperature influences their metabolism, feeding activity, and development and reproductive cycles. Furthermore, Rosa and Bonecker (2003) show that the dilution effect is a factor responsible for the low density of zooplankton (especially Rotifers) in the rainy season.

The lake's diversity index values (1.61 to 2.75 bits) reflect the existence of less structured and immature communities with a pronounced density difference between taxa. (Somoue ***et al.***, 2005). These low values would be due to the high relative abundances of *Brachionus angularis*, *Thermocyclops dicipiens*and copepod nauplii. These results differ from those of Yté ***et al.,*** (2009) in Lake Ayamé.

The zooplankton communities in the studied lakes appear to be balanced, as shown by the high evenness values observed (0.77 to 0.93). Indeed, high evenness is generally considered an indicator of a balanced community. (Yté and Kouassi, 1983; Daget, 1979). These results are identical to those of Yté ***et al.,*** (2009).

## CONCLUSION AND PERSPECTIVES

The combined analysis of physicochemical parameters and the structure of the zooplankton community in Lake Ehuikro reveals an ecosystem subject to moderate environmental pressures, likely related to local human activities. The seasonal variations observed in water parameters reflect a natural dynamic influenced by the climatic regime, while the dominance of copepods and...

The presence of rotifers suggests a mesotrophic environment. Thus, Lake Ehuikro exhibits an intermediate ecological quality, reflecting a fragile balance between natural and human influences. Sustainable management of activities around the lake is therefore essential to preserve its ecological integrity.

**Competing interests:** The authors declare that they have no competing interests in the data of this study.

**Author contributions**

FOFANA Nahon Mamadou designed the study, directed data collection, and participated in the manuscript writing. GBAI Medard and TIEMOKO Gogbé Jean-Luc participated in the manuscript writing, data analysis, and interpretation of results. ETILE Raphael N'doua supervised the work and also participated in the manuscript writing. All authors read and approved the final manuscript.

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