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The Macrophytic Vegetation of River Ethiope at the Umuaja Ukwani Local Government Area of Delta State, Nigeria †

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Abstract: This abstract presents an overview of aquatic macrophytes and their importance for the structure and function of aquatic ecosystems. It also discusses the effect of water quality and nutrient enrichment on macrophyte distribution, and the development of survey and monitoring techniques for characterizing waterside habitats. Finally, it highlights the need for detailed data for detecting changes at individual sites. Physicochemical parameters are major factors when considering the quality of water samples with the presence of macrophytes in an aquatic ecosystem. A study carried out from January to March in 2019 shows that the mean value of the water temperature was the highest in February, with a mean value of 26.5 °C; the PH, alkalinity, sulfate (SO_4^{2-}), and nitrate (NO_3^-) were the highest in January, while the conductivity, total hardness of the water, magnesium, biological oxygen demand (BOD), and phosphate were the highest in March. Moreover, the water was 100% transparent during the whole study period. Twelve (12) macrophytes belonging to ten (10) families were encountered. The most abundant macrophytes encountered were the species *Bumbusa vulgaris* (Poaceae family). A single emergent macrophyte Ipomoea aquatic (Convolvulaceae family) was encountered. Free-floating and submerged macrophytes were absent due to the high flow rate of the river. It was observed that the physiocochemical parameters of River Ethiope fall under the normal range of good quality water, supporting Macrophytic vegetation.

Keywords: diversity; aquatic macrophytes; physiochemical parameter; river ethiope

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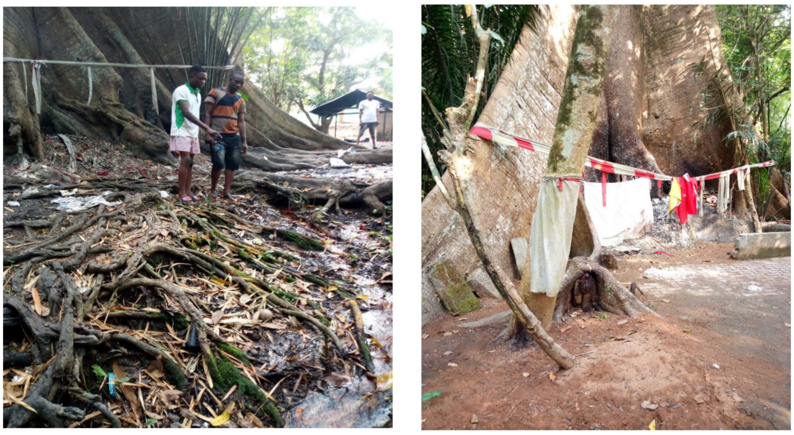
1. Introduction

Macrophytes can be functionally classified into life-forms, based on the occurrence of emergent, floating, and submerged leaves. Aquatic macrophytes are water vegetations comprising macro algae and the true angiosperms [1,2]. The presence of macrophytes is influenced by many factors: water quality, water depth, substrate characteristics, the indentation and slope of the shoreline, and the pollution of nutrients. A number of techniques have been developed for the survey and monitoring of aquatic macrophytes in rivers and for characterizing their waterside habitats, particularly in relation to the need for detailed data for detecting changes at individual sites [3,4]. Also considered are the effect of nutrient enrichment on the macrophyte distribution from the effect of other environmental factors (such as conductivity) and the effect of pH from phosphate and ammonium enrichment [5]. Aquatic macrophytes play an important role in the structure and function of aquatic ecosystems by altering water movement regimes (flow and wave impact conditions), providing shelter and refuge, serving as a food source, and altering the water and sediment quality [6,7]. Aquatic macrophytes are not only affected by water quality, but they also affect water quality and provide food and refugia for aquatic invertebrates and fish [8,9]. This study takes into account the rationale and methods adopted in the analysis of the River Ethiope source at Umuaja as one of the most important rivers (aquatic resource) in Delta

State and Nigeria at large. The River Ethiope in Delta State, Nigeria, originates from the foot of a giant silk-cotton tree and is unique for its cavernous size and unnaturally pure water (Figure 1A). Despite appearing shallow, the river is deep enough to accommodate ocean-going vessels. Its source is considered to be sacred and some areas are restricted to visitors due to their spiritual affiliation, with a footpath leading to the Onoku shrine (Figure 1B). However, much of its biotic information (macrophyte and physicochemical variables) is still unknown. Therefore, this study is aimed at providing baseline information on the species richness of its aquatic macrophytes and physicochemical variables.



(**A**) (**B**)

Figure 1. (**A**) River Ethiope, unlike sources of other rivers, originates from the foot of a giant silk-cotton tree; the river sprouts out from four different locations with two of these locations directly underneath the tree, while the other two from around the tree. (**B**) Some areas of the groove surrounding the river source are restricted to visitors, spiritual affiliation.

2. Materials and Methods

2.1. Sample Collectio

Water samples from the River Ethiope source Ukwuani were collected from the months of January 2019 to March 2019 (3-month study period). Aquatic macrophytes were collected along the river bank of the Ethiopia River and on the surface water for the floating macrophytes each time a trip was made to the site over a period of four months; both creeping and standing macrophytes were collected. The macrophytes collected were arranged and preserved in white paper and covered with a brown paper envelope to avoid them drying up. They were quickly transported to the Applied Biology Laboratory for identification. Water samples from the river were collected. During the collection, some water quality parameters were determined in situ.

2.2. Physicochemical Parameters

The chemical and biological parameters of the water samples (nitrate (NO_3), phosphate (PO_4), sulphate (SO_4), calcium (Ca^{2+}), chloride (Cl^-), magnesium (Mg^{2+}), total alkalinity, and biological Oxygen Demand (BOD)) and their conductivity, transparency, temperature, and total hardness were analyzed in an applied biological laboratory within an hour after the sampling. In situ measurements (temperature) were also carried out by a water quality portable thermometer. These measurements provided the same results as the laboratory surveying. For the detection of nitrate (NO_3), phosphate (PO_4), and sulphate (SO_4), an ICP-OES spectrometer (Vista-Pro, Varian Inc., Palo Alto, CA, USA) was used. Calcium (Ca^{2+}), chloride (Cl^-), magnesium (Mg^{2+}), total hardness, and total alkalinity were determined using the titration method. For a determination of the pH in the laboratory, a SenTix electrode (UNISCOPE PHS-3E pH meter, Surgifield) was used, and for the conductivity, a laboratory conductometer (DDS-307 JENWAY) was used. Dissolved Oxygen (DO): The amount of dissolved oxygen was determined in situ using Winkler's methods.

3. Results and Discussion

The result of the physiochemical chemical is shown in Table 1.

Table 1. The result of the physiochemical chemical.

Parameters	January	February	March
	Mean ± SD	**Mean ± SD**	**Mean ± SD**
Temperature (°C)	26.5 ± 0.602	27.2 ± 0.19	26.6 ± 0.16
Conductivity (ms/m)	133.9 ± 0.637	110.06 ± 0.34	114.2 ± 0.42
Alkalinity (mg/L)	73.33 ± 26.26	58.33 ± 19.29	59.00 ± 17.45
pH	7.93 ± 0.367	4.25 ± 0.39	5.76 ± 0.25
Calcium (mg/L)	7.46 ± 0.754	13.00 ± 0.18	9.07 ± 1.36
Total Hardness (mg/L)	10.00 ± 1.63	13.74 ± 0.81	14.53 ± 1.80
Magnesium (mg/L)	2.54 ± 0.88	0.74 ± 0.63	5.46 ± 0.44
DO (mg/L)	4.13 ± 0.94	9.73 ± 2.97	8.26 ± 1.00
BOD (mg/L)	1.16 ± 0.19	3.00 ± 0.38	5.67 ± 0.57
Sulphate (mg/L)	190.63 ± 2.81	180.4 ± 0.92	165.46 ± 4.24
Transparency (%)	100 ± 0	100 ± 0	100 ± 0
Chloride (mg/L)	−0.04 ± 0.039	−0.12 ± 0.027	−0.10 ± 0.01
Nitrate (mg/L)	7.60 ± 0.66	10.13 ± 0.66	7.33 ± 0.57
Phosphate (mg/L)	0.14 ± 0.02	0.40 ± 0.37	0.76 ± 0.48

The study investigated the water quality parameters over a three-month period at a particular location. In February, the mean water temperature was recorded as 26.5 °C, whereas the mean temperatures in January and March were lower and higher, respectively. The conductivity exhibited a mean value of 114.2 ms/mL in March, which was higher than the means observed in February and January. The pH mean value was highest in January and lowest in February, while the alkalinity showed a similar trend, with the highest mean value being in January and the lowest being in February. The total hardness, calcium, and magnesium all exhibited seasonal variations, with the highest mean values being observed in March and the lowest in either January or February. The dissolved oxygen showed an opposite trend, with the highest mean value being observed in February and the lowest in January. The biological oxygen demand exhibited the same seasonal variation as the total hardness, calcium, and magnesium, with the highest mean value being observed in March and the lowest in January. Sulphate was found to have the highest mean value in January and the lowest in March. In contrast, the mean value of chloride was the highest in February and the lowest in January. Nitrate exhibited a seasonal variation, with the highest mean value being observed in January and the lowest in March. Finally, phosphate showed its highest mean value in March and its lowest in January. Overall, the study found that the water quality parameters exhibited seasonal variations, with some parameters showing their highest mean values in January, some in February, and others in March.

Biodiversity of Aquatic Macrophyte

The percentage abundance of the macrophytic types is shown in Table 2. Below, embankment species had a percentage greater than 90%. There were more embankment species in the study area than any other form. The percentage abundance of the emergent macrophytes was less than 8%. Floating and submerged macrophytes were 0%. No floating or submerged macrophytes were encountered in the study area. This absence of floating and submerged macrophytes may have been due to the high flow rate that is evident in the study area.

Table 2. Biodiversity of aquatic macrophyte.

Botanical Name	Family Name	Life Form	Abundance	Ecological Status
Bumbus vulgaris	Poaceae	Embankment	5	Abundance
Cieba pentandra	Malvaceae	Embankment	1	Rare
carex spp	Cyperaceae	Embankment	4	Abundance
Elaeis guineensis	Areceae	Embankment	4	Abundance
Azonopus compressus	Poaceae	Embankment	4	Abundance
Acanthus montanus	Acanthaceae	Embankment	2	Rare
Tectona grandis	Lamiaceae	Embankment	4	Abundance
Calopogonium mucunoids	Fabaceae	Embankment	2	Rare
Anacardium occidentale	Anacardiaceae	Embankment	2	Rare
Alternanthera sessilis	Amaranthaceae	Embankment	3	Abundance
Ipomoea aquatica	Convolvulaceae	Emergent	2	Rare
Leersia hexandra	Convolvulaceae	Embankment	3	Abundance

4. Conclusions

The River Ethiope source at Umuaja supports the growth of Poaceae, which has higher important plants such as *Bumbusa vulgaris* and *Azonopus compressus* (Figure 2). It was observed that the physicochemical parameters of the water quality of the River Ethiope source fall under a moderate range that shows good quality water. The pH value proved that the river is freshwater, which supports the growth of the aquatic macrophytes that were identified.

(**A**) (**B**)

Figure 2. (**A**) = *Tectona grandis*, (**B**) = *Azonopus compressus*.

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