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Composition, distribution, and diversity of macrophytes and benthic macroinvertebrate communities in Eleyele Lake, southwestern Nigeria

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Many human activities that have an effect on water quality and aquatic health are increasing along Eleyele Lake, which is a vital resource for domestic water supply and fishery in Ibadan, southwest Nigeria. This study provides information on the composition of macrophytes and benthic macroinvertebrates (which are bioindicators) in association with physicochemical parameters in Eleyele Lake. Water, macrophytes, and benthic macroinvertebrates were collected from four stations monthly from March to August 2021 and analysed using standard methods. The relationship between the measured physicochemical variables, macrophytes, and the abundance of benthic macroinvertebrate was explored using canonical correspondence analysis (CCA). The encountered macrophytes represented 19 species (11 emergent, six floating and two submerged) in 16 genera and 12 families. The most abundant species was *Ipomea aquatica* (25.83%) in station 2 and *Sacciolepsis africana* (19.19%) in station 1. A total of 282 benthic macroinvertebrate individuals belonging to three phyla, four classes, 11 genera, and 11 species were encountered. Pollution indicator species including *Melanoides tuberculata, Biomphalaria pfeifferi* and *Chironomus* larvae observed in all the sampling stations were the dominant species. The CCA indicated that the abundance of macrophytes correlated with depth and nutrient factors (mostly phosphate). The result of the CCA showed the abundance of *Chironomus* larvae being patterned by dissolved oxygen and nutrient factors (phosphate, nitrate, and sulphate). These further confirmed the polluted status of Eleyele Lake, especially by nutrient enrichment. The dominant macrophytes and benthic macroinvertebrates in Eleyele Lake are pollution-tolerant species and the lake has been impacted by nutrient enrichment.

Keywords: macrophytes, benthic macroinvertebrates, environmental variables, nutrient enrichment

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INTRODUCTION

Aquatic macrophytes are plants visible to the naked eye, which can be submerged, emergent, or floating, depending on their position in the aquatic habitat. The merits of aquatic macrophytes include provision of shelter and food for aquatic organisms, absorption of excessive nutrients from water; they have also been used as manure, animal feed, biogas, and in paper production (Haroon, 2022). Excessive aquatic macrophytes could impact the habitat structure, aesthetic appeal, fishability, and recreational use of water bodies. The depth, density, diversity, and types of macrophytes present in a system are indicators of water body health (Sass et al., 2010). Changes in macrophyte communities may be especially indicative of major categories of urban stress, such as nutrient run off, hydrologic regime, and invasion by exotic species (Havry, 1996; King, Buckney, 2000).

Benthic macroinvertebrates are animals without backbones inhabiting the bottom substrate for at least part of their life cycle (Ajao, Fagade, 2002). Macroinvertebrates form an essential part of the aquatic food chain and can impact the nutrient cycle. A large number of individual taxa have a wide range of responses to stressors such as toxic pollutants, sedimentation, and habitat disturbance. Therefore, the number and kinds of the taxa collected and identified are relatively good indicators of water quality (Tonkin et al., 2017). Due to their variable sensitivity towards multiple disturbances, the abundance and richness of the macroinvertebrates were used by past studies to detect environmental responses (Arimoro, Keke, 2017; Raphahlelo et al., 2022).

Constructed in 1942, the Eleyele reservoir is a vital resource for the fishery, domestic water supply, and flood control. However, anthropogenic activities around its watershed have increased and changed over the years, which could have an adverse impact on the health of the lake ecosystem. Previous studies on this lake included aspects of fish biology (Zelibe et al., 1990; Ayoade, Ikulala, 2007; Ayoade, Akponine, 2016; Olanrewaju et al., 2017), macrobenthos composition (Idowu, Ugwunba, 2005), physicochemical parameters and pollution status (Olayinka et al., 2007; Adeogun et al., 2015), and trophic status (Ayoade et al., 2019). The present study was conducted to determine the current status of Eleyele Lake by investigating the composition and diversity of macrophytes (which are presently covering wide areas of the lake) and benthic macroinvertebrates in relation to the environmental factors to enhance effective management of the lake and its aquatic health.

MATERIALS AND METHODS

The Eleyele Dam is situated in the city of Ibadan, upstream on the River Ona, within geographical coordinates: Latitude 7°20'–7°25' N latitude and 3°51'–3°56' E longitude (Fig. 1). The lake is 240 m long across the dam, the catchments area is 323.7 km^2. The lake is 125 m above sea level with an average depth of 6.0 m (Adeleru, 2017). The surrounding area of the reservoir is made up of typical rain forest with a wetland margin around the perimeter of the lake. The vegetation on the shoreline of the lake is made up of mixtures of trees, shrubs, herbs, and grasses. Economic trees around the lake include *Carica papaya* (pawpaw), *Mangifera indica* (mango), *Elais guineensis* (palm), *Anarcadium occidentale* (cashew), and *Musa acuminate* (wild banana).

Collection of samples and analyses. Sampling in the reservoir was done monthly from March to August 2021 for the physicochemical parameters, macrobenthos, and macrophytes.

Sampling stations. Based on hydrological features, four sampling stations were chosen within the lake and were approximately 5–7 m apart (Fig. 1). The geographical coordinate readings at each sampling site were recorded with a hand-held Global Positioning System (GPS) unit.

Station 1 was covered by macrophytes; washing of clothes and spiritual baptism were frequent here. The geographical coordinates were 7°25'26.03" N latitude and 3°51'39.14" E longitude.

Station 2 was about 620 m from Station 1. It was covered by macrophytes; it received waste water from cassava-processing factories, car

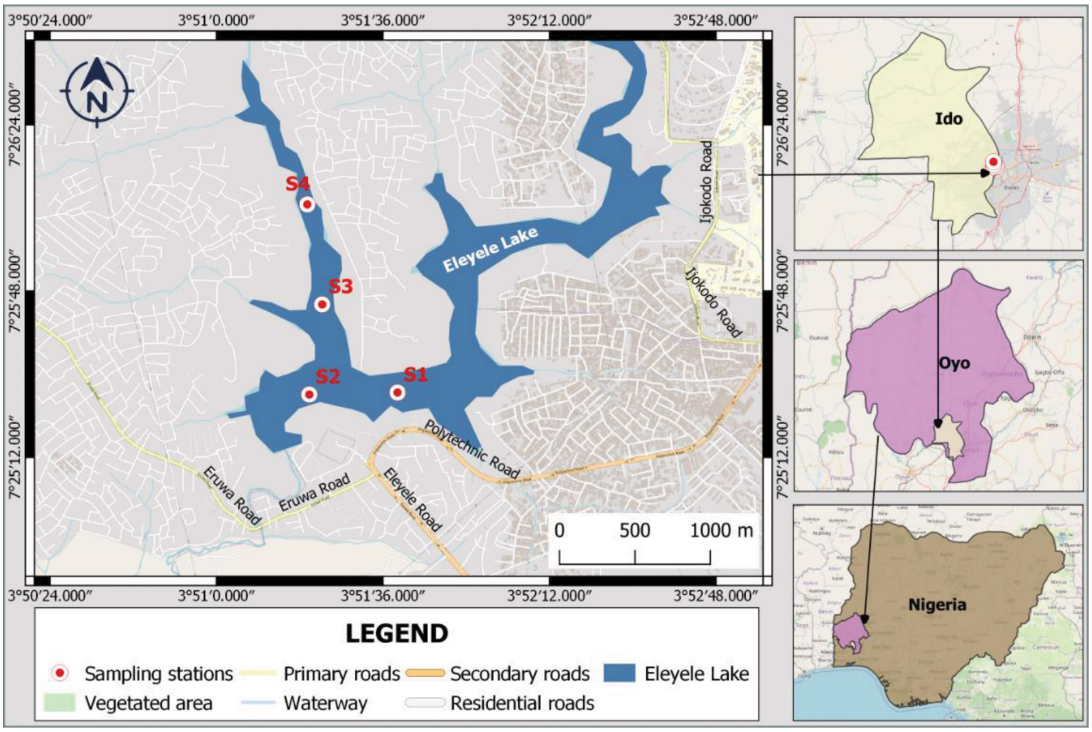

Fig. 1. Map of Eleyele Lake showing the four sampling stations

wash spots, and automobile repaire workshops. A dumpsite for solid waste from neighbouring communities was close to this station. The geographical coordinates were 7°25'25.60" N latitude and 3°51'20.06" E longitude.

Station 3 was within the geographical coordinates of 7°25'45.10" N and 3°51'22.85" E. It was about 600 m from Station 2 and was a pelagic zone without macrophytes.

Station 4 was about 652 m from Station 3, a pelagic zone where water-tanker drivers pumped their water supply for selling for domestic purpose. The geographical coordinates were 7°26'6.75" N and 3°51'19.63" E.

Physicochemical parameters. Water samples from four stations were collected into 250 mL clean plastic bottles. Temperature, biological oxygen demand, pH, dissolved oxygen, total dissolved solids, and conductivity were determined *in situ* with a water quality meter probe SPER Scientific AZ86031. Transparency was determined using a Secchi disc. Water depth was measured with a graduated stick calibrated in centimetres. Spectrophotometric screening according to APHA (2012) was used in the laboratory to determine the nitrate, phosphate, and sulphate content.

Collection and identification of macrophytes. Samples of aquatic plants found at stations 1 and 2 were collected, transferred into a polythene bag, and taken to the Department of Botany, University of Ibadan, for identification. Macrophyte abundance was estimated monthly by quadrat (area: 1 m^2) sampling (Kent, Coker, 1992).

Collection and identification of benthic macroinvertebrates (BMI). Benthic sediment samples were collected monthly using a 0.6 m^2 (surface area) Van Veen Grab sampler from the four sampling stations. Two random replicate hauls of sediment were taken from each station, emptied into pre-labelled polythene bags, and taken to the laboratory for sorting and analysis. In the laboratory, each sediment sample was diluted with water, sieved (0.5 mm and 0.125 mm mesh sizes) and sorted to separate the benthic macroinvertebrates. These were preserved in 10% formalin in a small sample bottle for further observation. Benthic macroinvertebrates were identified to genus level using

Pennak (1978), WHO (1978), Brown (1994), and numbered. Those too small for the naked eye to observe (less than 1 mm in size) were placed on glass slides and viewed under a light microscope with 1000× magnification.

Statistical analysis. Descriptive statistics (mean, standard deviation) were used in the physicochemical parameters, macrobenthos, and macrophytes abundance. Student t-test and one-way ANOVA were used to determine spatial variation in macrophytes and macrobenthic abundance, respectively. Shannon-Wiener, Margalef's, Simpson's, and Pileou's evenness indices were calculated in terms of abundance using the computer BASIC program SP DIVERS (Ludwig, Reynolds, 1988). The constrained ordination canonical correspondence analysis (CCA) (R Core Team, 2017) was explored to search and define the best explanatory water variables characterising the macrophyte habitats and influencing the macrobenthic invertebrates.

RESULTS

Macrophyte composition, distribution, and diversity

Macrophytes encountered during the study period in Eleyele Lake were of 19 species in 16 genera and 12 families. Six were free-floating: *Pistia stratiotes*, *Lemna minor* (Araceae), *Nymphaea lotus* (Nymphaeaceae), *Eicchornia crassipes* (Pontederiaceae), *Ipomea aquatica* (Convolvulaceae) and *Azolla africana* (Azollaceae); two submerged: *Ceratophyllum submersum* and *Ceratophyllum demersum* (Ceratophyllaceae), and 11 emergent species: *Panicum maximum*, *Pennisetum purpureum*, *Echinochloa pyramidalis*, *Echinochloa stagnina*, *Sacciolepsis africana* (Poaceae), *Alchornea cordifolia* (Euphorbiaceae), *Asystasia gangetica* (Acanthaceae), *Ludwigia deccurrens* (Onagraceae), *Typha latifolia*, *Typha australis* (Typhaceae), and *Commelina diffusa* (Commelinaceae). Spatial variation occurred in species distribution with eight species common to both stations while *P. maximum*, *E. pyramidalis*, *E. stagnina*, *L. minor*, *C. demersum*, *T. latifolia*, *T. australis*, and *A. africana* were observed only in station 2. *Pennisetum purpureteum*, *C. submersum*, and *C. diffusa* were encountered only in station 1 (Fig. 2). *Ipomea aquatica* (25.83%) was the most abundant species in station 2 and *Sacciolepsis africana* (19.19%) in station 1. More emergent plants were recorded in station 1 (61.96%) than in station 2 (46.69%), whereas there were more floating plants in station 2 (48.35%). Submerged

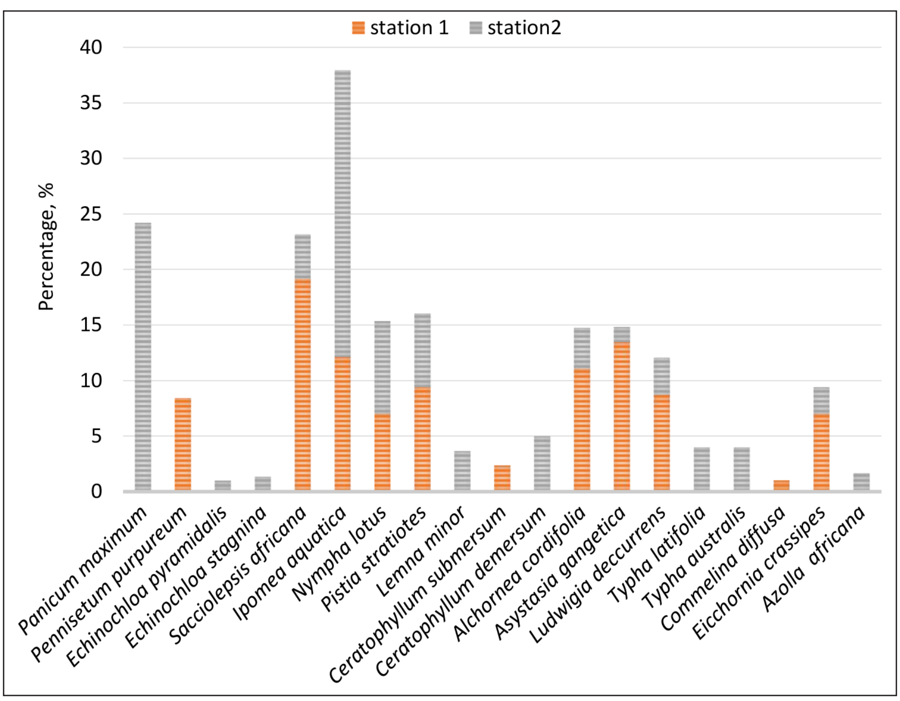

Fig. 2. Spatial variation in the abundance of macrophytes (%) in Eleyele Lake

species were the fewest in both station 1 (2.36%) and station 2 (4.97%). There was no significant difference in macrophyte abundance between both stations ($p < 0.05$). *Ludwiga decurrens* was the exotic species encountered in the lake and accounted for 6.01% of macrophytes. Species richness (Shanon-Weiner index = 2.282) and diversity (Margalef's index = 2.627) were higher in station 2, while station 1 had higher Evenness (0.8542) and Simpson's indices (0.8837) (Fig. 3).

Macrobenthos composition, distribution and diversity

A total of 282 macrobenthos individuals belonging to three phyla (Mollusca, Arthropoda, and Annelida), four classes (Gastropoda, Bivalvia, Insecta, and Clitellata), 11 genera, and 11 species were encountered. Mollusca had the highest number of taxa (7) and were the most abundant (gastropods 67%; bivalves 4%); they were followed by arthropods (3% and 28%, respectively) and annelids (1% and 1%, respectively), the least abundant during the sampling period. *Biomphalaria pfeifferi* was the most abundant species accounting for 32.6% of the total population of organisms during the sampling period, followed by *Melanoides tuberculate* (26.2%), *Chironomus* larvae (24.5%), and the least abundant *Lymnaea natalensis* and *Lumbricus terrestris*, each accounting for <1% of the total number of individuals (Fig. 4). Pollution indicator species, including *Melanoides tuberculata*, *Biomphalaria pfeifferi*, and *Chironomus* larvae, observed in

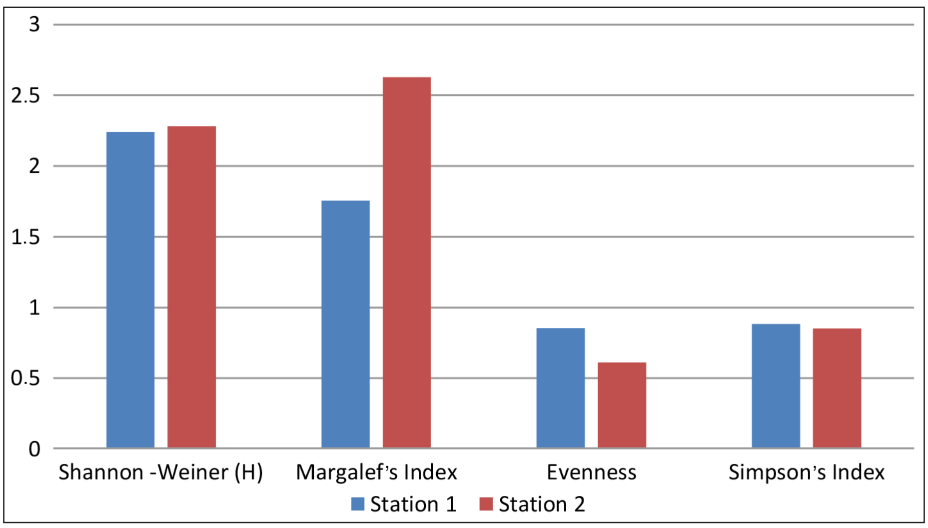

Fig. 3. Spatial variation in the diversity indices of macrophytes in Eleyele Lake

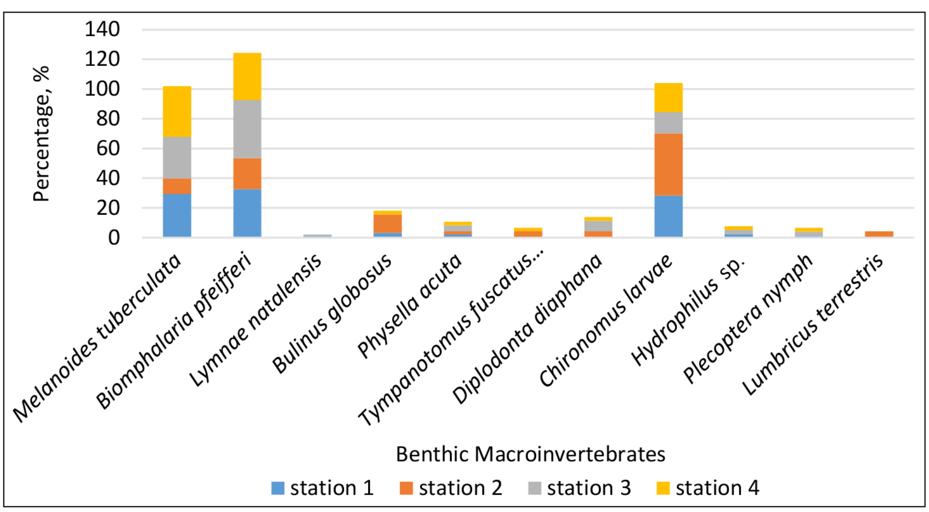

Fig. 4. Spatial variation in the abundance of benthic macroinvertebrates in Eleyele Lake

the four sampling stations were the dominant species (Fig. 4). The highest number of individuals (individuals /0.6 m^2) occurred in station 3 (97, nonvegetated) followed by station 1 (95, vegetated), then station 2 (48, vegetated), and the lowest in station 4 (41, nonvegetated). More molluscs were encountered in the nonvegetated sampling stations (Gastropods 11.11 ± 4.483; Bivalves 4.00 ± 3.00) than in vegetated stations (Gastropods 8.90 ± 3.548; Bivalves 2.00). Conversely, insects were higher in the vegetated (12.50 ± 6.513) than the nonvegetated area (5.000 ± 2.082). There was no significant difference ($p \leq 0.05$) in macrobenthos abundance between the vegetated and nonvegetated stations (Table 1). Shannon-Weiner (H'), Margalef's and Simpson's indices were higher in stations 2 and 4 than the other stations (Fig. 5).

Physicochemical parameters

The physicochemical parameters of the four sampling sites in Eleyele Lake during the study period is summarised in Table 2. The mean pH value of all water samples was neutral (pH 7.0 ± 0.5). The water temperature at all sites ranged from 25.9–31.1°C (28.0 ± 1.7°C). The concentration of dissolved oxygen (DO) were low in all the sites and ranged between 1.8–5.7 (3.5 ± 1.3 mg/L) with least mean DO concentration in station 1 (3.22 ± 1.33). The highest mean Secchi disc transparency was in station 4 (41.9 ± 7.47 cm) and the lowest in station 2 (30 ± 5.96 cm). The conductivity and total dissolved solids (TDS) varied across the sites: the highest mean conductivity (379.83 mg/L ± 34.97) and TDS (190.33 ± 16.88 mg/L) occurred in

Table 1. **Relative abundance (mean ± SD) of benthic macroinvertebrates in vegetated and non-vegetated stations in Eleyele Lake**

	Vegetation	Non-Vegetation	*P* value
Class Gastropoda	8.900 ± 3.548	11.11 ± 4.483	0.7009
Class Bivalvia	2.00	4.00 ± 3.00	–
Class Insecta	12.50 ± 6.513	5.000±2.082	0.2298
Class Clitellata	2.00	–	–

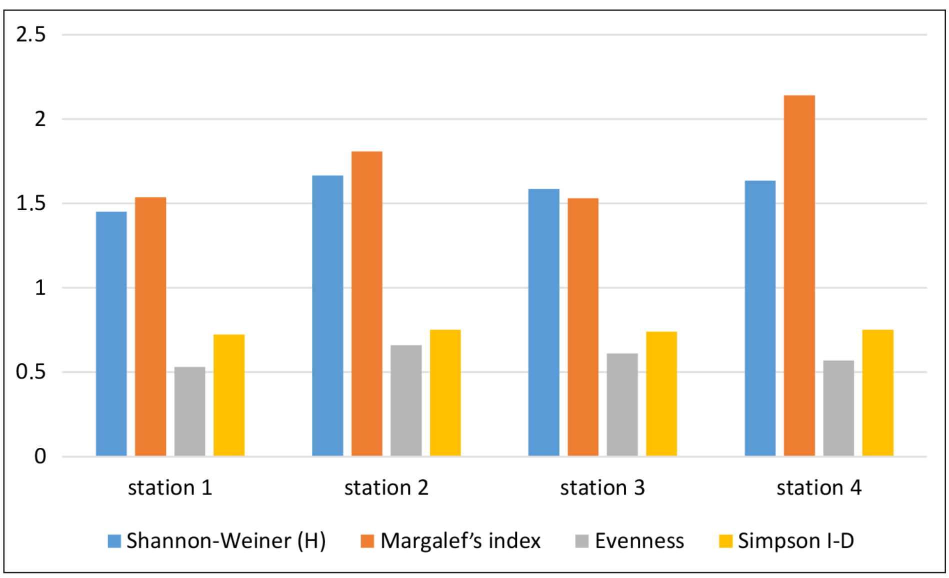

Fig. 5. Spatial variation in the diversity indices of benthic macroinvertebrates in Eleyele Lake

Table 2. **Spatial variation in physicochemical parameters of Eleyele Lake, Ibadan**

Parameters	Station 1	Station 2	Station 3	Station 4
Temperature (°C)	26.2–30.4 (28.13 ± 1.67)	25.9–31.1 (28.15 ± 2.11)	26.2–30.4 (28.22 ± 1.71	26.2–29.8 (27.65 ± 1.58)
Conductivity(µs/cm)	345–419 (376.5 ± 27.47)	338–432 (379.83 ± 34.97	337–408 (376 ± 27.05)	336–411 (370.17 ± 27.43)
pH	6.07–6.91 (6.6 ± 0.41)	6.61–7.96 (7.11 ± 0.48)	6.18–7.69 (7.0 ± 0.54)	6.93–7.6 (7.18 ± 0.28)
Transparency (cm)	29.5–34 (31.35 ± 1.73	24–34 (30 ± 5.96)	25–45 (35 ± 8.72)	35–53 (41.9 ± 7.47)
TDS (ppm)	172–209 (188.17 ± 13.47	171–216 (190.33 ± 16.88)	169–204 (188.5 ± 13.52)	169–202 (184.5 ± 12.50)
DO (mg/L)	2.2–5.7 (3.22 ± 1.33)	1.9–5.2 (3.3 ± 1.17)	1.8–5.6 (3.75 ± 1.72)	1.9–5.3 (3.58 ± 1.14)
BOD (mg/L)	0.3–2.9 (1.37 ± 1.03)	0.5–2.4 (1.33 ± 0.75)	0.6–3.4 (1.85 ± 1.15)	0.1–3.6 (1.43 ± 1.31)
Sulphate (mg/L)	0.072–2.84 (1.105 ± 1.138)	0.104–0.831 (0.37 ± 0.33)	0.067–0.705 (0.34 ± 0.30)	0.052–0.808 (0.461 ± 0.35)
Phosphate (mg/L)	0.03–0.208 (0.139 ± 0.07)	0.021–0.224 (0.16 ± 0.11)	0.02–0.497 (0.20 ± 0.16)	0.06–0.288 (0.16 ± 0.11)
Nitrate (mg/L)	0.021–1.053 (0.26 ± 0.39)	0.031–1.26 (0.30 ± 0.47)	0.016–1.381 (0.32 ± 0.53)	0.019–0.964 (0.26 ± 0.36)
Depth (cm)	71.5–83 (77.1 ± 4.80)	82–128 (102.2 ± 17.92)	98–130 (122.8 ± 29.41)	109–175 (147.6 ± 30.51)

station 2. The concentrations (mg/L) of phosphate and nitrate were relatively low in all samples. Mean depth was highest in station 4 (147.6 cm ± 30.51) and lowest in station 1 (89.1 cm ± 18.71).

Relationship of the macrophyte community and environmental variables

The relationships of macrophyte distribution and abundance to environmental variables are illustrated in a CCA ordination plot (Fig. 6). The first dimension, the axis 1, accounted for 20.05% of inertia, and the second dimension, i.e., the axis 2, accounted for 16.97% inertia. These two axes accounted for 37.02% variations in species distribution and abundance in the data under the influence of environmental variables. Axis 1 had positive correlation with *C. submersum* (0.332122) and *C. diffusa* (0.332122) and negative correlation with station 2 in June (–0.490679). Axis 2 showed a strong positive correlation with *I. aquatica* (0.827352), and a negative correlation with station 1 in June (–836919). Axis 1 had positive correlation with depth (0.464492), phosphate (0.249535) and negative correlation with nitrate (–0.209385). Axis 2 had a positive correlation with pH (0.507616), DO (0.313608), and the depth (0.335723) and a negative correlation with sulphate (–0.466528). There was an overlap between stations 1 and 2 during the sampling period (Fig. 6).

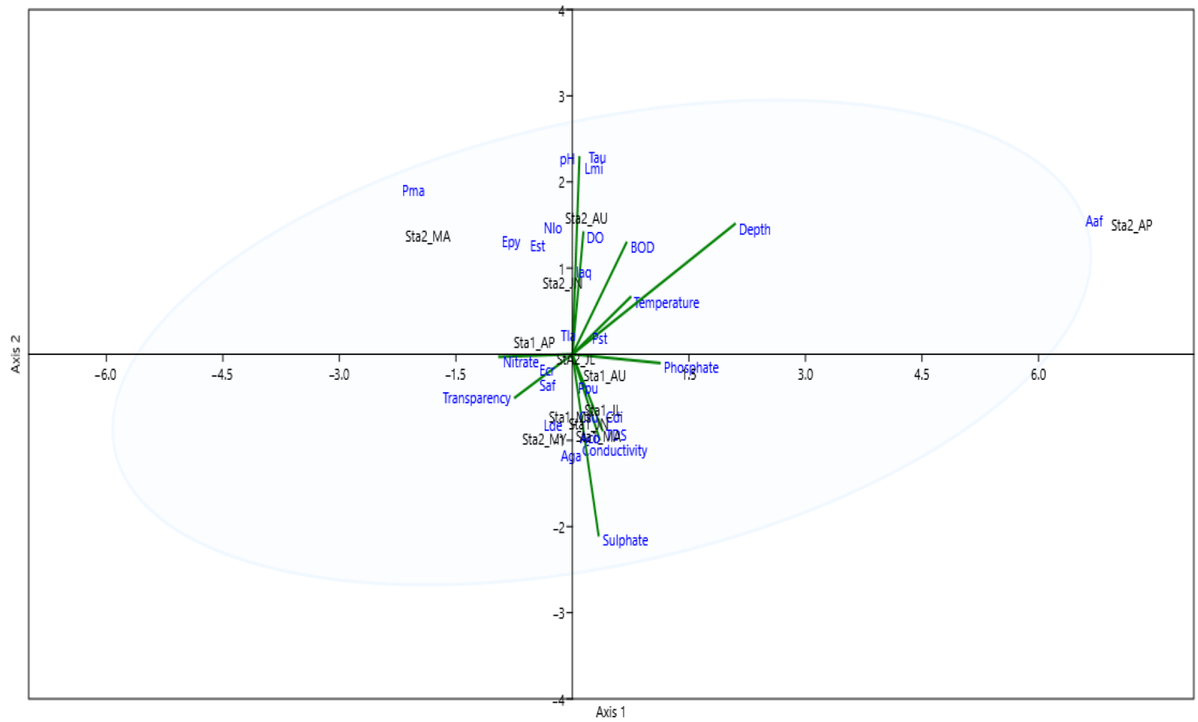

Fig. 6. Canonical correspondence analysis (CCA) illustrating the relationship between macrophytes and physicochemical parameters

Pst – *P. stratiotes*, Nlo – *N. lotus*, Saf – *S. africana*, Aco – *A. cordifolia*, Ppu – *P. purpureum*, Iaq – *I. aquatica*, Lmi – *L. minor*, Csu – *C. submersum*, Tau – *T. australis*, Aga – *A. gangetica*, Ecr – *E. crassipes*, Pma – *P. maximum*, Aaf – *A. africana*, Lde – *L. deccurrens*, Epy – *E. pyramidalis*, Est – *E. stagnina*, Cdi – *C. diffusa*, Tla – *T. latifolia*, Sta1_MA – station 1 sampled in March, Sta1_AP – Station 1 sampled in April, Sta1_MY – Station 1 sampled in May, Sta1_JU – Station 1 sampled in June, Sta1_JL – Station 1 sampled in July, Sta1_AU – Station 1 sampled in August, Sta2_MA – Station 2 sampled in March, Sta2_AP – Station 2 sampled in April, Sta2_MY – Station 2 sampled in May,Sta2_JU – Station 2 sampled in June, Sta2_JL – Station 2 sampled in July, Sta2_AU – Station 2 sampled in August.

Relationship of the benthic macroinvertebrate community and environmental variables

The relationships of BMI distribution and abundance to environmental variables are illustrated in a CCA ordination plot (Fig. 7). The CCA showed the dynamics of the three elements (namely, the sampling stations, 11 environmental variables, and species abundance) in two dimensions. The first dimension, the axis 1, accounted for 76% of inertia, and the second axis, axis 2, accounted for 18.18% of inertia. These two axes accounted for 94.73% of variations in species distribution and abundance in the data under the influence of environmental variables. Axis 1 had strong positive correlation with *Chironomus* larvae (r = O.897592) and station 2 (r = 0.857728). Axis 2 showed moderate negative correlation with *L. natalensis* (r = –0.665455). Axis 1 had moderate positive correlation with water depth (r = 0.750471) and negative correlation with DO and BOD (r = –0.608123 and r = –0.72598, respectfully). Axis 2 showed strong positive correlation with phosphate and nitrate (r = 0.833938 and r = 0.88438) and negative correlation with sulphate (r = –0.92019) (Fig. 7).

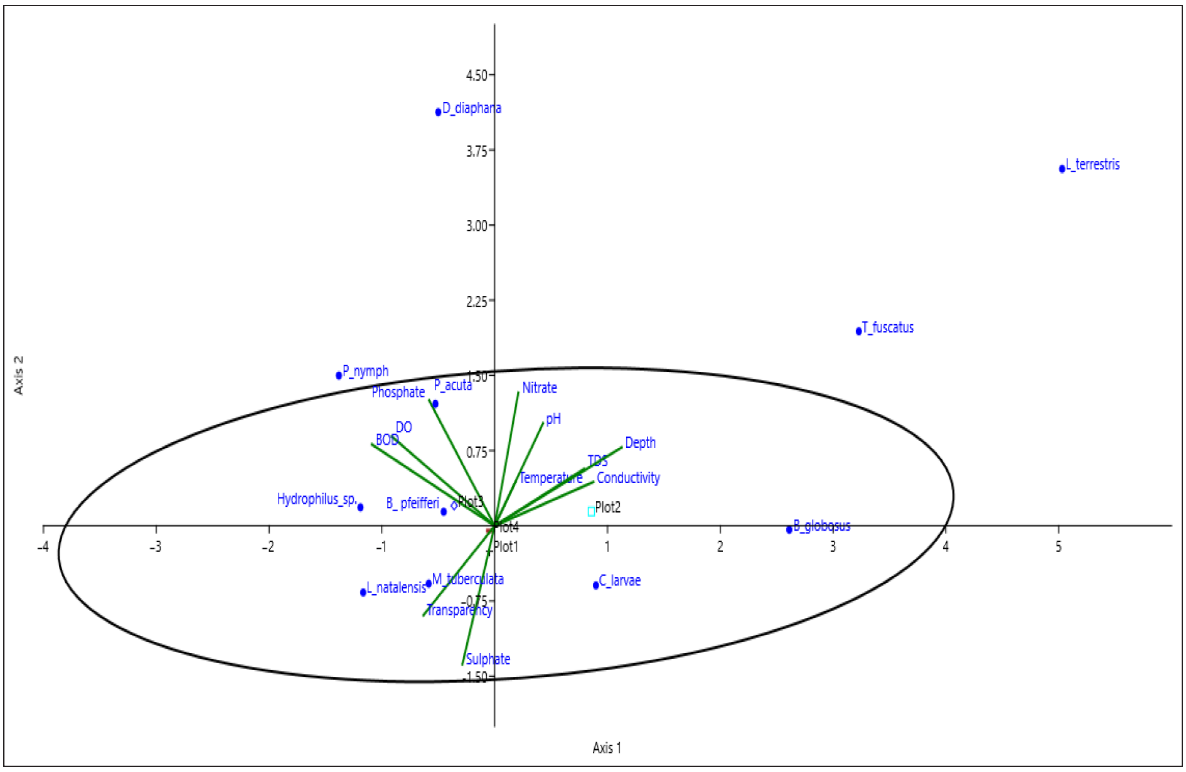

Fig. 7. Canonical correspondence analysis (CCA) illustrating the relationship between benthic macroinvertebrates and physicochemical parameters

Plots 1 – 4 represent Sampling stations 1 – 4.

DISCUSSION

Macrophytes

Both the total number of macrophyte species encountered, with more being emergent species in the study area agreed with Dienye (2005) who reported 20 species in Oyan Lake with 15 being emergent species. The variation observed in macrophyte species between the two stations in this study with more emergent species in station 1 could be due to the shallower depth. Although a similar number of species (19) was recorded by Olubode et al. (2011) in the Eleyele wetland, the species composition in the present study differs from that reported by the said authors, with only three species (*Panicum maximum*, *Eichinochloa staginina*, and *Commelina diffusa*) in common. This temporal variation in species composition could have been brought about by the changes in intensity and the types of anthropogenic activities in the watershed of the lake. The increased perturbation of the lake ecosystem, including toxic pollutants (Adeogun et al., 2015) and nutrient enrichment (Ayoade et al., 2019), has been reported by various researchers: these could have led to colonisation by resistant/tolerant species. Similarly, Albert and Minc (2004) reported an increase in growth of several species of aquatic macrophytes in Great Lake due to nutrient enrichment including *Typha* spp., *Phragmateis australis*, and *Lemna*, *Ceratophyllum demersum* that are also found in Eleyele Lake. Various researchers, including Jeffries and Mills (1990) and Zimmels et al. (2007), indicated that eutrophic waters are those which show signs of excess nutrient loading with associated changes in flora/macrophyte communities and fauna. According to Ayoade et al. (2019), Eleyele Lake was in hypereutrophic condition and this may have favoured the excessive growth of the floating and emergent plants that occurred during this study period. Portielje and Roijackers

(1995) also indicated that in temperate climate zones, dense beds of duckweeds (Lemnaceae) and small floating water ferns (Azollaceae) are a symptom of high-nutrient loading in ponds and canals. Finlayson et al. (1986) and Kadlec (1990) stated that emergent species including various annual species, cattail, and common reed often dominate enriched wetlands. Scheffer et al. (2002) concluded that nutrient control may be an important strategy to reduce the risk of invasion by native or exotic floating plants. According to Marie et al. (2015), *Eichhornia crassipes*, *Echinochloa* sp. (Water grass), and *Lemma gibba* were the most dominant aquatic plants in some streams with high nutrient concentration in the Egyptian governorates. The depth and nutrient enrichments (mostly phosphate) are the dominant drivers of macrophyte abundance in the lake as indicated by the result of CCA. This corroborates the polluted status of Eleyele Lake by nutrient enrichment.

Macroinvertebrates

In the Ona River, Andem et al. (2013) similarly encountered only the three phyla observed in this study; however, Arthropoda were more abundant in the river contrary to Mollusca in the lake. Similarly, phylum Mollusca had the highest number of taxa in both the Ona River and Eleyele Lake. The dominant mollusc reported by Ajani et al. (2020) in Eleyele Lake was *Melanoides tuberculate*, which differed from *Biomphalaria pfefferi* (a snail that transmits disease to humans) encountered in the present study. The Shanon-Weiner's diversity index obtained (1.451–1.665) was in a poor ecological status as indicated by Plotka et al. (2009). Raphahlelo et al. (2022) also corroborated it by stating that the diversity >1 was an indication of moderate pollution in the Mohlaptisi River, South Africa. The polluted status of Eleyele Lake is due to the ongoing anthropogenic activities in the catchment area that led to an influx of diverse pollutants. Furthermore, pollution-tolerant species including *Melanoides tuberculata* and *Chiromonus larvae* being dominant species among the macrobenthic fauna indicated the perturbed state of the lake.

The result of the CCA showed the abundance of *Chironomus* larvae being patterned by dissolved oxygen and nutrient factors (phosphate, nitrate, and sulphate) particularly in station 2. This further confirmed the polluted status of Eleyele Lake, especially by nutrient enrichment.

CONCLUSIONS

The dominant macrophytes and benthic macroinvertebrates in Eleyele Lake are pollution-tolerant species, and the lake has been impacted by nutrient enrichment.

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MAKROFITŲ IR BENTOSO MAKROBESTUBURIŲ SUDĖTIS, PASISKIRSTYMAS IR ĮVAIROVĖ ELEYELE EŽERE (PIETVAKARIŲ NIGERIJA)

Santrauka

Eleyele ežeras yra gyvybiškai svarbus buitiniam vandens tiekimui ir žuvininkystės ištekliams Ibadane (Pietvakarių Nigerija), tačiau aplink jį intensyvėjanti žmonių veikla turi įtakos vandens kokybei. Šiame tyrime pateikiama informacija apie makrofitų ir bentoso makrobestuburių (vadinamųjų bioindikatorių) sudėtį atsižvelgiant į fizinius ir cheminius Eleyele ežero parametrus. Vanduo, makrofitai ir bentoso makrobestuburiai buvo renkami iš keturių stočių kas mėnesį nuo 2021 m. kovo iki rugpjūčio mėn. ir analizuojami standartiniais metodais. Ryšys tarp fizinių ir cheminių savybių, makrofitų ir bentoso makrobestuburių gausos buvo ištirtas naudojant CCA. Aptikta 19 rūšių makrofitų iš 16 genčių ir 12 šeimų (11 iškylančių, 6 plūduriuojančios ir 2 panirusios). Gausiausia rūšis, rasta 2-oje stotyje, ‑ *Ipomea aquatica* (25,83 %), o 1-oje stotyje – *Sacciolepsis africana* (19,19 %). Iš viso buvo aptikti 282 bentoso makrobestuburių individai, priklausantys trims tipams, keturioms klasėms, 11 genčių ir 11 rūšių. Visose mėginių ėmimo stotyse taršos indikatorių rūšys, įskaitant *Melanoides tuberculata*, *Biomphalaria pfeifferi* ir *Chironomus* lervas, buvo dominuojančios. Tyrimo rezultatai rodo, kad makrofitų gausa koreliuoja su gyliu ir maistinėmis medžiagomis (daugiausia fosfatais), *Chironomus* lervų gausa priklauso nuo ištirpusio deguonies ir maistinių medžiagų (fosfatų, nitratų ir sulfatų).

Raktažodžiai: makrofitai, bentoso makrobestuburiai, tarša, fizinės ir cheminės savybės