CLADOCERANS OF ERUVBI STREAM, BENIN CITY, EDO STATE, NIGERIA

BY

Precious Osemudiamen IYINBOR

LSC1608932

DEPARTMENT OF ANIMAL AND ENVIRONMENTAL BIOLOGY

FACULTY OF LIFE SCIENCES

UNIVERSITY OF BENIN

BENIN CITY

EDO STATE

SEPTEMBER, 2023.

CLADOCERANS OF ERUVBI STREAM, BENIN CITY, EDO STATE, NIGERIA.

BY

Precious Osemudiamen IYINBOR

LSC1608932

DISSERTATION SUBMITTED TO THE DEPARTMENT OF ANIMAL AND ENVIRONMENTAL BIOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCE B.Sc. (Hons) IN ANIMAL AND ENVIRONMENTAL BIOLOGY, UNIVERSITY OF BENIN CITY, NIGERIA.

SEPTEMBER, 2023

CERTIFICATION

This is to certify that this project work carried Out by **Precious Osemudiamen IYINBOR** (Miss) with Matriculation No. **LSC1608932** in the Department of Animal and Environmental Biology, University of Benin, Benin City, Nigeria.

________________________ ________________________

PROF. T.O.T IMOOBE **DATE**

(Project Supervisor)

________________________ ________________________

PROF. MYKE OMOIGBERALE **DATE**

(HEAD OF DEPARTMENT)

________________________ ________________________

EXTERNAL EXAMINER **DATE**

DEDICATION

This work is dedicated to God Almighty and my entire family.

ACKNOWLEDGEMENTS

My deepest acknowledgement goes to God Almighty for his Love and grace over my life throughout my stay in school

I wish to express my appreciation to my supervisor, Prof. T.O.T. Imoobe for his support, patience, guidance and teachings during the course of my project.

I will also like to appreciate my Head of department Professor M.O. Omoigberale, my course advisor Dr Asemota and other members of staff of the Department of Animal and Environmental Biology University of Benin, for their assistance all through my stay in the university.

I want to specially appreciate my parents Mr and Mrs Iyinbor and my friend for their immense care and support financially, physically and emotionally all through my academic pursuit, I definitely wouldn't have made it without you guys strongly behind me

Finally, I want to appreciate my project colleague, Joy, Favour, Amara, Sandra. May God continue to reward you all.

Once again, I say thank you all.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

ABSTRACT

This study was conducted in Eruvbi stream, Benin City Edo State, Nigeria, aimed at investigating community structure of cladocerans in Eruvbi stream. The sampling period was carried out from the early dry season in march 2023 to the early rainy season period of My 2023.Three sampling stations were selected. Water samples were collected in 3 replicates monthly. Fifteen (15) Physico-chemical parameters including, pH, Electrical Conductivity, Total Suspended Solids, Dissolved oxygen, Biochemical Oxygen Demand, Nitrate (NO_3), Suphate (SO_4), Phosphate (PO_4), Calcium (Ca), and Magnesium (Mn) were analyzed using standard methods. Phosphate and Nitrate were the only two Physico-chemical parameters with significant difference($p<0.05$) among all the physicochemical Parameters of the stations. Seven Species were uncovered within the Eruvbi stream wiz; *Alonella excise, Bosmina longirostris, Moina micrura, Pleuroxus hamatus hamatus, Acroperus harpae* and *moina macrocopa,* Amongst which station two results appeared to have the highest diversity and evenness, while Station 1 has the lowest diversity but relatively even distribution of species. Station 3 falls in between in terms of diversity and evenness. Thus, the findings of the research study provides crucial in understanding the health and ecological dynamics of the Ervubi stream and may have implications for conservation and management efforts.

CHAPTER ONE

INTRODUCTION

1.0 Background of study

Cladocerans are small aquatic crustaceans that belong to the Class Branchiopoda, Order Cladocera, Subphylum Crustacea, Phylum Arthropoda. They are commonly found in freshwater environments and play important ecological roles in aquatic ecosystems. They are an essential food source for many aquatic organisms, including fish, amphibians, and insects. They also serve as indicators of water quality and environmental health due to their sensitivity to pollutants and changes in habitat condition (Egborge, 1994)

Cladocerans also known as water fleas are found in a wide range of freshwater environments around the world like the lakes, ponds, rivers and streams. They thrive in both still and flowing waters, and their populations can fluctuate in response to changes in water quality and nutrient levels. There are over 700 known species of Cladocerans (Dumont, 1994). The common cladoceran often found in many freshwater habitats is the Daphnia. Daphnia is a genus of small crustaceans that are important members of freshwater ecosystems.

Reproduction in Cladocerans is usually parthenogenic, meaning that females can produce offspring without fertilization by males under certain conditions. Males are often rare or absent in some species, and females can switch between sexual and asexual reproduction in response to environmental cues. Their life cycle involves several stages which are the egg stage, hatching stage, molting and growth stage with the time spent in each phase varying depending on numerous environmental factors, most notably temperature. In temperate regions, breeding typically begins during the warmer months when the water temperatures becomes more favourable for reproduction.

Cladocerans are used extensively in ecological research to study food webs, trophic interactions, and responses to environmental changes. Some species are employed in laboratory studies to examine the effects of pollutants and environmental stressors on aquatic organisms.

1.1Justification for the study

Given that the study of Cladocerans have the potential significance to various insight that they provide like the ecological importance, their sensitivity to environmental changes and many more. It is critical that preliminary research on cladocerans should be conducted in every other freshwater bodies in Nigeria.

1.2 Aim and Objectives of the Research Study

This study aims to investigate the community structure of cladocerans in Eruvbi stream, Benin city, Edo state, Nigeria.

The specific objectives of this study are to determine the;

1. spatio-temporal variation in the physiochemical water quality of Eruvbi stream, Benin city, Edo state, Nigeria.

2. species composition, abundance and diversity of cladocerans in Eruvbi stream, Benin city, Edo state, Nigeria

CHAPTER TWO

LITERATURE REVIEW

2.1 The Biology of Cladocerans

Cladocerans are microscopic invertebrate that belong to the group of small aquatic crustaceans and one of the most promising indicators for environmental change (Jeppesen *et al.*2011). They have a distinctive body shape, resembling a small, oval-shaped shrimp and typically range from 0.2 to 6 millimeters in size. They possess a transparent carapace or exoskeleton that encases their body (Peredo 2006). Cladocerans are found in various aquatic environments, including freshwater lakes, ponds, rivers, and even temporary water bodies. They are often planktonic, meaning they drift in the water column. They are filter feeders, using specialized appendages called thoracic limbs to create water currents that bring in small particles such as algae, bacteria, and detritus. They are an essential part of the aquatic food web, as many fish and other organisms feed on them (Sterner 2009). In favorable conditions, they can produce offspring rapidly through a process called parthenogenesis, where females produce genetically identical offspring without fertilization. Sexual reproduction occurs when environmental conditions become less favorable, leading to the production of resting eggs, which can survive harsh conditions and hatch when conditions improve.

Cladocerans have simple eyespots and antennae that help them detect changes in light and water currents. These sensory adaptations are essential for their survival and navigation in their aquatic habitats. They are commonly used in ecological and toxicological studies. Their sensitivity to environmental changes and pollutants makes them valuable indicators of water quality. Researchers often use them to assess the health of aquatic ecosystems. The life cycle of cladocerans typically includes several molting stages, from juveniles to adults. Their lifespan can vary depending on species and environmental conditions. Cladocerans exhibit various behaviors, such as vertical migration in response to light and temperature changes. These behaviors help them optimize their position in the water column for feeding and avoiding predators.

2.2 Importance of Freshwater Cladocerans

Cladocerans are filter feeders that consume suspended particles in water, including algae and detritus. By doing so, they help regulate nutrient levels in freshwater ecosystems, which can prevent eutrophication (excessive nutrient enrichment) and maintain water quality. They serve as a primary food source for many aquatic organisms, including small fish and juvenile stages of larger fish. They are an essential link in the aquatic food web, transferring energy from lower trophic levels to higher ones. The abundance and diversity of cladocerans can be used as indicators of water quality and ecological health. Changes in their populations can signal environmental disturbances or pollution in aquatic ecosystems. Labej *et al*. (2014) (2015) and Thienpont *et al*. (2016) used cladocerans as bioindicators to assess mining population and it was discovered that the most tolerant taxa to mining pollution are Bosmina spp. and *Chydorus spharicus*. Changes in their populations can help identify water pollution and guide conservation effort.

Cladocerans are widely used in laboratory research due to their small size and ease of cultivation (Imoobe 2008). They are used as model organisms to study various biological processes, including reproductive strategies, development, and responses to environmental stressors. According to Zhou *et al*. (2008) they play a role in the cycling of carbon in aquatic ecosystems. They consume organic matter and, through their excretion and eventual decomposition, contribute to the flow of carbon in aquatic food webs. By feeding on algae, cladocerans can influence water clarity. Their grazing can reduce algal blooms, which can be beneficial for maintaining clear water and supporting a diverse range of aquatic life. In some cases, introduced or invasive species of cladocerans have been used as biological control agents to manage nuisance algae or invasive aquatic plants.

2.2.1 Economic importance of freshwater cladocerans

Cladocerans serve as a primary food source for juvenile fish in many freshwater ecosystems. Healthy populations of cladocerans can indirectly support fisheries by providing a reliable food source for fish, which can enhance fish growth and reproduction. In some aquaculture systems, particularly those that culture small fish species, cladocerans are used as live feed for fish larvae and fry (Ikomi, 2010). This can reduce the reliance on expensive artificial feeds and improve the survival rates of cultured fish. According to a study by Sousa *et al* 2023, invasive cladoceran species, such as Daphnia lumholtzi, have been explored for their potential in controlling nuisance algae blooms in water bodies. While this is still a relatively niche application, it could have economic benefits in managing water quality and recreational activities in affected areas.

Cladocerans are often used as model organisms in scientific research and education. They are relatively easy and cost-effective to maintain in laboratory settings. This accessibility supports research in various fields, including biology, ecology, and environmental science, which can lead to discoveries with economic applications. In certain cases, water treatment facilities use cladocerans and other zooplankton to help control algae blooms and maintain water quality. While this application is more common in larger bodies of water like reservoirs and lakes, it indirectly contributes to the economic well-being of communities reliant on clean water source. In some regions, the presence or absence of specific cladoceran species can be used as an indicator of water quality. Regulatory agencies may use this data to enforce water quality standards, which can have economic implications for industries reliant on clean water for processes or tourism.

The study of cladocerans often requires specialized equipment, such as microscopes and water quality monitoring devices cause of their microscopic nature. The demand for such equipment can create economic opportunities for manufacturers and suppliers of scientific instruments.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Description of The Study Area

Eruvbi Stream is a low altitude (265m above sea level) heterotrophic stream which is located about 15km north of Benin City, Edo state, Southern Nigeria (Latitude 6.5°N; Longitude 5.8°N). This spring-fed stream is a small and it takes it source from Oluku, Iguosa, Ovwe and Ekosondi river (fig3.1). The stream is found in Iguosa community.

3.1.1 Climate

The climate of Benin City varies; there is the rainy season which begins from April to October and the dry season which begins from November to March. The rainy season being wet and humid affect the stream by increasing it depth while the dry season affect the stream by decreasing it depth.

3.1.2 Vegetation

The Eruvbi stream region consists of secondary rainforest, which has been greatly subjected to deforestation and other human activities like taking livestock to graze on it. The dominant vegetation comprises of rubber palm, bamboo (*Bambusa bambusa*), and palm trees with epiphytic ferns growing on it.

3.2 Sampling Stations

3.2.1 Station one (1)

Station 1 (Lat 6°27'12"N, Long 5°36'34"E) is located upstream covered with algae bloom, lot of vegetation and also less flowing. There was much input of human activities such as washing feet and dumping waste during the study which was notice, the water was not clear.

3.2.2 Station Two (2)

Station 2 (Lat 6°27'8"N, Long 5°36'37"E) is located downstream about 2m meter long and moderate flowrate. The water was clear due to less human activities, around it is noticed that manure of cows was present, due to vegetation grazing from these cows are more.

3.2.3 Station Three (3)

Station 3 (Lat 6°27'2"N, Long 5°36'40"E) is located about 500m downstream of station2. About 5m in width, high flow rate compared to the other stations. Clear water environment

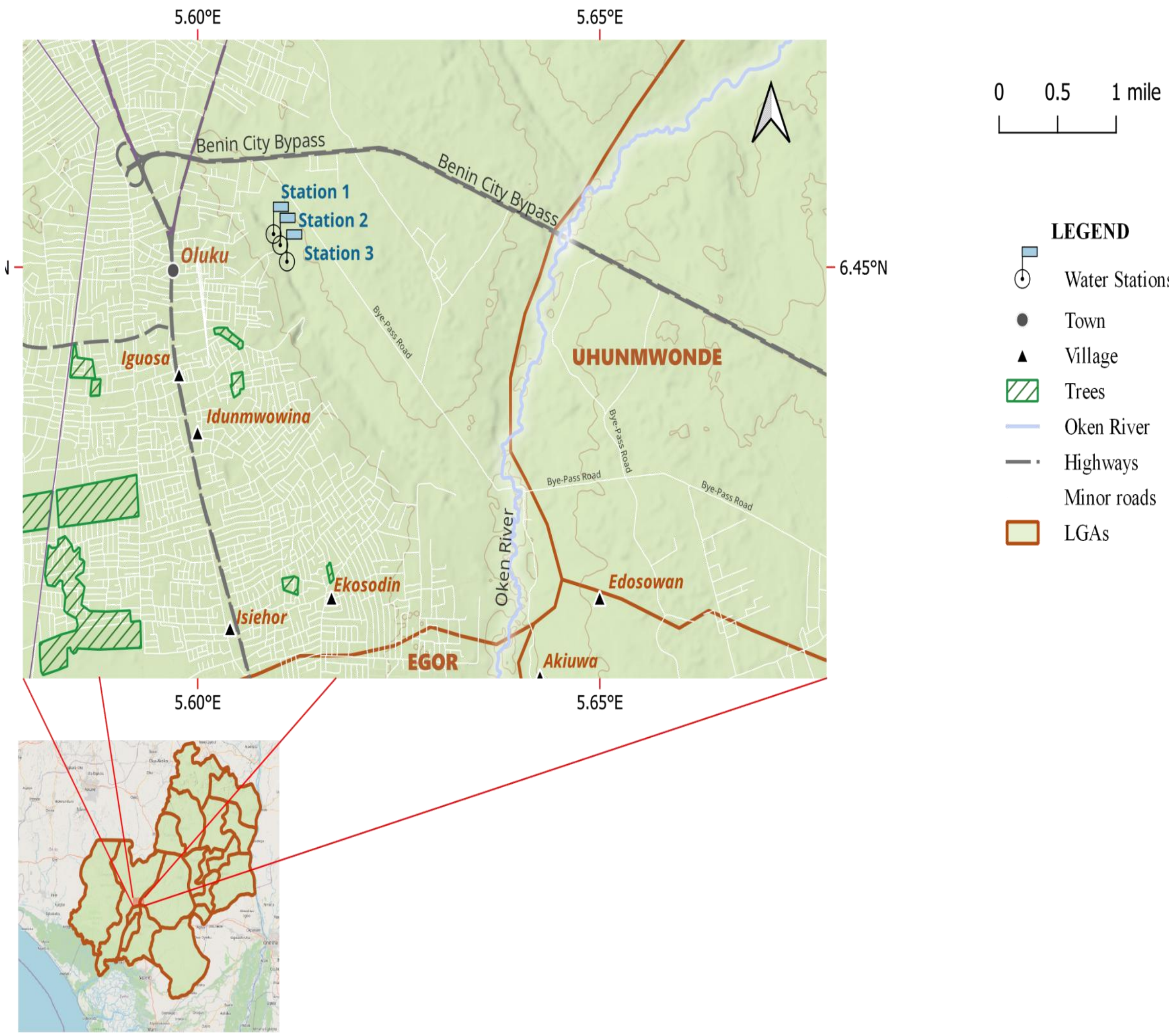

Figure 3.1: Map of Eruvbi Stream Benin City, Edo State depicting the sample stations.

Plate 3.1: Station 1 of Eruvbi river, Benin city, Edo state, Nigeria.

Plate 3.2: Station 2 of Eruvbi river, Benin city, Edo state, Nigeria

Plate 3.3: Station 3 of Eruvbi river, Benin city, Edo state, Nigeria.

3.3 Collection of Samples

Monthly sampling of Eruvbi Stream was carried out in the wet season months from March to May, 2023. Samples were collected between 7am and 10am on each sampling day. Each time, sampling began in station 1 and terminated in station 3. Acceptable standard methods and instrumentations were followed during sample collection procedures (APHA, 1998). At each station, the surface water temperature, air temperature, depth and flow rate was taken in-situ. Zooplankton net of about 500micrometer was used to collect Cladocerans and preserved with formalin. Surface water samples for physicochemical analyses were collected into thoroughly cleaned 1liter polyethylene bottles and tightly closed. Each bottle was rinsed with the appropriate sample before the final sample collection. The samples were placed in a cooler box and then taken to the laboratory for analyses. For dissolved oxygen (DO) determinations, separate samples were collected in 300 ml plain glass bottles and the samples fixed using the Winkler's solution (APHA, 1998). Samples for biochemical oxygen demand (BOD) were collected into dark glass bottles for incubation and subsequent DO determination. In the laboratory, suspended solids, turbidity, pH, electrical conductivity, dissolved oxygen, biochemical oxygen demand (BOD), total alkalinity, chemical oxygen demand(COD), hardness, calcium, magnesium, potassium, sulfate, phosphate and nitrate were determined.

3.3.1 Air and Water Temperature

Temperature was measured in °C with the aid of mercury-in-glass thermometer. Water

temperature is measured by immersing the thermometer into the water and left for 5 minutes after which the water temperature reading was taken. The air temperature was also taken, by holding the end of the thermometer and keeping it in place in the air for about 5minutes, after which reading was taken.

3.3.2 Depth

Depth varies from one water body to the other and it was measured by weighted and graduated rope and unit in centimeter

3.3.3 Turbidity

Turbidity is the inverse of transparency. The higher the turbidity of water, the lower the transparency, and vice versa. It was measured using the turbidimeter and unit NTU.

3.3.4 Suspended solid

Suspended Solids in mg/l is the difference in weight between total and dissolved solids.

3.3.5 Flow rate

This was measured using surface floatation technique method. In this method a floater (cork) was placed n the surface of the water body and allowed to flow through a distance of 1m and the time taken to cover the distance was recorded using a stop watch. From the data obtained the flow rate was calculated in centimeter per seconds (cm/s) using the formula:

$$\frac{Distance\ cm/s}{Time}$$

3.3.6 Hydrogen – ion concentration (pH)

The pH is one of the most important measurements commonly carried out in natural waters and wastewaters. It expresses the H+ concentration in water, and it is used to indicate the acidic or alkaline nature of water. It was measured using a pH meter.

3.3.7 Conductivity

Electrical Conductivity (EC) of water, also called specific conductance is a measure of the capacity of water sample to convey electrical current, and it is directly related to the concentration of ionized substances in water. Conductivity also measures the concentration of inorganic substances in water. It is influenced by ions like H+, Na+, K+, Mg2+, Ca2+, Ct, SO42- and HCO3-. Water conductivity increases with temperature owing to a decrease in viscosity and increasing dissociation. The conductivity of water is measured in-situ using HACH portable

conductivity meter, and the unit is μScm-1 (S = Siemens).

3.3.8 Sulfate

Sulfate ions was measured using the gravimetric analysis method where precipitating sulfate ions as an insoluble salt (usually barium sulfate, BaSO4) by adding a barium chloride (BaCl2) solution to the sample. The resulting precipitate is filtered, dried and weighed. The mass of the precipitate is proportional to the sulfate ion concentration in the sample.

3.3.9 Phosphate

Phosphate was measured using the ion chromatography method which is a precise and accurate. It separates and quantifies ions, including phosphate, in a water samples based on their interaction with a chromate graphic column.

3.3.10 Nitrate

Nitrate was measured using the ion chromatography method which is a precise and accurate. It separates and quantifies ions, including nitrate, in a water sample based on their interaction with a chromatographic column.

3.3.11 Calcium, Potassium and Magnesium

Concentration of minerals (magnesium, calcium and potassium) in the water samples were analyzed using Flame Atomic Absorption Spectrometry (FAAS)

3.3.12 Alkalinity

Total alkalinity was measured by measuring the amount of acid (e.g., sulfuric acid) needed to bring the sample to a pH of 4.2. At this pH, all the alkaline compounds in the sample are "used up". The result is reported as milligrams per liter of calcium carbonate (mg/L $CaCO_3$).

3.3.13 Chemical Dissolved Oxygen (COD)

COD was measured via a laboratory assay in which a sample is incubated with a strong chemical oxidant for a specified time interval and at constant temperature (usually 2 h at 150°C). The most commonly used oxidant is potassium dichromate, which is used in combination with boiling sulphuric acid.

3.3.14 Biochemical Oxygen Demand (BOD5)

The oxygen content of water samples stored in full, air tight bottle decreases with time owing to oxidation of organic matter by microorganisms. The sources of this organic matter are the excretions of aquatic biota, water soluble humic compounds and industrial, domestic and agricultural effluents. The biochemical oxygen demand (BOD_5) is an empirical determination of the amount of oxygen required to oxidize the organic matter in a sample. BOD is determined by incubating the water sample with aerobic microorganisms under specific conditions of time and temperature. The most widely used test, BOD_5 is based on a 5-day incubation period at 20^oC.

The DO_2 is measured at the beginning and end of the incubation period and the BOD_5 is calculated thus;

BOD_5 = (Initial DO_2 - Final DO_2) mg L-1

3.3.15 Dissolved Oxygen

Oxygen is required for respiration in all aerobic life forms, including the aquatic ones. Dissolved Oxygen concentration of at least 5mg/l is required to support a diversified biota in the aquatic ecosystem. This was done using the Winkler's method or by means of DO_2 meter or probe.

3.3.16 Hardness

Hardness was measured by colorimetric titration with an EDTA solution. A titration involves adding indicator and then titrant solution in small increments to a water sample until the sample changes color.

3.4 Zooplankton Sorting

In the laboratory, organisms were sorted from each sample bottle, under a compound microscope using sorting pins, glass slide and Pasteur pipette. Representative organisms were identified under the microscope using their characteristic taxonomic features to delineate them into appropriate species

3.5 Statistical analysis

Analysis of Variance (ANOVA) in addition to the computation of mean and standard deviation (SD) was used to test significant difference of the physical and chemical condition across the three stations using Statistical Package for Social Scientists (SPSS) 22.

Correlation coefficient of Physico-chemical parameters of cladocerans of the Eruvbi stream were computed using the Microsoft Excel 2021, Windows 10 application.

3.6 Estimation of fauna diversity

Hutcheson's t-test was used in calculating the significance of dominant taxa of Zoobenthos distribution and significant difference in their diversity indices by the application of the Paleontological Statistics software package for education and data analysis (PAST version 2.12).

The taxa richness of Cladocera (zooplankton) involves:

3.6.1 Simpson index

$$\text{Simpson Index (D)} = \frac{1}{\sum_{i=1}^{s} P i^{2}}$$

Where p_i = proportion of individuals of one particular species found divided by the total number of individuals found

3.6.2 Shannon Weiner index

This was expressed using Shannon Weiner index as;

$$H = \frac{N log - \sum ni \log ni}{N}$$

Where N = sample size

ni = no of individual in a species

(Shannon and Weiner, 1963).

3.6.3 Evenness index

This expresses the degree of uniformity in the distribution among the species in the collections.

$$E = \frac{H1}{H\, max}\ or\ \frac{H1}{\log k}$$

Where H1 = Shannon Weiner's index

H*max* or logs = the maximum expected diversity (Zar, 1983).

K = number of species

3.6.4 Margalef index
This was calculated using the margalef's index (d).

$d = \frac{S-1}{\text{InN}}$

Where S = no of species

In = natural logarithm

N = total no of individuals (Margaleff, 1996).

CHAPTER FOUR

RESULTS

4.1 Spatio-temporal variation in the physiochemical water quality

The table presents the results of various physicochemical parameters analyzed at three different stations (Station 1, Station 2, and Station 3) during the months of March to May. The values are reported as the mean (average) ± standard deviation (SD) for each parameter and station.

Physical Characteristics

4.1.1 pH:

From figure 4.1, the pH at Station 1 fluctuated significantly, with a mean and standard deviation of 6.2 ± 0.78, with it been the lowest recorded value 6.1 which occurred in the month of April 2023. These values are within the permissible limit. Station 2 had a more stable pH of 6.43 ± 0.83, and highest occurrence happened in March (7.1) and lowest in May 2023 (5.5), which falls within the typical range for natural water bodies. Similar to Station 2, Station 3 had a relatively stable pH of 6.6 ± 0.2, with the highest pH at March (6.8) and Lowest at May (6.4).

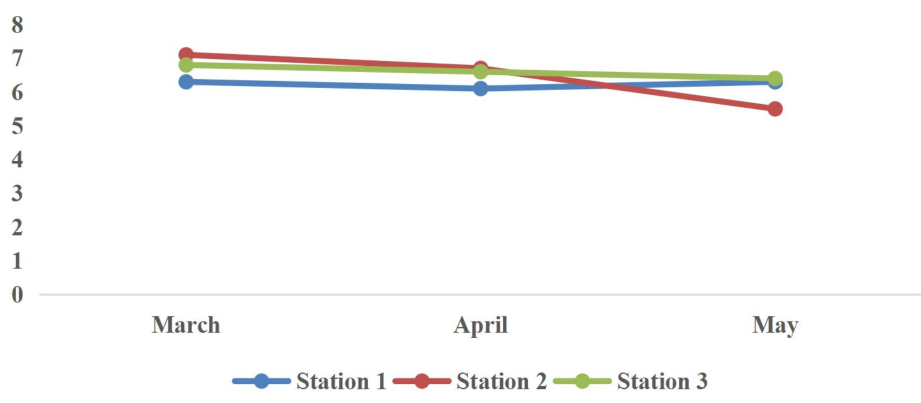

Figure 4.1: Spatio-temporal variation of pH in Eruvbi Stream

4.1.2 Conductivity:

From figure 4.2, station1 has a low conductivity with a mean and Standard deviation value of 55.33 ± 5.77, with the highest recorded conductivity in April (62) and lowest between March and May 2023 (52) indicating low ion concentration. Very high conductivity at Station 2, with a mean of 1900 ± 123.59, with the highest recorded conductivity recorded in March (284) and lowest in May 2023, which suggests the presence of dissolved salts and ions. Moderate conductivity occurred at Station 3, with a mean of 72.67 ± 4.619, with lowest conductivity occuring in between April and May and Highest recorded in March 2023, indicates the presence of some dissolved ions.

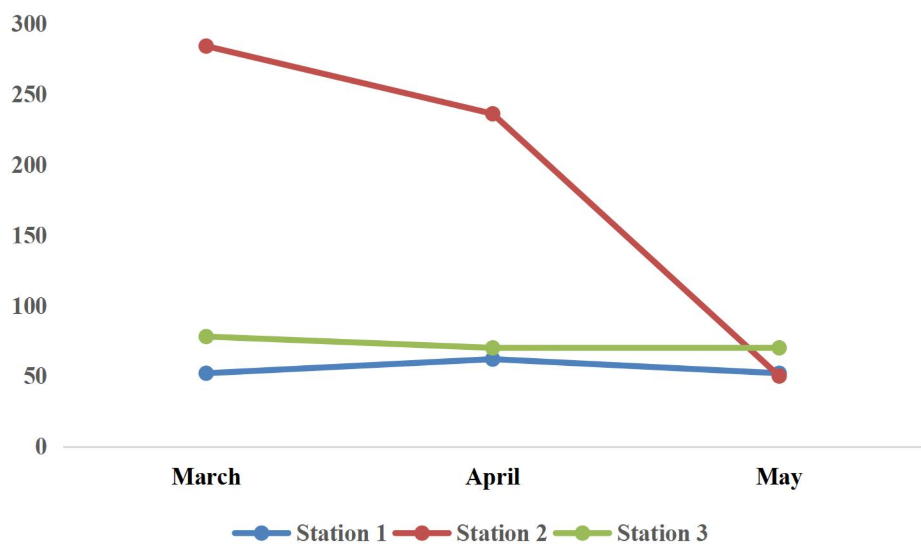

Figure 4.2: Spatio-temporal variation of Conductivity in Eruvbi Stream

4.1.3 Suspended Solids:

From figure 4.3, at station 1 there is Low levels of suspended solids with a mean and standard deviation value of 11.0 ± 7.211, with lowest recorded (5) in April and highest (19) in May, 2023. Higher levels of suspended solids occurred at Station 2, with a mean of 38.33 ± 9.292, with highest recorded value at March (46) and lowest (28) in May, 2023. Moderate levels of suspended solids occurred at Station 3, with a mean of 20.33 ± 6.429, with the highest recorded occurrence 41 in May 2023, and lowest (13) in March 2023.

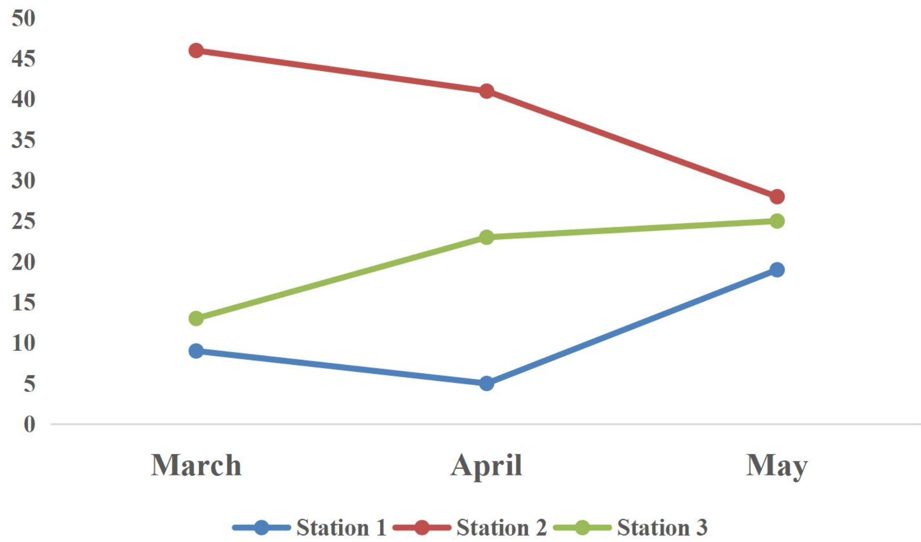

Figure 4.3: Spatio-Temporal Variation of Suspended solids for Eruvbi Stream

4.1.4 Turbidity

From fig. 4.4, there is low turbidity at Station 1, with a mean and standard deviation value of 13.67 ± 7.23, with highest occurrence (22) in May, 2023 and Lowest (9) in April 2023. Higher turbidity occurred at Station 2, with a mean of 67 ± 18.68, highest occurrence 84 in March, 2023 and lowest (47) in May, 2023. Moderate turbidity at Station 3, with a mean of 33.67 ± 8.74, with highest occurrence (41) in May, 2023 and lowest (24) in March 2023.

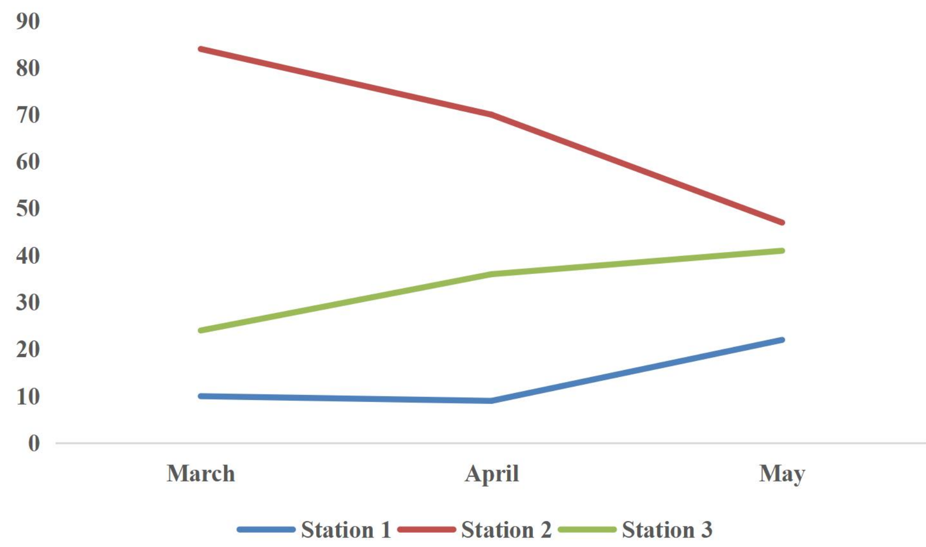

Figure 4.4: Spatio-temporral variation of Turbidity in Ervubi Stream

4.1.5 Sulphate

From fig. 4.5, there is low Sulphate at Station 1, with a mean and standard deviation value of 6.67 ± 3.79 with highest occurrence (11) in May, 2023 and Lowest (4) in March 2023. Higher turbidity occurred at Station 2, with a mean of 21.33 ± 6.028, with highest monthly occurrence (27) at March, 2023 and Lowest (15) May, 2023. Moderate turbidity at Station 3, with a mean of 11.33 ± 4.16, with highest monthly occurrence (15) in May, 2023 and Lowest (8) March, 2023.

4.1.6 Phosphate

From fig. 4.6, there is low phosphate at Station 1, with a mean and standard deviation value of 0.051 ± 0.045, with highest occurrence (0.1) in May, 2023 and Lowest (0.01) in April 2023. Higher Phosphate occurred at Station 2, with a mean of 0.36 ± 0.26, with highest monthly occurrence (0.64) in April, 2023 and Lowest (0.119) March, 2023. Moderate turbidity at Station 3, with a mean of 0.084 ± 0.027, with highest monthly occurrence between (0.1) April, May 2023 and Lowest (0.053) March, 2023.

The levels of these parameters vary between stations, but there are no extreme values, indicating a moderate range of ion concentrations.

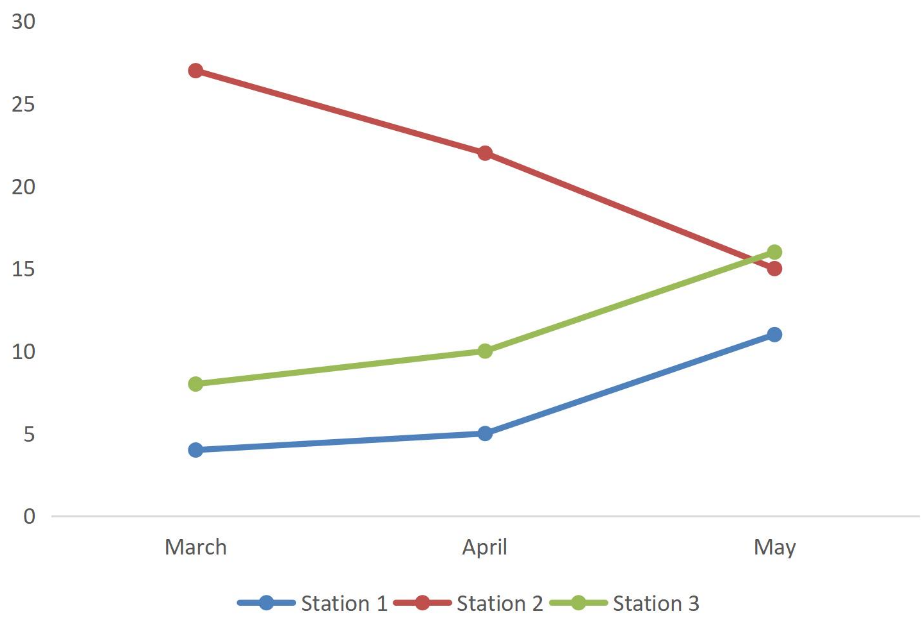

Figure 4.5: Spatio-temporral variation of Sulphate in Eruvbi Stream

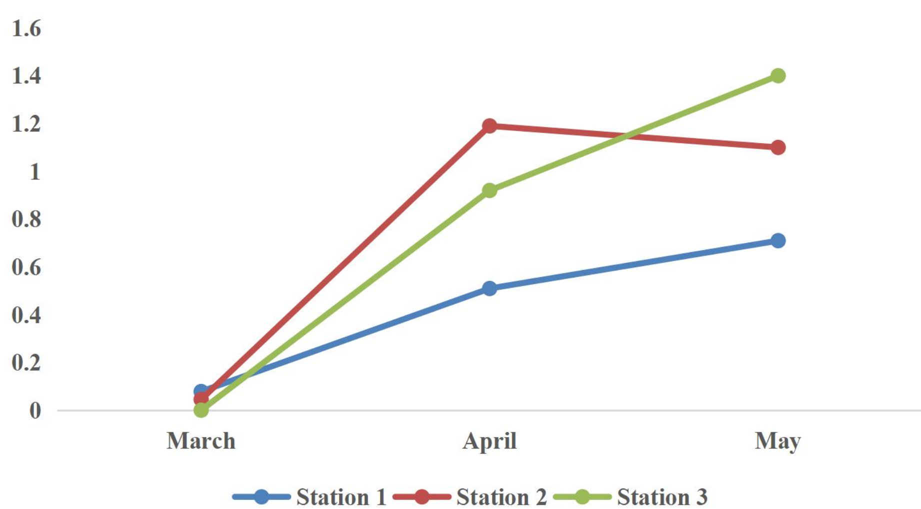

Figure 4.6: Spatio-temporal variation of Nitrate in Eruvbi Stream

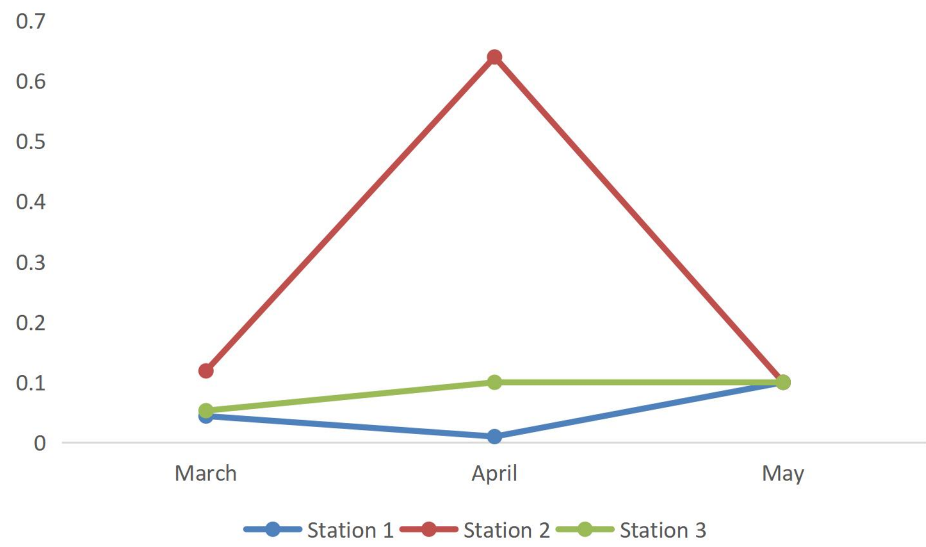

Figure 4.7: Spatio-temporal variation of Phosphate in Eruvbi Stream

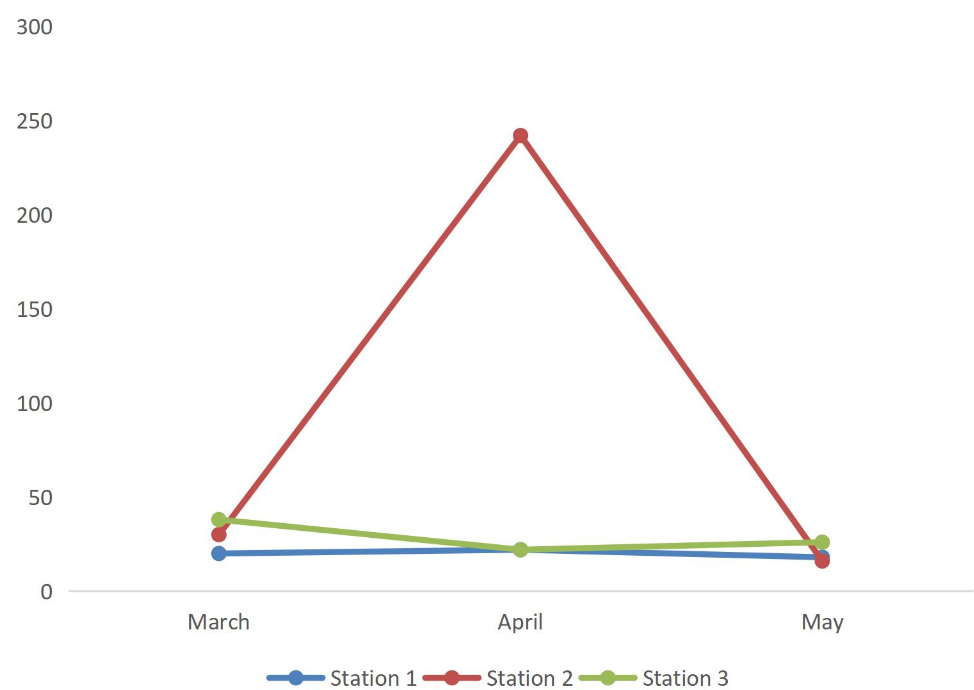

Figure 4.8: Spatio-temporal variation of Alkalinity in Eruvbi Stream.

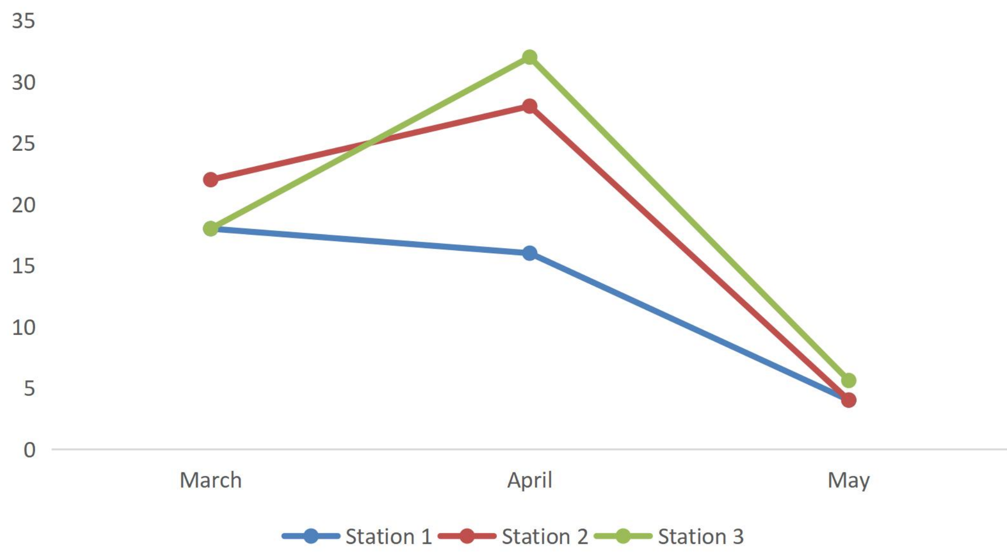

Figure 4.9: Spatio-temporal variation of Hardness in Eruvbi Stream

4.1.7 Nitrate

From fig. 4.7, there is low Nitrate on station 1, with a mean and standard deviation value of 0.433 ± 0.322, with highest monthly occurrence (0.71) in May, 2023 and Lowest (0.079) in March 2023. Higher Nitrate occurred at Station 2, with a mean of 0.78 ± 0.64, with highest monthly occurrence (1.19) in April, 2023 and Lowest (0.0.046) March, 2023. Moderate Nitrate occurred at Station 3, with a mean of 0.77 ± 0.71, with highest monthly occurrence (1.4) May, 2023 and Lowest (0.001) March, 2023.

4.1.8 Alkalinity

From fig. 4.8, there is low alkalinity on station 1, with a mean and standard deviation value of 20.00 ± 2.0, with highest monthly occurrence (22) in April, 2023 and Lowest (18) in May 2023. Higher Alkalinity occurred at Station 2, with a mean of 89.33 ± 132.24, with highest monthly occurrence (242) in April, 2023 and Lowest (16) May, 2023. Moderate Alkalinity occurred at

Station 3, with a mean of 22.0 ± 4.0, with highest monthly occurrence (38) March, and Lowest (2) May, 2023.

4.1.9 Hardness

From fig. 4.9, there is low recorded hardness on station 1, with a mean and standard deviation value of 12.67 ± 7.56, with highest monthly occurrence (6) in April, 2023 and Lowest (2.3) in May 2023. Higher Hardness occurred at Station 2, with a mean of 18.0 ± 12.48, with highest monthly occurrence (28) in April, 2023 and Lowest (4.01) May, 2023. Moderate Hardness occurred at Station 3, with a mean of 18.53 ± 13.20, with highest monthly occurrence (32) April, and Lowest (5.61) May, 2023.

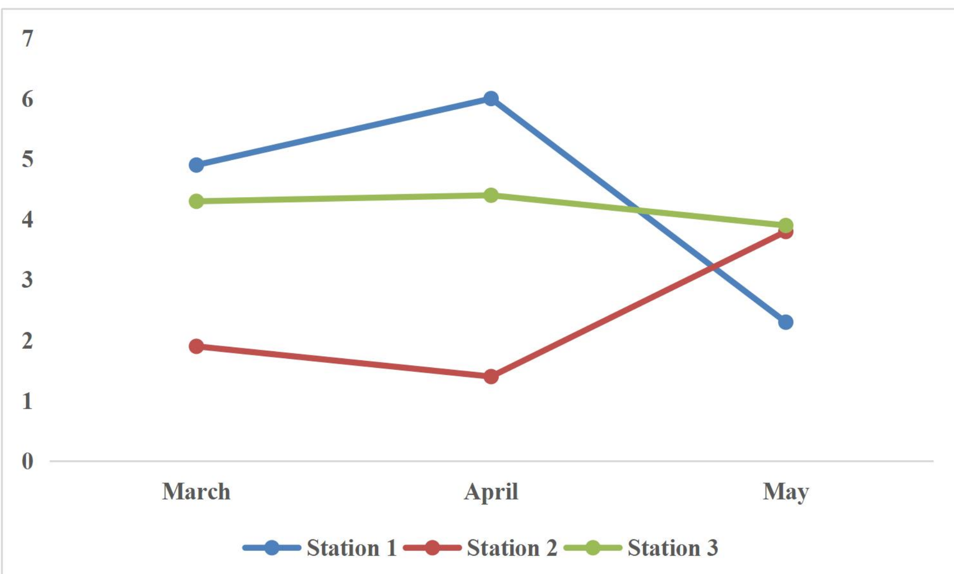

Figure 4.10: Spatio-temporal variation of Dissolved Oxygen in Eruvbi Stream

4.10 Dissolved Oxygen (DO):

From fig. 4.10 above, High DO levels occurred at Station 1, with a mean of 4.4 ± 1.9, having highest monthly occurrence (6) in April 2023 and lowest (2.3) May, 2023. Lower DO levels at Station 2, with a mean of 2.36 ± 1.26, with highest monthly occurrence recorded (3.8) in May, 2023 and lowest (1.4) April, 2023. High DO levels at Station 3, with a mean of 4.2 ± 0.265, having highest occurrence (4.4) in April, 2023 and lowest, (3.9) recorded in May, 2023.

4.1.11 Biochemical Oxygen Demand (BOD)

From fig. 4.11, High BOD levels occurred at Station 2, with a mean of 4.17 ± 1.35, having highest monthly occurrence (5.5) in April 2023 and lowest (4.2) May, 2023. Lower DO levels occurred at Station 3, with a mean of 1.9 ± 0.50, with highest monthly occurrence recorded (2.4) in April, 2023 and lowest (1.4) May, 2023. Moderate BOD levels occurred at Station 1, with a mean of 1.93 ± 0.15, having highest occurrence (2.1) in March, 2023 and lowest, (1.8) recorded in May, 2023.

4.1.12 Chemical Oxygen Demand

From fig. 4.12, High COD levels occurred at Station 2, with a mean of 29.67 ± 20.50, having highest monthly occurrence (50) in April 2023 and lowest (9) March, 2023. Lower COD levels occurred at Station 1, with a mean of 12.73 ± 6.36, with highest monthly occurrence (20) in April 2023 and lowest (8.2) March, 2023. Moderate BOD levels occurred at Station 1, with a mean of 18.93 ± 11.64, having highest occurrence (30) in April, 2023 and lowest, (6.8) recorded in March, 2023.

Thus, Low BOD and COD values at Station 1, indicating low organic pollution. Higher BOD and COD values at Station 2, suggesting higher organic pollution. Moderate BOD and COD values at Station 3.

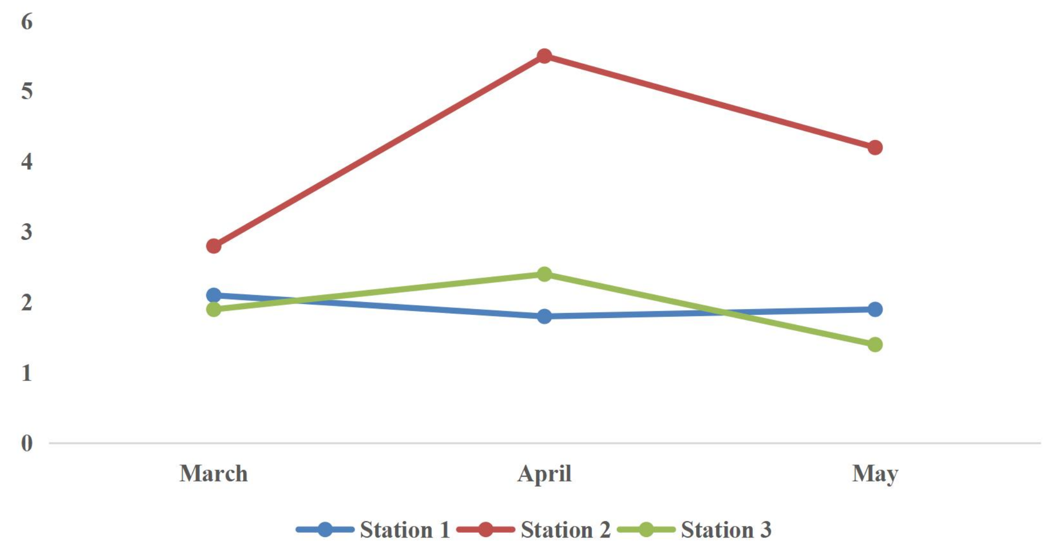

Figure 4.11: Spatio-temporal variation of Biochemical Oxygen Demand in Eruvbi Stream

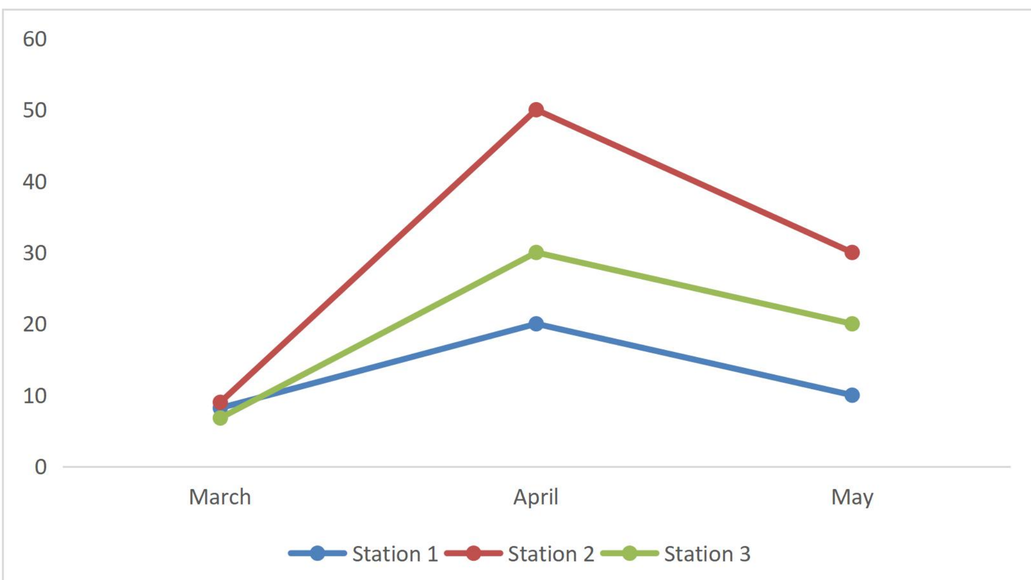

Figure 4.12: Spatio-temporal variation of Chemical Oxygen Demand in Eruvbi Stream

4.1.13. Potassium

From fig. 4.13, High potassium levels occurred at Station 2, with a mean of 1.72 ± 0.55, having highest monthly occurrence (2.54) in March 2023 and lowest (1.12) May, 2023. Lower potassium levels occurred at Station 3, with a mean of 1.137 ± 0.80, with highest monthly occurrence (1,5) in May 2023 and lowest (0.46) March, 2023. Moderate potassium levels occurred at Station 1, with a mean of 1.65 ± 0.77, having highest occurrence (2.54) in March, 2023 and lowest, (1.3) recorded in March, 2023

4.1.14 Calcium

From fig. 4.14, High Calcium levels occurred at Station 2, with a mean of 6.41 ± 2.40, having highest monthly occurrence (8.82) in May 2023 and lowest (6.41) March, 2023. Lower Calcium levels occurred at Station 1, with a mean of 4.81 ± 0.80, with highest monthly occurrence (5.61) in March 2023 and lowest (4.01) May, 2023. Moderate Calcium levels occurred at Station 1, with a mean of 5.61 ± 0.8, having highest occurrence (4.81) in March, 2023 and lowest, (5.61) recorded in March, 2023.

4.1.15 Magnesium:

From fig. 4.15, High Magnesium levels occurred at Station 3, with a mean of 2.27 ± 1.40, having highest monthly occurrence (3.89) in April 2023 and lowest between (1.46) March, and May 2023. Lower Magnesium levels occurred at Station 1, with a mean of 1.13 ± 0.28, with highest monthly occurrence (1.46) in May 2023 and lowest between (0.97) March, and April 2023. Moderate Calcium levels occurred at Station 1, with a mean of 1.29 ± 0.28, having highest occurrence between (1.46) in March, April 2023 and lowest, (0.97) recorded in May, 2023

These nutrient levels vary between stations but generally fall within expected ranges for natural water bodies.

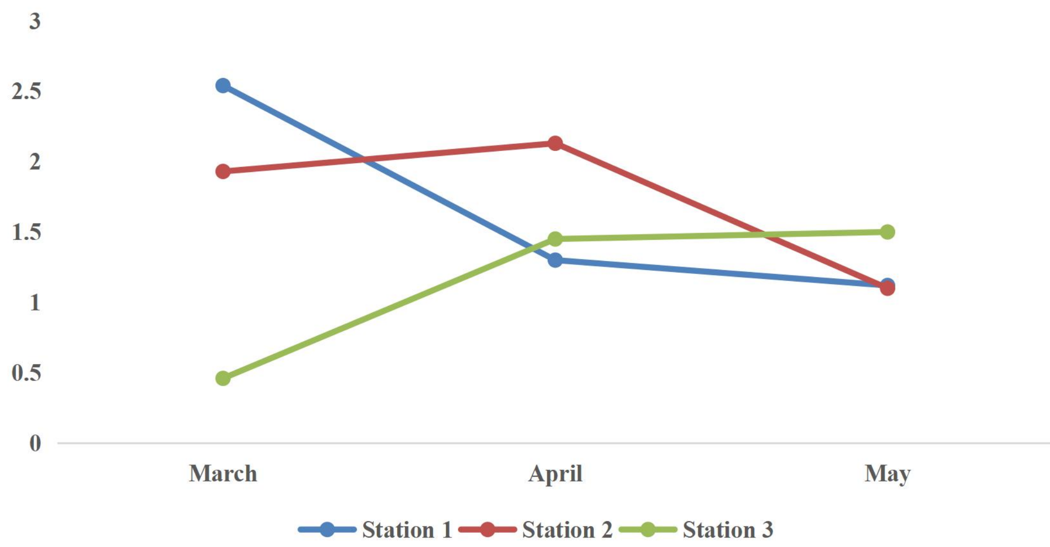

Figure 4.13: Spatio-temporal variation of Potassium Demand in Eruvbi Stream.

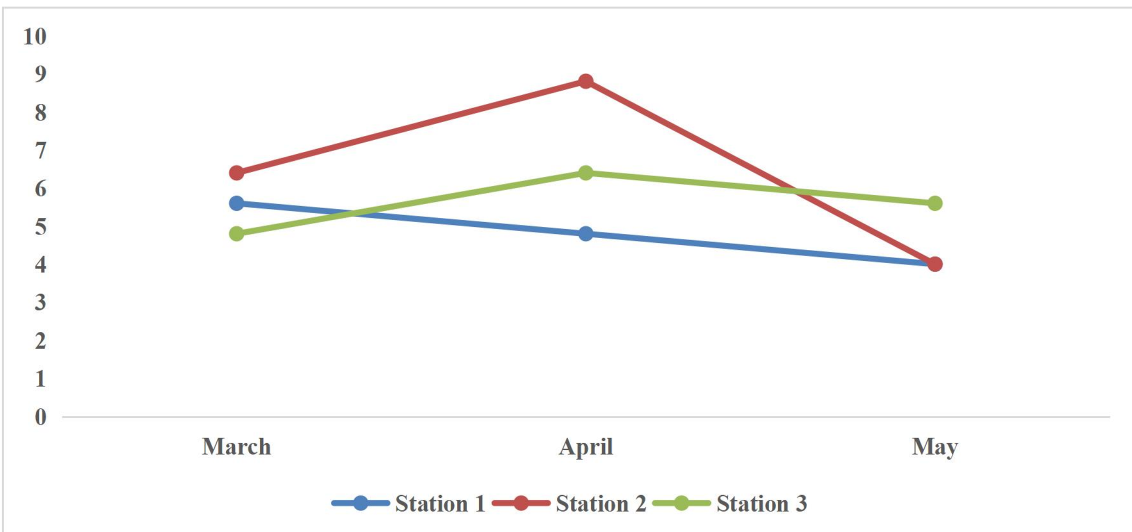

Figure 4.14: Spatio-temporal variation of Calcium in Eruvbi Stream

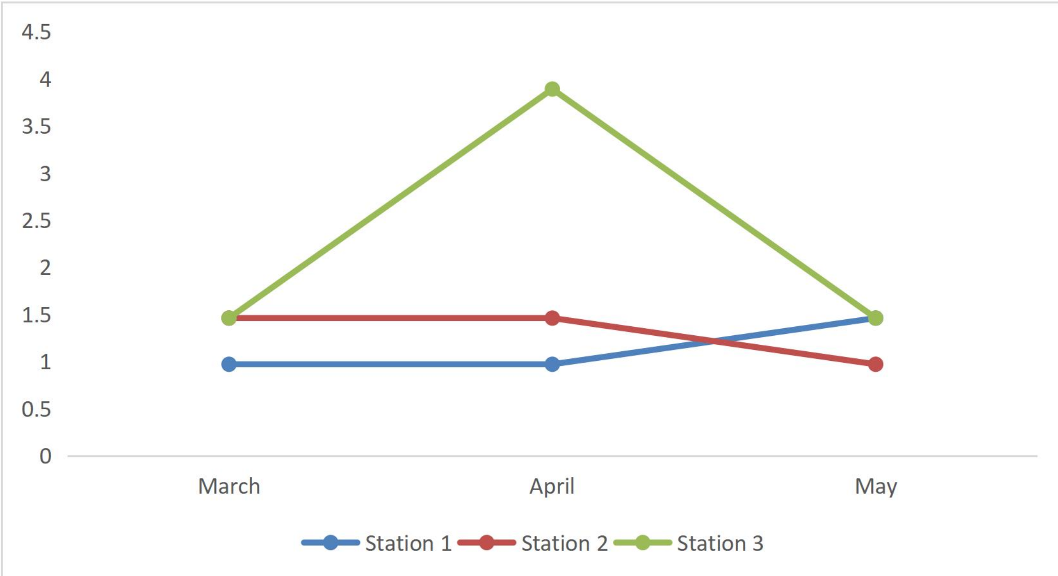

Figure 4.15: Spatio-temporal variation of Magnesium in Eruvbi Stream

In summary, the results indicate significant variability in water quality parameters between the three stations. Station 2 shows signs of higher pollution levels and greater mineral ion concentration, while Stations 1 and 3 exhibit more stable and typical values. These findings suggest potential environmental concerns at Station 2 that may warrant further investigation and management efforts

Table 4.1: Analyzed parameters result for station 1, 2 and 3 From March to May

Physic chemical	UNIT	Station 1 Mean ± SD	Station 2 Mean ± SD	Station 3 Mean ± SD	P value	Limit
pH	-	6.73 ± 1.23	6.43 ± 0.83	6.6 ± 0.2	*p > 0.05*	6.5 - 8.5
Conductivity	***µS/cm***	55.33 ± 5.77	1900 ± 123.59	72.67 ± 4.619	*p > 0.05*	1000
Suspended Solid	***mg/l***	11.0 ± 7.211	38.33 ± 9.292	20.33 ± 6.429	*p > 0.05*	
Turbidity	***NTU***	13.67 ± 7.23	67 ± 18.68	33.67 ± 8.74	*p > 0.05*	
Sulphate	***mg/l***	6.67 ± 3.79	21.33 ± 6.028	11.33 ± 4.16	*p > 0.05*	
Phosphate	***mg/l***	0.051 ± 0.045	0.36 ± 0.26	0.084 ± 0.027	*p > 0.05*	
Nitrate	***mg/l***	0.433 ± 0.322	0.78 ± 0.64	0.77 ± 0.71	*p > 0.05*	50
Alkalinity	***mg/l***	20.00 ± 2.0	89.33 ± 132.24	22.0 ± 4.0	*p > 0.05*	
Hardness	***mg/l***	12.67 ± 7.56	18.0 ± 12.48	18.53 ± 13.20	*p > 0.05*	
Dissolved Oxygen	***mg/l***	4.4 ± 1.9	2.36 ± 1.26	4.2 ± 0.265	*p >*	7.5

					0.05	
BOD	***mg/l***	1.93 ± 0.15	4.17 ± 1.35	1.9 ± 0.50	$p >$ *0.05*	0.05
COD	***mg/l***	12.73 ± 6.36	29.67 ± 20.50	18.93 ± 11.64	$p >$ *0.05*	
Potassium	***mg/l***	1.65 ± 0.77	1.72 ± 0.55	1.137 ± 0.80	$p >$ *0.05*	
Calcium	***mg/l***	4.81 ± 0.80	6.41 ± 2.40	5.61 ± 0.8	$p <$ *0.05*	
Magnesium	***mg/l***	1.13 ± 0.28	1.29 ± 0.28	2.27 ± 1.40		

4.2 Species composition, Abundance, Community Structure, and Diversity of Cladocera

A total of seven species of Cladocerans consisting of *Alonella excisa* (Richard, 1894) *Bosmina longirostris* (Muller, 1785), *Moina micrura* (Fisher,1854), *Pleuroxus hamatus hamatus* (Muller, 1776), *Acroperus harpae* (Muller, 1776), *Daphnia carinata* (Leydig, 1860) and *Moina macropoda* (Richard, 1854) were recorded from Eruvbi stream. They all belonged to the same kingdom, phylum, class, Sub class and family. Most of the species belonged to the Order Anomopoda as shown in tabele 4.1, Plate 3-7 (*Moina micrura, Pleuroxus hamatus hamatus, Acroperus harpae, moina macrocopa*). Whereas *Alonella excisa belonged to Order* Ctenopoda. While *Bosmina longirostris* belonged to the order Diplostraca as shown in table 4.2.

Table 4.2 Checklist of Cladocera Community (Branchiopoda)

KINGDOM	ANIMALIA		
PHYLUM:	ARTHROPODA		
CLASS:	Branchiopoda		
SUBCLASS	Phyllopoda		
ORDER:	Ctenopoda		
FAMILY:	Daphniidae		
Species:	*Alonella excisa*	Richard, 1894	Plate 4.1
ORDER:	Diplostraca		
Species:	*Bosmina longirostris*	Muller, 1785	Plate 4.2
ORDER:	Anomopoda		.
Species:	*Moina micrura*	Fisher, 1854	Plate 4.3
ORDER:	Anomopoda		
Species:	*Pleuroxus hamatus hamatus*	Muller, 1776	Plate 4.4
ORDER:	Anomopoda		Plate 4.5
Species:	*Acroperus harpae*	Muller, 1776	
ORDER:	Anomopoda		Plate 4.6
Species:	*Daphnia carinata*	Leydig, 1860	
ORDER:	Anomopoda		
Species:	*moina macrocopa*	Richard, 1854	Plate 4.7

4.3 Diversity of Fauna

From table 4.3, fig. 4.16 in terms of diversity, the stations that were in order of importance were station 2, station 1 and station 3. Identical species were discovered in the three stations of Ervubi stream in this *Alonella excise, Bosmina longirostris, Moina micrura*, *Pleuroxus hamatus hamatus*, *Acroperus harpae, Daphnia carinata* and *moina macrocopa.* The species richness calculated for the three stations using Margalef's index showed that station 2 had the highest species richness (2.117) and station 3 the lowest (1.497). While Station 1 had (1.8). Shannon Weiner's index was used to calculate general diversity and showed that Station 2 had the highest diversity (1.81) followed by station 1 (1.69) and station 3 (1.42). The evenness index showed that maximum evenness was in station 2 (0.93) and the minimum in station 1 (0.728).

Overall, Station 2 appears to have the highest diversity and evenness, while Station 1 has the lowest diversity but relatively even distribution of species. Station 3 falls in between in terms of diversity and evenness. This result provides crucial in understanding the health and ecological dynamics of the Eruvbi stream and may have implications for conservation and management efforts.

Table 4.3: Diversity of Cladocerans in stations of Eruvbi stream

	Station 1	Station 2	Station 3
Number of sample(S)	3	3	3
Number of species(S)	7	7	7
Margalef's Index(D)	1.800	2.117	1.497
Shannon-weiner index(H)	1.69	1.81	1.42
Evenness Index(E)	0.86	0.93	0.728

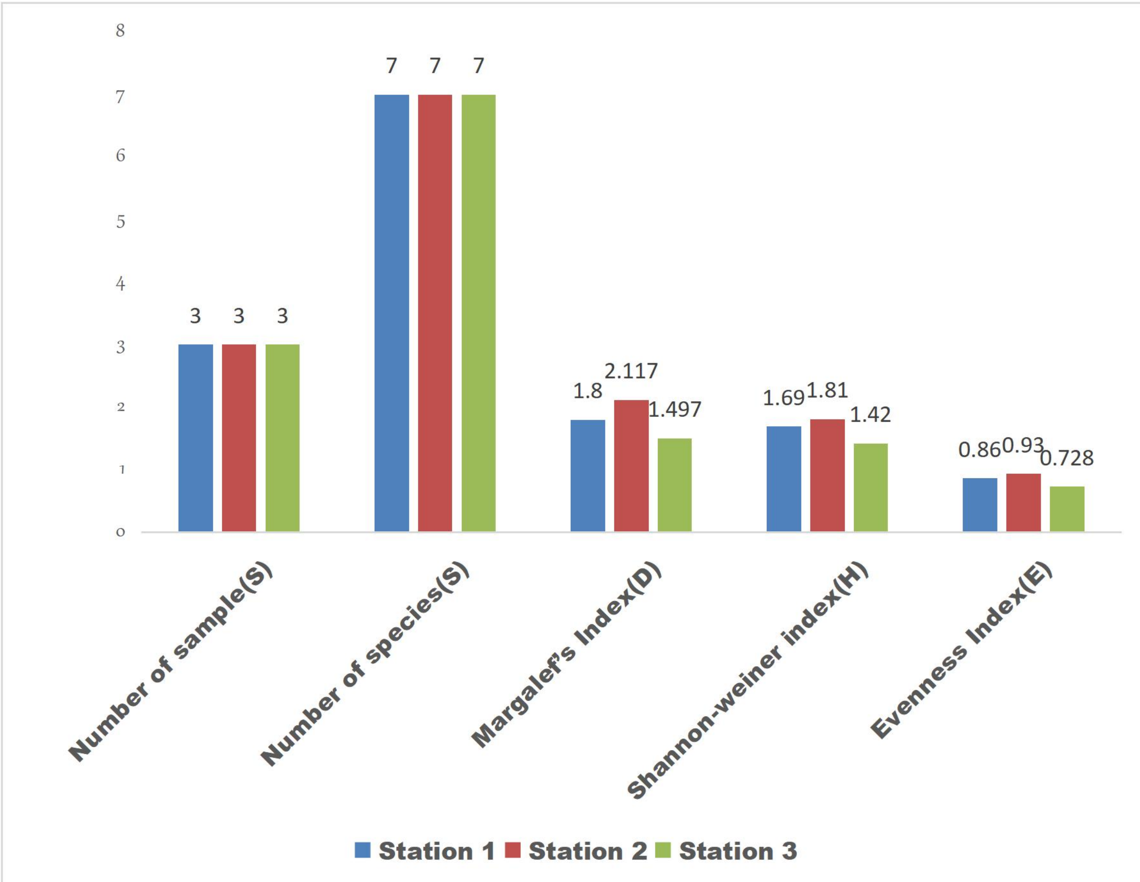

Figure 4.16: Diversity of Cladocerans in the Eruvbi Stream

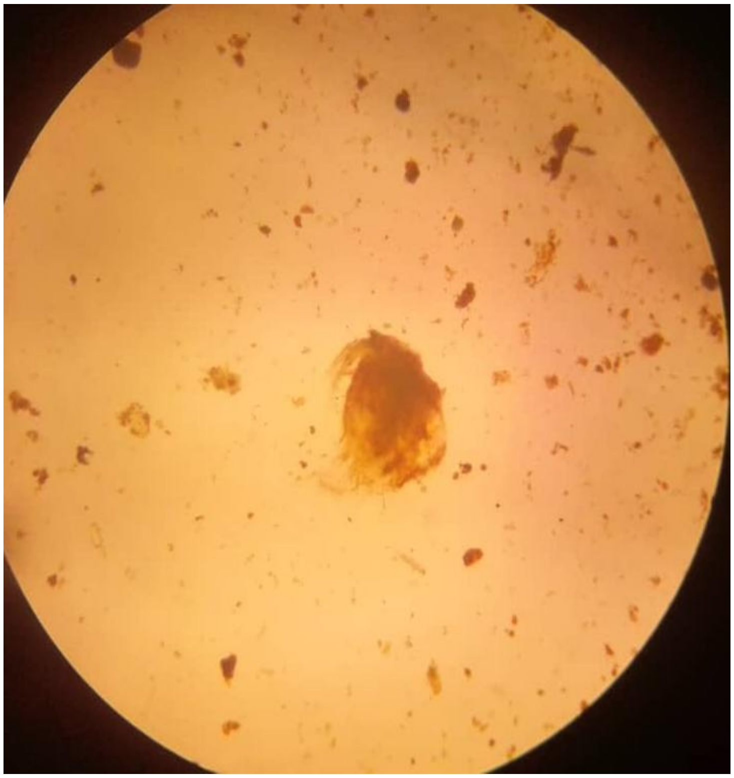

Plate 4.1: *Alonella excisa*

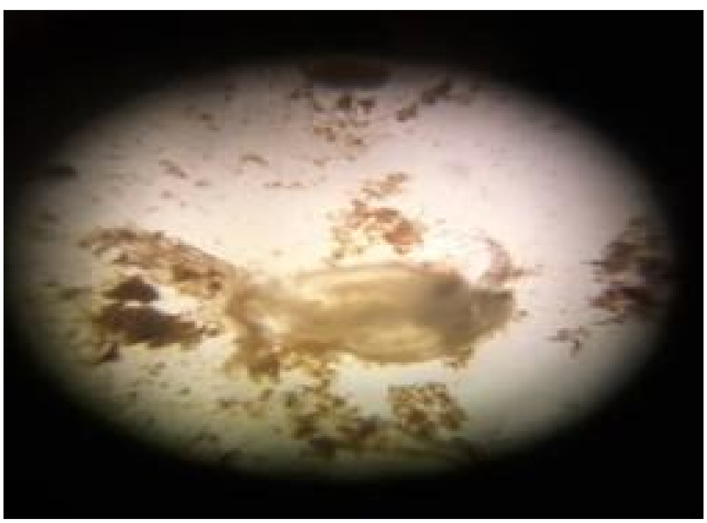

Plate 4.2: *Bosmina longirostris*

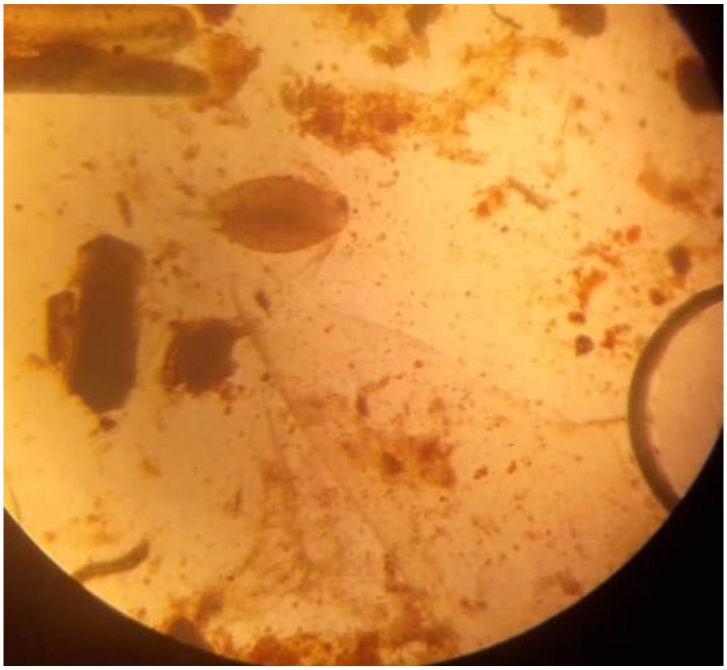

Plate 4.3: *Moina micrura*

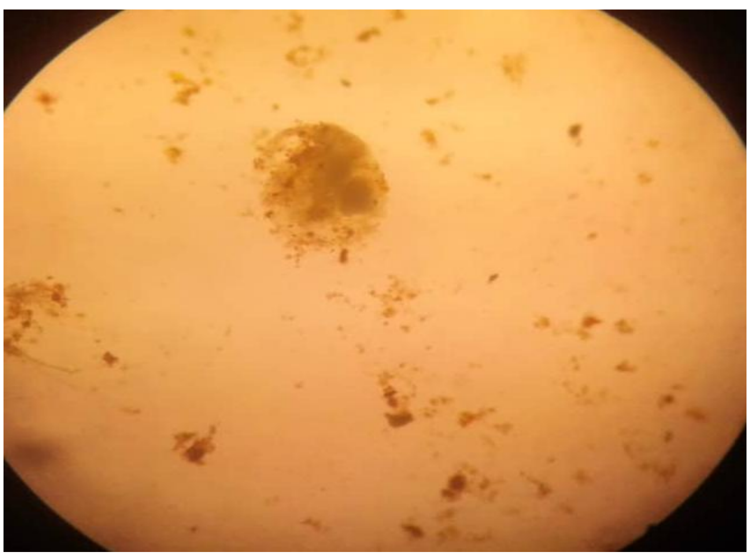

Plate 4.4: *Pleuroxus hamatus hamatus*

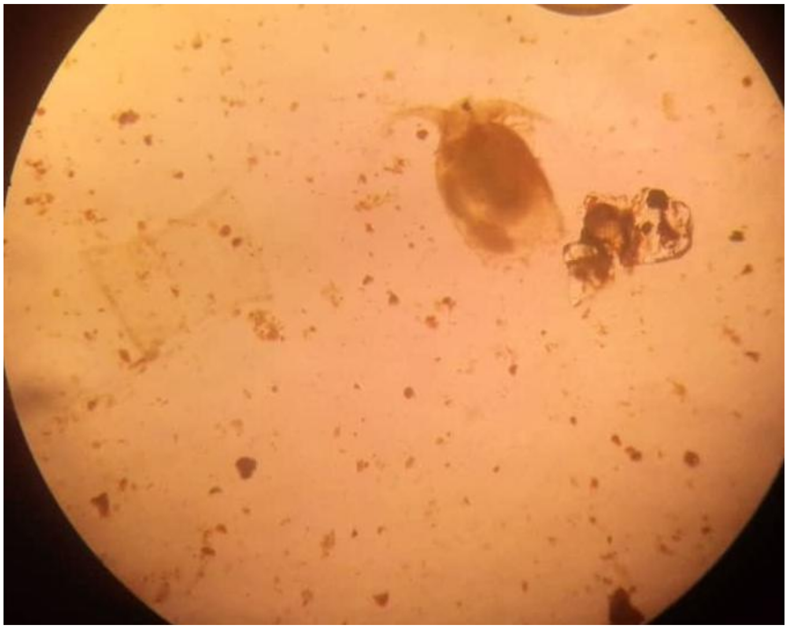

Plate 4.5:*Acroperus harpae*

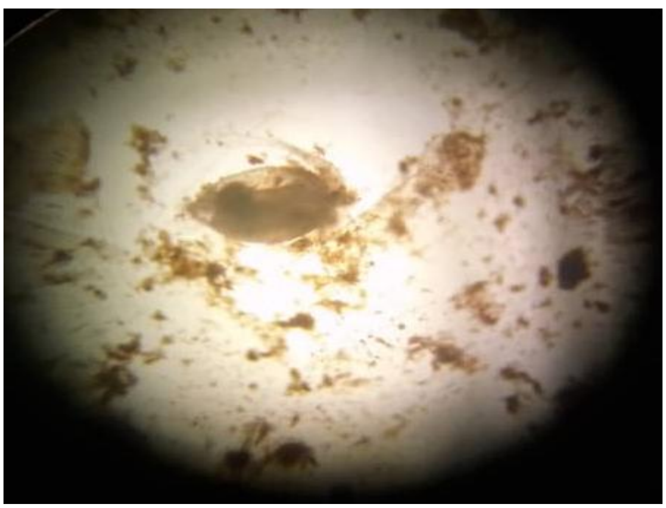

Plate 4.6: *Daphnia Carinata*

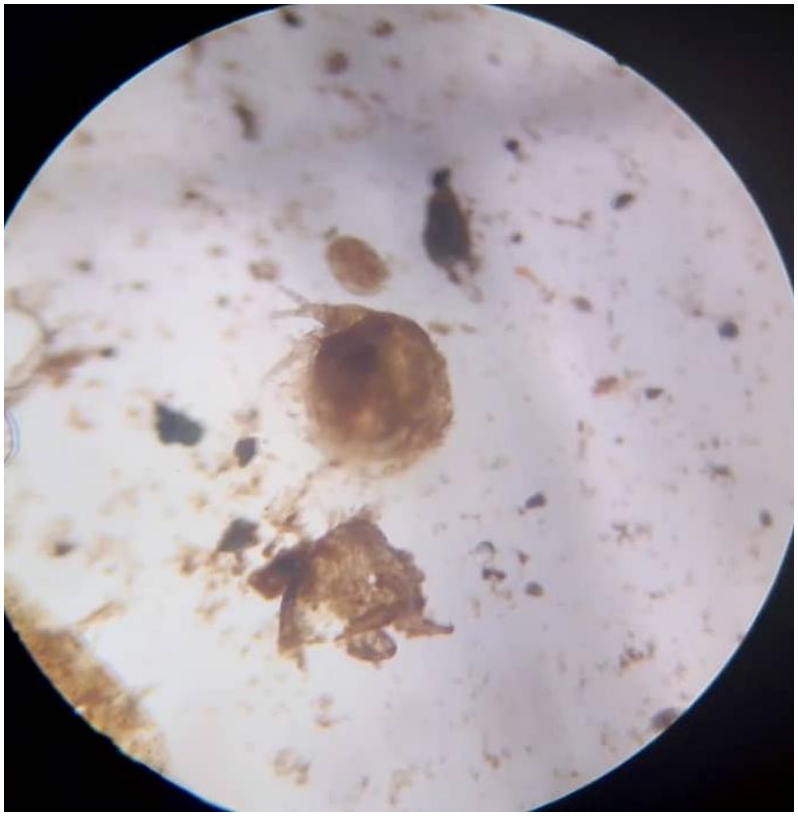

Plate 4.7: *Moina macropoda*

CHAPTER FIVE

DISCUSSION AND CONCLUSION

5.1 Introduction

The Eruvbi Stream in Benin City, Edo State, Nigeria, is a vital water body with considerable ecological significance. As a crucial component of the local ecosystem, it plays a pivotal role in sustaining biodiversity and providing valuable resources to the community. The intricate web of life within this aquatic ecosystem is exemplified by the presence of Cladocerans, a group of microscopic crustaceans that serve as bioindicators of water quality. Understanding the community structure of Cladocerans in Eruvbi Stream is imperative, as it sheds light on the health and dynamics of this aquatic ecosystem.

5.2 Spatio-Temporal Variation in Physiochemical Water Quality

The research conducted in Eruvbi Stream has revealed intriguing patterns of spatio-temporal variation in physiochemical water quality parameters. These variations hold significant implications for both the aquatic ecosystem and the surrounding community. Here, we delve into the key findings that underscore the complex interplay between water quality and Cladoceran communities:

5.2.1 pH Variability:

Station 1 exhibited fluctuating pH levels, while Stations 2 and 3 maintained more stable values. The lowest pH recorded in Station 1 during April 2023 hints a potential ecological shift in response to environmental conditions. In contrast, Stations 2 and 3 remained within the typical pH range for natural water bodies. These observations underscore the importance of pH stability in maintaining healthy aquatic communities.

The finding of this study is in agreement with (Sharma & Michael, 1987) on the distribution of Cladocera where it was discovered that the optimum conditions in coastal rivers ranges between 4-6.5, which shows the slight acidic nature of the tendencies of the seven species unraveled within the Eruvbi stream. In these acidic coastal waters, salinity variations certainly determined the quality, quantity, seasonality and distribution of Cladocera

Also, the study is similar to findings by Nkwoji *et al*., (2016) whose pH was within 6.8-7.8. and shows the river was slightly acidic to neutral. Unlike study by Agreement Nkwoji *et al*. (2010), Chukwu and Nwankwo (2004) who recorded a slightly pH range (7.2 – 8.2)

5.2.1 Conductivity and Ion Concentration:

Station 2 presented alarmingly high conductivity levels, indicative of elevated ion concentrations. This stark contrast with Stations 1 and 3 suggests a potential source of pollution or environmental stressors. Such disparities raise concerns about the long-term health of the ecosystem and call for rigorous monitoring and mitigation efforts. This study is contrast with More detailed studies of Chigbu (1987) on the distribution of Cladocera which revealed the presence of both species in medium conductivity (5- 10 x 103S cm 1 at 25 C) waters of Forcados Estuary

5.2.3 Suspended Solids and Turbidity:

Suspended solids and turbidity levels fluctuated across stations and months. Station 2 consistently exhibited higher suspended solids and turbidity, signifying increased particulate matter in the water. These findings are indicative of possible sedimentation and erosion issues, which can impact water clarity and, consequently, aquatic life. The level of suspended solid obtained were lower compared to those uncovered by Nwoji *et al., (*2016) and Abdulsam *et al*., (2010)

5.2.4 Nutrient Levels - Sulphate, Phosphate, Nitrate:

The levels of these nutrients varied across stations and months. While all stations generally fell within acceptable ranges, subtle differences were observed. These variations may influence nutrient availability to Cladoceran communities and their associated flora and fauna.

The level of nitrate detected in the stream was lower than that recorded by Nwokji *et al*., (2016) which was within (2.0 ± 1.0 mg/l and 5.0 ± 2.5 mg/l, respectively), likewise the levels of phosphate and sulphate discovered ranged from ranged from 277.5 ± 274.5 mg/l to 1750.0 ± 1388 mg/l respectively. Similar result were reported in studies by AbdusSalam *et al.* (2010), Nkwoji *et al*. (2010) and Yakub *et al.* (2013).

5.2.5 Alkalinity and Hardness:

Alkalinity and hardness values exhibited fluctuations, with Station 2 displaying markedly higher alkalinity. These parameters influence the buffering capacity of the water and can impact the pH stability, which, in turn, affects the overall ecosystem health.

The findings were closely correlated with Nwokji *et al*., (2016)

5.2.6 Dissolved Oxygen and Organic Pollution - BOD and COD:

Dissolved oxygen levels were relatively stable across all stations, indicating sufficient oxygen availability for aquatic organisms. However, Stations 1 and 3 displayed lower BOD and COD levels, reflecting lower organic pollution compared to Station 2. The elevated BOD and COD levels at Station 2 suggest a potential source of organic contaminants that require immediate attention.

With regards to dissolved oxygen (DO), the study is similar to study by Ajibare (2014) and Nwokji *et al*., (2016) both recorded Do values between 4.75-10.0mg/l and 7.54-7.60mg/L. Dissolved oxygen has been described as having great impact on the survival of aquatic biota, as well as their distribution, diversity and abundance (Nkwoji, 2014). It also affects the growth, survival, distribution, behavior and physiology of shrimps and other aquatic organisms (Ajibare, 2014)

The relatively low DO found at Eruvbi stream could be attributed to high levels of anthropogenic activities due to large human population size at the location. It is possible that discharge of household wastes such as human sewage and other degradable matters from the large population have led to the decline in DO level at the station. Biodegradation of organic rich wastes by aerobic microbes is a major cause of the dissolved oxygen depletion. This has been reported to be a major problem in Nigerian natural water bodies especially in highly populated coastal zones (Abowei and Sikoki, 2005; Arimoro *et al.,* 2008; Yakub and Ugwumba, 2009b; Nkwoji *et al.*, 2010; Yakub *et al.*, 2013) There was no significant difference ($P > 0.05$) in the values of dissolved oxygen recorded in this study

5.2.7 Potassium, Calcium, and Magnesium:

The levels of these essential nutrients showed variability between stations. Potassium was highest at Station 2, while calcium levels were elevated at Stations 1 and 2. Magnesium levels were significantly higher at Station 3. These variations could influence nutrient cycling and availability within the ecosystem.

Hence, the spatio-temporal variation in physiochemical water quality parameters underscores the dynamic nature of the Eruvbi Stream ecosystem. The presence and distribution of Cladocerans within this ecosystem are intricately linked to these variations. Station 2, characterized by elevated conductivity, suspended solids, and nutrient levels, may experience altered Cladoceran communities as they respond to these environmental stressors.

The relative stability in water quality parameters at Stations 1 and 3 suggests a healthier ecosystem, potentially supporting more diverse and stable Cladoceran communities. However, the presence of diverse Cladoceran species in all stations (as indicated by the Margalef's Index, Shannon-Weiner Index, and Evenness Index) highlights the resilience of these microcrustaceans to adapt to changing environmental conditions (Abdulsalem *et al*., 2010, Nwokji *et al.,* 2010, Nwokji *et al*., 2016)

5.3 Species composition

In this enchanting aquatic realm, a total of seven Cladoceran species graced our presence. These included *Alonella excisa* (Richard, 1894), *Bosmina longirostris* (Muller, 1785), Moina micrura (Fisher, 1854), *Pleuroxus hamatus hamatus* (Muller, 1776), *Acroperus harpae* (Muller, 1776), *Daphnia carinata* (Leydig, 1860), and *Moina macropoda* (Richard, 1854). What's truly remarkable is that these diverse species all belong to the same kingdom, phylum, class, subclass, and family, showcasing the intricacy of nature's tapestry

As we ventured deeper into the Cladoceran realm, we uncovered their distinct orders. Most of these captivating creatures were part of the Order Anomopoda, exemplifying their shared ecological traits and adaptations. This group included *Moina micrura*, *Pleuroxus hamatus hamatus, Acroperus harpae*, and *Moina macrocopa*, each contributing its unique charm to the ecosystem.

However, the diversity didn't stop there. *Alonella excisa* showcased its distinctiveness as a member of the Order Ctenopoda, adding a touch of uniqueness to the community. Meanwhile, *Bosmina longirostris* carved its place within the order Diplostraca, enriching the ecosystem's diversity even further

This research study is particularly, similar to a study conducted by Imoobe (2011), where the author ascertained the characterization of Zooplankton community structure of the Polluted Eruvbi Stream, Benin City, Nigeria. The key differences from the finding uncovered is that back then in 2011 9 species of these cladocerans were unraveled out the over fourty (40) species discovered. This might point to the fact that as result of the pollution occurring overtime as result of human discharges both from agricultural and industrial runoff, as led to the gradual decrease in this unique group of zooplankton.

Additionally, the study is also in contrast with Dejenie *et al.*, (2012) *who* conducted a study on Cladoceran community composition in tropical semi-arid highland reservoirs in Tigray (Northern Ethiopia): A metacommunity perspective applied to young reservoirs, only 15 taxa of these species where unraveled with most of these taxa occurring at the littoral zone. The common genera similar to the present study were Ceriodaphnia, Moina and Diaphanosoma found to be relatively widespread and abundant. Also, according to Denjenie in 2012, carried out a study on Species composition (presence/absence) of the cladoceran communities in the reservoirs was not related to geographic distance but it's usually significantly associated to environmental distance. This explains why environmental factors are much more important in explaining variation in cladoceran species presence than spatial factors

Also, unlike this study where only Seven species of cladocerans were identified, according to Egborge *et al*., (1994) fifty-three (53) species were identified which occurred in seven families with *Bosmina longirostris, and* Moina micrura been the two species related from both study and are regarded as weeds associated with Cladocera

5.4Community Structure

The findings of reveals the intricate web of life within Eruvbi Stream, with its wonderful community structure of Cladocerans. These tiny organisms, each with its own role and niche, contribute to the harmonious functioning of this aquatic ecosystem. Their interactions, behaviors, and adaptations are a testament to the delicate balance that exists in nature. The study is similar to Imoobe, (2011).

The zooplankton communities of tropical and temperate systems tend to strongly differ in structure. These differences include the predominance of smaller species (including rotifers) in tropical compared to temperate lakes (Nilssen 1984; Fernando, 1980b, Dumont 1994).

In temperate lakes, large cladocerans may play an important role in controlling algal blooms, whereas large herbivorous zooplankton such as Daphnia species are rare or absent in tropical systems (Green 1976; Fernando 1980a,b; Fernando *et a*l. 1987; Dumont 1994; Gillooly and Dodson 2000). These differences suggest that fish predation may be much more important in the tropics than in temperate regions, probably related to the fact that temperatures are high year-round, so that fishes are continuously active (Moss 1998; Jeppesen *et al*. 2010).

5.5 Diversity of Fauna

The diversity of Cladocerans in Eruvbi Stream is not just a matter of quantity but also of significance. From the data presented in Table 4.3 and Figure 4.16, the hierarchy of importance among the sampling stations was understood. Station 2 emerged as the biodiversity hotspot, followed by Station 1 and Station 3

The presence of identical species in all three stations, including *Alonella excisa*, *Bosmina longirostris*, *Moina micrura*, *Pleuroxus hamatus hamatus*, *Acroperus harpae*, *Daphnia carinata*, and *Moina macrocopa*, showcases the resilience and adaptability of these Cladoceran communities. They have thrived in different microenvironments, highlighting their ability to cope with varying conditions.

Margalef's Index revealed that Station 2 boasted the highest species richness, indicating a thriving community of Cladocerans. Station 3, on the other hand, exhibited lower species richness, suggesting a more specialized community. Station 1 fell in between, showcasing its unique ecological character.

Shannon-Weiner's Index provided insight into the overall diversity, with Station 2 taking the lead, followed by Station 1 and Station 3. This hierarchy reflects the intricate tapestry of life within Eruvbi Stream.

The Evenness Index unveiled the balance within these Cladoceran communities, with Station 2 showcasing the maximum evenness, indicating a well-balanced distribution of species. Station 1, although diverse, displayed slightly lower evenness, while Station 3 exhibited the minimum evenness, suggesting some ecological variations

The findings with regards Diversity of fauna found is still similar to that Imoobe, (2011)

In terms of the species richness the seven species of cladocerans identified is in comparion with the Macrothricidae (7), Daphniidae (6), Sididae (4), Moinidae (3), Bosminidae (2) and the Podonidae (1) are all characteristic of tropical freshwater zooplankton (Dumont, 1981; Dumont *et al*., 1981; Egborge, 1987; Green, 1962; Mamaril & Fernando, 1978; Rey & Saint-Jean 1968; Sharma & Michael, 1987; Van de Velde, 1978) one key characteristics of these tropical species such as *Bosmina longirostris, and* Moina micrurais the fact that they are confined to the slow flowing, aquatic macrophytes rich backwaters of Abraka in the upper limits of the Niger delta swamps..

5.6 Conclusion

In summary, the community structure of Cladocerans in Eruvbi Stream reflects the intricate interplay between water quality and biodiversity. Understanding these dynamics is essential for effective ecosystem management and conservation efforts. Further research and ongoing monitoring are crucial to assess the long-term impacts of these spatio-temporal variations and to develop strategies for maintaining the health and resilience of this vital aquatic ecosystem.

Additionally, the Eruvbi Stream is a world of wonder where Cladocerans dance to the rhythm of nature's symphony. Their diversity, adaptability, and ecological significance underscore the importance of safeguarding this aquatic ecosystem. As we navigate the intricate dynamics of Cladoceran communities, we gain a deeper appreciation for the delicate balance that sustains life in Eruvbi Stream. This study serves as a testament to the enduring mysteries of our natural world and the importance of its preservation

REFERENCES

Abdus-Salam, N., Adekola, F.A. and Apata, A.O. (2010). A physicochemical assessment of water quality of oil producing areas of Ilaje, Nigeria. *Advances in Natural. and Applied Science*, **4** (3), 333–344.

Abowei, J.F and Sikoki, F.D. (2005). Water Pollution; Management and Control. Double Trust Publishers, Port Harcourt, Nigeria, p. 254.

Abowei, J.F. and Sikoki, F.D. (2005). Water Pollution; Management and Control. Double Trust Publishers, Port Harcourt, Nigeria, p. 254.

Ajibare, A.O. (2014). Assessment of physico-chemical parameters of waters in Ilaje local government area of Ondo State, Nigeria. *International Journal of Fish. Aquatic Studies*, **1** (5), 84–92.

Anyanwu, E. D., Ikomi, R. B. and Arimoro, F. O. (2013). Water quality and zooplankton of the Ogba River, Benin City, Nigeria. *African Journal of Aquatic Science*, **38**(2), 193-199.

Arimoro, F.O., Iwegbue, M.A.C. and Enemudo, B.O (2008). Effects of cassava effluents on benthic macro-invertebrate assemblages in a tropical stream in southern Nigeria. *Current Journal of Advanced Environmental Science*, **18** (2), 147–156.

Chigbu, P. (1987). The zooplankton of Warri River, Nigeria. M.Sc thesis. University of Benin, Nigeria.

Dejenie, T., Declerck, S. A. J., Asmelash, T., Risch, S., Mergeay, J., De Bie, T. and De Meester, L. (2012). Cladoceran community composition in tropical semi-arid highland reservoirs in Tigray (Northern Ethiopia): A metacommunity perspective applied to young reservoirs. *Limnologica - Ecology and Management of Inland Waters*, **42**(2), 137–143.

Dumont, H. J. (1994). On the diversity of the Cladocera in the tropics. *Studies on the Ecology of Tropical Zooplankton*, 27-38.

Dumont, H. J., Pensaert, j. and Van de Velde,I. (1981). The crustacean zooplankton of Mali (West Africa). *Hydrobiologia* **80**: 161-187.

Egborge, A. B. (1987). Salinity and the distribution of Cladocera in Warri River, Nigeria. *Hydrobiologia*, 145, 159-167.

Egborge, A. B. M. (1987). Salinity and the distribution of Cladocera in Warri River, Nigeria. *Hydrobiologia* **145**: 159- 165.

Egborge, A. B. M., Onwudinjo, E. and Chigbu, P. C. (1994). *Cladocera of coastal rivers of western Nigeria.* Hydrobiologia*,* **272**(1-3*), 39–46.*

Egborge, A. B., Onwudinjo, E. and Chigbu, P. C. (1994). Cladocera of coastal rivers of western Nigeria. *Hydrobiologia*, **272**, 39-46.

Fernando, C.H. (1980b). The species and size composition of tropical freshwater zooplankton, with special reference to the Oriental region (South East Asia). Int. Rev. *Freshwater Biology*, **65**, 411–426.

Fernando, C.H., Paggi, J.C. and Rajapaksa, R. (1987). Daphnia in tropical lowlands. *Freshwater Biology*. 45, 107–141.

Green, J. (1976). Changes in the zooplankton of Lakes Mutanda, Bunyonyi, and Mulehe (Uganda). *Freshwater Biology*, **6**, 433–436.

Green, J. E. (1962). Zooplankton of the River Sokoto. *The Crustacea Proceeding of Zoological Society. London* **138**: 415-453.

Havel, J. E. (2009). Cladocera. *Encyclopedia of Inland Waters,* 611–622.

Ikomi, R. B., & Anyanwu, E. D. (2010). Zooplankton of Ogba River, Benin City, Nigeria. *Tropical Freshwater Biology*, **22**, 255-258.

Imoobe, T. O. T. and Adeyinka, M. L. (2009). Zooplankton-based assessment of the trophic state of a tropical forest river in Nigeria. *Archives of Biological Sciences*, **61**(4), 733-740.

Imoobe, T. O. T., Tawari-Fufeyin, P. and Ejoh, A. S. (2008). Community structure of crustacean zooplankton in Ekpan Creek, a perturbed tributary of Warri River, Niger Delta, Nigeria. *African Scientist*, **9**(4), 123-134.

Imoobe, T.O.T. (2011). Characterization of the Zooplankton Community Structure of Polluted Eruvbi Stream, Benin City, Nigeria. *Semantic Scholar*, **12**: 13-32.

Jeppesen, E., Moss, B., Bennion, H., Carvalho, L., De Meester, L., Feuchtmayr, H., Friberg, N., Gessner, M.O., Hefting, M., Lauridsen, T.L., Liboriussen, L., Malmquist, H.J., May, L., Meerhoff, M., Olafsson, J.S., Soons, M.B. and Verhoeven, J.T.A. (2010). Chapter 6: interaction of climate change and eutrophication. In: Kernan, M., Battarbee, R.W., Moss, B.R.(Eds.), *Climate Change Impacts on Freshwater Ecosystems*. Wiley-Blackwell. Moss, B. (1998). Ecology of Fresh Waters, Man and Medium. Blackwell Scientific Publications, London, p. 557

Maia Martins, G. B., Santos, E. G., Elmoor-Loureiro, L. M. A. and Sousa, F. D. R. (2023). Large sampling effort is not related to richness and geographic distribution of Cladocera (Crustacea, Branchiopoda) in the Brazilian Savannah. *Studies on Neotropical Fauna and Environment*, 1-9.

Mamaril, A. C. and Fernando, C. H. (1978). Freshwater zooplankton of the Phillipines (Rotifera, Cladocera & Copepoda). *Natural and Applied Science Bulletin,* **30**: 106- 221.

Nkwoji, J. A., Yakub, A. S., Abiodun, A. O., & Bello, B. O. (2016). Hydrochemistry and community structure of benthic macroinvertebrates in Ilaje coastal waters, Ondo State, Nigeria. *Regional Studies in Marine Science,* **8***, 7–13.*

Nkwoji, J.A. (2014). The effects of hypoxia on the distribution, abundance and diversity of benthic macroinvertebrates of Lagos Lagoon, Nigeria. *Current Journal of Advanced Environmental Science*, **2** (3), 90–100.

Nkwoji, J.A., Yakub, A., Ajani, G.E., Balogun, K.J., Renner, K.O., Igbo, J.K., Ariyo, A.A. and Bello, B.O. (2010). Seasonal variations in the water chemistry and benthic macroinvertebrates of a South Western Lagoon, Lagos, Nigeria. *Journal of American Science*, **6** (3), 85–92.

Offem, B. O., Samsons, Y. A., Omoniyi, I. T. and Ikpi, G. U. (2009). Dynamics of the limnological features and diversity of zooplankton populations of the Cross River System SE Nigeria. *Knowledge and Management of Aquatic Ecosystems*, **393**, 02-12.

Omoigberale, M. O. and Aikhuele, V. O. (2011). The Zooplankton Assemblage of a Tropical Rainforest River in Nigeria. *Tropical Freshwater Biology*, *20*, 65-75.

Rey, J. and Saint-Jean, L (1968). Les Cladoceres (*Crustaces: Brachiopodes*) du Tchad (Premiere note). Cah. ORSTOM. *Hydrobiologica*. **2**: 79-118.

Sarma, S. S. S., Peredo-Alvarez, V. M. and Nandini, S. (2007). Comparative study of the sensitivities of neonates and adults of selected cladoceran (Cladocera: Crustacea) species to acute toxicity stress. *Journal of Environmental Science and Health, Part A*, **42**(10), 1449-1452.

Sharma, B. K. R. and Michael, G. (1987). Review of taxonomic studies on freshwater Cladocera from India with remarks on Biogeography. *Developmental journal* of Hydrobiology. **35**: 29-34

Van de Velde, I. (1978). Cladocera and Copepoda from the valley of the River Senegal. . *Hydrobiologia* **46**: 192- 201

Yakub, A.S. and Ugwumba, A.A.A. (2009b). Effects of Abattoir effluents on some physic - chemical parameters and freshwater prawns (Macrobrachium) of Lower Ogun River, Western Nigeria. Niger. *Journal of Fish*. **6** (2), 93–101

APPENDIX

Oneway

Notes

Output Created		05-SEP-2023 21:56:28
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	9
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on cases with no missing data for any variable in the analysis.
Syntax		ONEWAY pH Conductivity SuspendedSolid Turbidity Sulphate Phosphorus Nitrate Alkalinity Hardness DissolvedOxygen BOD COD Potassium Calcium Magnesium BY Months

		/STATISTICS DESCRIPTIVES /MISSING ANALYSIS /POSTHOC=DUNCAN ALPHA(0.05).
Resources	Processor Time	00:00:00.09
	Elapsed Time	00:00:00.13

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
pH	station 1	3	25.133	32.7936	18.9334	-56.331	106.597	6.1	63.0
	station 2	3	6.433	.8327	.4807	4.365	8.502	5.5	7.1
	station 3	3	6.600	.2000	.1155	6.103	7.097	6.4	6.8
	Total	9	12.722	18.8597	6.2866	-1.775	27.219	5.5	63.0
Conductivit	station	3	55.33	5.774	3.333	40.99	69.68	52	62

y	1								
	station 2	3	190.00	123.596	71.358	-117.03	497.03	50	284
	station 3	3	72.67	4.619	2.667	61.19	84.14	70	78
	Total	9	106.00	88.645	29.548	37.86	174.14	50	284
Suspended Solid	station 1	3	11.00	7.211	4.163	-6.91	28.91	5	19
	station 2	3	38.33	9.292	5.364	15.25	61.41	28	46
	station 3	3	20.33	6.429	3.712	4.36	36.30	13	25
	Total	9	23.22	13.773	4.591	12.64	33.81	5	46
Turbidity	station 1	3	13.67	7.234	4.177	-4.30	31.64	9	22
	station 2	3	67.00	18.682	10.786	20.59	113.41	47	84
	station 3	3	33.67	8.737	5.044	11.96	55.37	24	41
	Total	9	38.11	25.766	8.589	18.31	57.92	9	84
Sulphate	station 1	3	6.67	3.786	2.186	-2.74	16.07	4	11

	station 2	3	21.33	6.028	3.480	6.36	36.31	15	27
	station 3	3	11.33	4.163	2.404	.99	21.68	8	16
	Total	9	13.11	7.688	2.563	7.20	19.02	4	27
Phosphorus	station 1	3	.05133	.045446	.026238	-.06156	.16423	.010	.100
	station 2	3	.35633	.263572	.152174	-.29842	1.01108	.119	.640
	station 3	3	.08433	.027135	.015667	.01693	.15174	.053	.100
	Total	9	.16400	.197687	.065896	.01204	.31596	.010	.640
Nitrate	station 1	3	.43300	.322470	.186178	-.36806	1.23406	.079	.710
	station 2	3	.77867	.636102	.367253	-.80150	2.35883	.046	1.190
	station 3	3	.77367	.710887	.410431	-.99227	2.53961	.001	1.400
	Total	9	.66178	.531920	.177307	.25291	1.07065	.001	1.400
Alkalinity	station 1	3	20.00	2.000	1.155	15.03	24.97	18	22

	station 2	3	89.33	132.247	76.353	-239.19	417.85	10	242
	station 3	3	22.00	4.000	2.309	12.06	31.94	18	26
	Total	9	43.78	74.468	24.823	-13.46	101.02	10	242
Hardness	station 1	3	12.6700	7.56615	4.36832	-6.1254	31.4654	4.01	18.00
	station 2	3	18.0033	12.48439	7.20787	-13.0096	49.0163	4.01	28.00
	station 3	3	18.5367	13.20318	7.62286	-14.2619	51.3352	5.61	32.00
	Total	9	16.4033	10.23479	3.41160	8.5362	24.2705	4.01	32.00
Dissolved Oxygen	station 1	3	4.400	1.9000	1.0970	-.320	9.120	2.3	6.0
	station 2	3	2.367	1.2662	.7311	-.779	5.512	1.4	3.8
	station 3	3	4.200	.2646	.1528	3.543	4.857	3.9	4.4
	Total	9	3.656	1.5043	.5014	2.499	4.812	1.4	6.0
BOD	station	3	1.933	.1528	.0882	1.554	2.313	1.8	2.1

	1								
	station 2	3	4.167	1.3503	.7796	.812	7.521	2.8	5.5
	station 3	3	1.900	.5000	.2887	.658	3.142	1.4	2.4
	Total	9	2.667	1.3379	.4460	1.638	3.695	1.4	5.5
COD	station 1	3	12.733	6.3571	3.6703	-3.059	28.525	8.2	20.0
	station 2	3	29.667	20.5020	11.8369	-21.263	80.597	9.0	50.0
	station 3	3	18.933	11.6367	6.7185	-9.974	47.841	6.8	30.0
	Total	9	20.444	14.2859	4.7620	9.463	31.426	6.8	50.0
Potassium	station 1	3	1.6533	.77313	.44637	-.2672	3.5739	1.12	2.54
	station 2	3	1.7200	.54617	.31533	.3632	3.0768	1.10	2.13
	station 3	3	1.1367	.58654	.33864	-.3204	2.5937	.46	1.50
	Total	9	1.5033	.62167	.20722	1.0255	1.9812	.46	2.54
Calcium	station 1	3	4.8100	.80000	.46188	2.8227	6.7973	4.01	5.61

	station 2	3	6.4133	2.40500	1.38853	.4390	12.3877	4.01	8.82
	station 3	3	5.6100	.80000	.46188	3.6227	7.5973	4.81	6.41
	Total	9	5.6111	1.49934	.49978	4.4586	6.7636	4.01	8.82
Magnesium	station 1	3	1.1333	.28290	.16333	.4306	1.8361	.97	1.46
	station 2	3	1.2967	.28290	.16333	.5939	1.9994	.97	1.46
	station 3	3	2.2700	1.40296	.81000	-1.2151	5.7551	1.46	3.89
	Total	9	1.5667	.90297	.30099	.8726	2.2607	.97	3.89

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
pH	Between Groups	693.202	2	346.601	.966	.433
	Within Groups	2152.313	6	358.719		
	Total	2845.516	8			
Conductivity	Between Groups	32202.667	2	16101.333	3.151	.116
	Within Groups	30661.333	6	5110.222		

	Total	62864.000	8			
Suspended Solid	Between Groups	1158.222	2	579.111	9.670	.013
	Within Groups	359.333	6	59.889		
	Total	1517.556	8			
Turbidity	Between Groups	4355.556	2	2177.778	13.678	.006
	Within Groups	955.333	6	159.222		
	Total	5310.889	8			
Sulphate	Between Groups	336.889	2	168.444	7.431	.024
	Within Groups	136.000	6	22.667		
	Total	472.889	8			
Phosphorus	Between Groups	.168	2	.084	3.489	.099
	Within Groups	.145	6	.024		
	Total	.313	8			
Nitrate	Between Groups	.236	2	.118	.348	.719
	Within Groups	2.028	6	.338		
	Total	2.264	8			
Alkalinity	Between Groups	9344.889	2	4672.444	.801	.492
	Within Groups	35018.667	6	5836.444		
	Total	44363.556	8			
Hardness	Between Groups	63.147	2	31.573	.244	.791
	Within Groups	774.862	6	129.144		
	Total	838.008	8			

Dissolved Oxygen	Between Groups	7.536	2	3.768	2.139	.199
	Within Groups	10.567	6	1.761		
	Total	18.102	8			
BOD	Between Groups	10.127	2	5.063	7.245	.025
	Within Groups	4.193	6	.699		
	Total	14.320	8			
COD	Between Groups	440.382	2	220.191	1.108	.389
	Within Groups	1192.320	6	198.720		
	Total	1632.702	8			
Potassium	Between Groups	.612	2	.306	.740	.516
	Within Groups	2.480	6	.413		
	Total	3.092	8			
Calcium	Between Groups	3.856	2	1.928	.819	.485
	Within Groups	14.128	6	2.355		
	Total	17.984	8			
Magnesium	Between Groups	2.266	2	1.133	1.597	.278
	Within Groups	4.257	6	.709		
	Total	6.523	8			

Post Hoc Tests

Homogeneous Subset

pH

Duncan[a]

Months	N	Subset for alpha = 0.05
		1
station2	3	6.433
station3	3	6.600
station1	3	25.133
Sig.		.286

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Conductivity

Duncan[a]

Months	N	Subset for alpha = 0.05
		1
station1	3	55.33
station3	3	72.67
station2	3	190.00

Sig.		.068

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Suspended Solid

Duncan[a]

Months	N	Subset for alpha = 0.05	
		1	2
station1	3	11.00	
station3	3	20.33	
station2	3		38.33
Sig.		.190	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Turbidity

Duncan[a]

Months	N	Subset for alpha = 0.05	
		1	2
station1	3	13.67	
station3	3	33.67	

station2	3		67.00
Sig.		.100	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Sulphate

Duncan[a]

Months	N	Subset for alpha = 0.05	
		1	2
station1	3	6.67	
station3	3	11.33	
station2	3		21.33
Sig.		.275	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Phosphorus

Duncan[a]

Months	N	Subset for

		alpha = 0.05
		1
station1	3	.05133
station3	3	.08433
station2	3	.35633
Sig.		.059

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Nitrate

Duncan[a]

		Subset for alpha = 0.05
Months	N	1
station1	3	.43300
station3	3	.77367
station2	3	.77867
Sig.		.507

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size

= 3.000.

Alkalinity

Duncan[a]

Months	N	Subset for alpha = 0.05
		1
station1	3	20.00
station3	3	22.00
station2	3	89.33
Sig.		.323

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Hardness

Duncan[a]

Months	N	Subset for alpha = 0.05
		1
station1	3	12.6700
station2	3	18.0033

station3	3	18.5367
Sig.		.562

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Dissolved Oxygen

Duncan[a]

Months	N	Subset for alpha = 0.05
		1
station2	3	2.367
station3	3	4.200
station1	3	4.400
Sig.		.120

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

BOD

Duncan[a]

Months	N	Subset for alpha = 0.05	
		1	2
station3	3	1.900	
station1	3	1.933	
station2	3		4.167
Sig.		.963	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

COD

Duncan[a]

Months	N	Subset for alpha = 0.05
		1
station1	3	12.733
station3	3	18.933
station2	3	29.667
Sig.		.205

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size

= 3.000.

Potassium

Duncan[a]

Months	N	Subset for alpha = 0.05
		1
station3	3	1.1367
station1	3	1.6533
station2	3	1.7200
Sig.		.323

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Calcium

Duncan[a]

Months	N	Subset for alpha = 0.05
		1

station1	3	4.8100
station3	3	5.6100
station2	3	6.4133
Sig.		.262

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Magnesium

Duncan[a]

Months	N	Subset for alpha = 0.05
		1
station1	3	1.1333
station2	3	1.2967
station3	3	2.2700
Sig.		.161

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000..