Assessing Water Quality and Macroinvertebrate Assemblage of Ahi River, South-East Nigeria

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Abstract

Natural processes and increasing anthropogenic activities have negatively affected ecosystem health of lotic systems globally. Macroinvertebrate assemblage of a rural river was assessed in relation to anthropogenic stressors and water quality. The study was carried out during the wet season (May-October 2023) in 3 stations with standard protocols. Twelve (12) physicochemical parameters (temperature, flow velocity, transparency, depth, pH, electrical conductivity, total dissolved solids, turbidity, dissolved oxygen, biochemical oxygen demand, phosphate, and nitrate) were evaluated in association with the macroinvertebrates. The parameters were within acceptable limits except for some pH and dissolved oxygen values. The physicochemical parameters were majorly influenced by rainfall rather than anthropogenic activities. Fourteen (14) macroinvertebrate species and 226 individuals were recorded. The assemblage was poor, dominated by tolerant species, with Mollusca (*Bulinus wrighti*) being the most abundant species. The biodiversity indices were low: Shannon-Weiner diversity index (1.114-1.435), Margalef Species Richness Index (1.188-2.217), and Evenness index (0.3705-0.6997) confirmed the status of aquatic biota in the river. It can be concluded that there may be some stressors of possible human or natural sources acting on the environment which were not captured by the physicochemical parameters. This emphasized the need to combine physicochemical assessment with biomonitoring.

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Introduction

Rivers are naturally occurring freshwater bodies that empty into lakes, the ocean, and other rivers (Erõs and Lowe, 2019). River ecosystems are beneficial to humanity in many ways, including supplying food and water, regulating the climate, and acting as recreation areas. However, human activities like mining, industrial processes, agriculture, the generation of domestic waste, and urbanization contribute significantly to the pollution of aquatic ecosystems. These activities change the physicochemical condition and community structure of aquatic species, including macroinvertebrates (Anyanwu and Umeham, 2020; Odo *et al.,* 2023; Arimoro *et al.,* 2025).

Aquatic macroinvertebrates, which are usually large and visible to ordinary eyes, are important components of the aquatic ecosystem. (Hauer and Resh, 2017). The health of aquatic environments is reflected in the community structure of aquatic macroinvertebrates (Jonah *et al.,* 2020; Qiqi *et al*., 2023). Clean rivers and streams with well-oxygenated water are home to the highest diversity of macroinvertebrates. On the other hand, the diversity and composition of aquatic ecosystems affected by local environmental conditions, including pollution or other manmade influences, is reduced (Morán-Ordóñez *et al*., 2015; Stenert *et al.,* 2019).

Consequently, macroinvertebrates have been extensively used globally for the determination of aquatic ecosystem health. Macroinvertebrates possess some advantageous characteristics which include universality, difference tolerance capacity, and cheap and easy sampling that have contributed to their use in biomonitoring (Tampo *et al*., 2021). They are also linked to a variety of substrates, including detritus, macrophytes, mineral deposits, and filamentous algae (Anyanwu and Jerry, 2017).

Benthic macroinvertebrates have been used in a number of lotic environment studies for biomonitoring and aquatic ecosystem health assessment due to their potential for long-term anthropogenic impact monitoring programmes (Arimoro *et al.,* 2015; Anyanwu *et al*., 2019; Sumudumali *et al*., 2021; Sabha *et al*., 2022).

Generally, most research on Nigerian lotic systems has been focused on large rivers (Anyanwu and Umeham, 2020; Odo *et al.,* 2023). However, small, rural rivers like Ahi have been found to harbor rich diversity of aquatic biota and/or subjected to intense anthropogenic pressures, but have received much less attention (Anyanwu *et al*., 2021)**.** Ahi River is a rural freshwater body located in Ohiya Community, Umuahia. The river is used for several purposes, particularly in the dry season. Hence, the objective of this study is to evaluate macroinvertebrate community structure in relation to anthropogenic stressors and water quality.

Materials and Methods

Study Area

The study was carried out in Ahi River located in Ohiya Community, Umuahia, Abia State, Nigeria (Figure 1). The area falls within the sub-equatorial zone, characterized by high temperatures (29 - 31°C), high relative humidity (over 70%), and an annual mean rainfall of about 4000 mm. The study area is under the influence of two seasons—the wet season that usually occur between May and October, and the dry season from November to April. A double maximam peak period of rainfall usually occurs between July and September, with a short period of reduced rainfall in August known as the "August break".

Station 1 (N5° 31' 44.91984", E7° 27' 23.61672") was located upstream, and its substrate was a mix of sand, stones, and debris from improperly disposed solid waste. Human visitation and activities were higher due to its location by the road. Observed human activities included laundry and traditional religious activities. Storm water from parts of the community discharged into the river just upstream of Station 1.

Station 2 (N5° 31' 36.68664", E7° 27' 26.61672") was 0.97 km downstream of Station 1, and the sediment was sandy. There was rich riparian vegetation around the station. The entrance of the station had been increasingly used as a solid waste dump, with leachates from the dump being released into the river especially after rains. Human activities here include sand mining, bathing, washing, and food processing.

Station 3 (N5° 31' 53.2452" E7° 27' 13.87944") had a muddy stream bottom and was located in a deep valley, about 1.83 km downstream of Station 2. Riparian vegetation was also sparse. Bathing and washing were the few human activities observed around the station. Additionally, effluents from some cottage industries (oil palm processing mill, cassava processing mill, and pig farm) are discharged into the river around the station.

Samples collection

Water samples and analyses

The water sampling was carried out once every month from May to October 2023. The water samples for physicochemical analysis were collected using a 1 litre water sample and transferred into 1 litre plastic bottles, while samples for biochemical oxygen demand were collected with 250 mL reagent bottles with glass stoppers. All samples collected were transported in an ice-filled chest to the laboratory for analysis. Water temperature, dissolved oxygen, electrical conductivity,

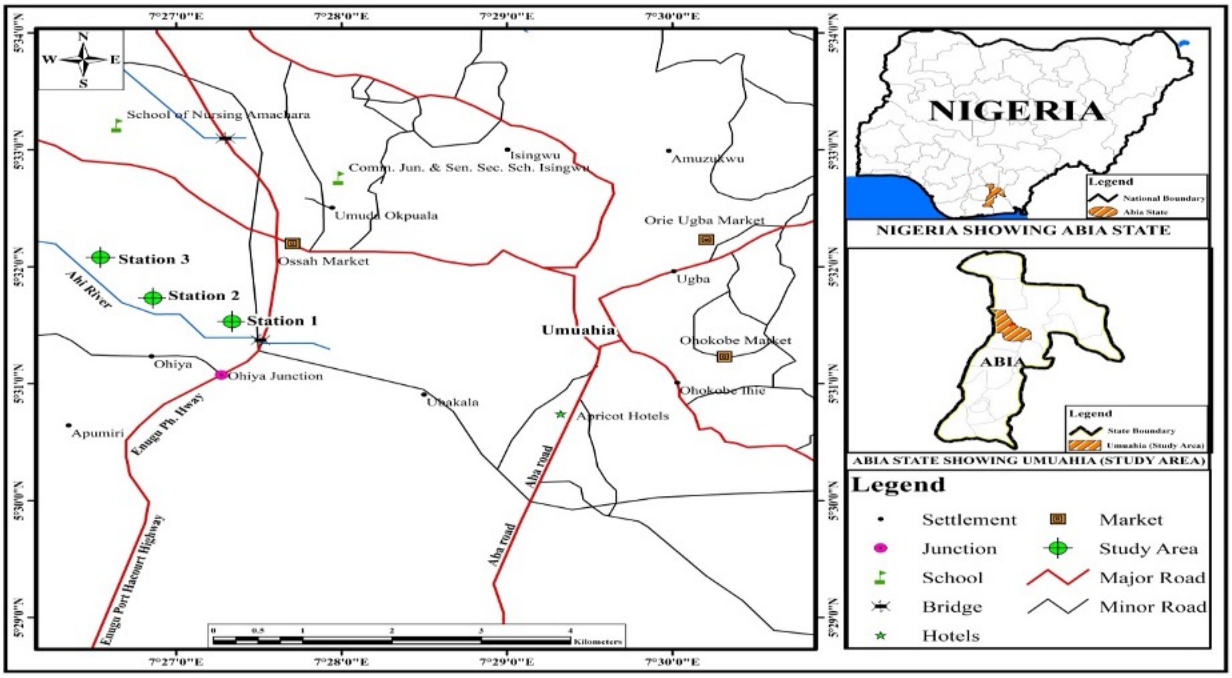

Figure 1: Map of Ohiya Community, Umuahia, Abia State, Nigeria showing the sampling stations in Ahi River

pH, total dissolved solids, flow velocity, transparency, turbidity, and maximum depth were determined *in-situ,* while biochemical oxygen demand, phosphate, nitrate-nitrogen were determined in the laboratory based on AWWA (2017) methods (Table 1).

Macroinvertebrates samples

Macroinvertebrate samples were collected in each of the stations with water samples. The D-net was placed in the downstream and the sediment upstream was disturbed by kicking with the heel for about 5 minutes, and the dislodged organisms were washed into the net. Aquatic macrophytes within the river and around the banks were also disturbed against the current with a sweep net. The samples were preserved with 10% formalin and taken to the laboratory for identification

Table 1: The physical-chemical parameters evaluated and methods of determination

Parameter	Method/Measuring Equipment	Note
Water Temperature	Mercury-in-glass Thermometer	*In-situ*
pH	Jenway 550 Portable pH meter	*In-situ*
Total Dissolved Solids/ Electrical Conductivity	HACH CO. 150 TDS/ Conductivity Meter	*In-situ*
Turbidity	Jenway 6035 Portable Turbidimeter	*In-situ*
Dissolved oxygen	DO meter	*In-situ*
Biochemical Oxygen Demand	Titrimetric Method - Winklers Method (Azide Modification)	*Ex-situ*
Transparency	Secchi Disk	*In-situ*
Flow Velocity	Floatation Method	*In-situ*
Phosphate	Titrimetric Method (Stannous Chloride Method)	*Ex-situ*
Nitrate	UV Spectrophotometric Method	*Ex-situ*
Maximum Depth	Graduated Wooden Pole	*In-situ*

and counting. The identification was carried out using the following taxonomic materials: Willoughby (1976), Merritt and Cummins (1996), and Umar *et al.* (2013).

Statistical Analyses

All data were summarized with Microsoft Excel. One-way Analysis of Variance (ANOVA) was used to determine significant variations (P <0.05) in the spatial mean values of physicochemical parameters, while the Tukey pairwise post-hoc test was used to locate the source of significant difference. Biodiversity indices Shannon-Wiener index (H), Margalef index (d), and evenness index (E) were used to characterize the diversity and determine the ecosystem health of the river.

Results

Spatio-temporal variations of physiochemical parameters

The physicochemical parameters are presented in Table 2. The water temperatures were moderate (25.2–27.0°C). The lowest value was recorded in Station 2 (June 2023) and the highest values in Stations 1 and 2 (May 2023). Station 3 consistently had low values. The flow velocity values were moderate (0.15–0.46 m/s). The lowest and highest values were recorded in August 2023 and October 2023 respectively in Station 1. The water transparency was moderate (14.0-78.5cm). The lowest and highest values were recorded in Station 2 in October 2023 and June 2023.

Table 2. Summary of physiochemical parameters of Ahi River (with range in parenthesis)

Parameters	Station 1 X±SEM	Station 2 X±SEM	Station 3 X±SEM	P- Value	NESREA 2011*
Water Temperature (°C)	26.3±0.17 (25.9-27.0)	26.1±0.25 (25.2–27.0)	25.9±0.07 (25.6–26.0)	F = 0.96 P > 0.05	-
Flow Velocity (m/s)	0.35±0.03^{a} (0.27–0.46)	0.31±0.04^{a} (0.15–0.41)	0.24±0.01^{b} (0.22–0.28)	F = 4.27 P < 0.05	-
Transparency (cm)	49.62±6.44 (17.5–57.5)	49.12±9.96 (14.0–78.5)	45.58±6.34 (15.0–54.0)	F = 0.08 P > 0.05	-
Depth (cm)	63.0±6.62 (54.5-96.0)	83.1±4.67 (65.0-96.0)	61.8±8.65 (51.0–105.0)	F = 3.05 P > 0.05	-
pH	6.85±0.31 (5.7–7.8)	6.85±0.32 (5.7–7.7)	6.81±0.87 (5.6–7.7)	F = 0.00 P > 0.05	6.5-8.5
Elect. Conductivity (µS/cm)	80.33±4.48 (66.0-98.0)	81.66±3.24 (72.0-92.0)	80.0 ± 2.68 (70.0–88.0)	F = 0.06 P > 0.05	-
Total Dissolved Solids (mg/l)	40.17±2.24 (33.0-49.0)	41.00±1.57 (36.0-46.0)	40.17±1.42 (35.0–44.0)	F = 0.07 P > 0.05	-
Turbidity (NTU)	0.88±0.12 (0.3–1.1)	0.80±0.20 (0.2–1.7)	0.65±0.17 (0.1–1.4)	F = 0.47 P > 0.05	5
Dissolved Oxygen (mg/l)	3.93±0.29 (3.2 – 5.2)	3.97±0.30 (3.4–5.2)	4.80±0.38 (3.8–6.4)	F = 0.40 P > 0.05	> 6
Biochemical Oxygen Demand (mg/l)	1.77±0.26 (1.0–2.6)	1.97±0.17 (1.5–2.4)	2.2±0.23 (1.2–2.7)	F = 0.97 P > 0.05	< 3
Phosphate (mg/l)	0.03±0.00 (0.02–0.04)	0.02±0.00 (0.01-0.03)	0.02±0.00 (0.01 – 0.03)	F = 0.62 P > 0.05	3.5
Nitrate (mg/l)	0.05±0.00 (0.03–0.8)	0.05±0.00 (0.03–0.6)	0.04±0.00 (0.02–0.05)	F = 0.72 P > 0.05	9.1

Means with different superscripts in the same row are significantly difference at P < 0.05; SEM - Standard Error of Mean; *Guidelines and Standards for Environmental pollution control in Nigeria, Nigeria Environmental Standard and Regulatory Enforcement Agency (NESREA).

The water depth values were also moderate (51.0–105.0cm). The lowest and highest values were recorded August 2023 and October 2023 respectively in Station 3. The pH was moderate acidic to slight alkaline (5.6–7.8). Most of the values were within the optimal water pH (6.5–8.5) for freshwater organisms set by NESREA (2011). The lowest value was recorded in Station 3 (June 2023), while the highest was in Station 1 (September 2023).

The electrical conductivity values (66.0–98.0 µS/cm) and Total Dissolved Solids (33.0–49.0 mg/l) were also moderate and exhibited similar trend. The lowest value was recorded in Station 1 (August 2023), while the highest was in May 2023.

The turbidity values were low (0.1–1.7 NTU) and well within the acceptable limit (5 NTU) set by NESREA (2011). The lowest value was recorded in Station 3 (June 2023), while the highest recorded was in Station 2 (August 2023).

The Dissolved Oxygen (DO) values (3.2–6.4 mg/l) were generally lower than acceptable limit (6 mg/l) set by NESREA (2011) except one (Station 3, June 2023). The lowest and highest values were in Station 3 in October 2023 and June 2023 respectively.

Biochemical oxygen demand ranged from 1.0 to 2.7 mg/l and within the acceptable limit (3.0 mg/l) set by NESREA (2011). The lowest value was recorded in Station 1 (June 2023) while the highest was in Station 3 (June 2023).

The concentrations of phosphate were 0.01–0.04 mg/l and within the acceptable limit (3.5 mg/) set by NESREA (2011). The highest value was recorded in Station 1 (September 2023) while the lowest values were in Station 3 between June and July 2023 respectively.

On the other hand, nitrate ranged from 0.02 to 0.8 mg/l and within the acceptable limit (9.1 mg/l) set by NESREA (2011). The highest value was recorded in Station 1 (May 2023), while the lowest was in Station 3 (October 2023).

Macroinvertebrates Composition and Diversity

The composition, abundance, and distribution of Macroinvertebrates recorded in Ahi River are presented in Table 3. A total of 226 individuals were recorded from 3 phyla, 11 families and 14 taxa (species). The most abundant phylum was Mollusca with 173 individuals, contributing 76.6% of the total macroinvertebrates recorded. This is followed by Arthropoda with 43 individuals (19.02%), and the least was class Malacostraca with 10 individuals (4.42%). Most of the species recorded were pollution-tolerant species. The most abundant species was *Bulinus wrighti* (129 individuals, 57.1%), while the least was *Macrobrachium macrobrachion* (1, 0.44%). Among the stations, the highest number of individuals was recorded in Station 2 (91) while the least was recorded in Station 1 (67).

Biodiversity Indices

The macroinvertebrates community structure is presented in Table 4. The number of taxa (species) ranged from 6 (Station 1) to 11 (Station 2) and the number of individuals followed the same trend—67 individuals (Station 1) to 91 individuals (Station 2). The biodiversity indices were low. The Shannon-Weiner diversity index was low and ranged between 1.114 and 1.435. The lowest value was recorded in Station 3, while the highest was recorded in Station 1. The Margalef species richness index was also low and ranged between 1.188 and 2.217. The lowest was recorded in Station 1 while the highest was in Station 2. The Evenness index values were also low and ranged between 0.3705 and 0.6997. The lowest value was recorded in Station 2 while the highest was recorded in Station 1.

Discussion

The physicochemical parameters were moderate or within the acceptable limits to support aquatic life, except for pH and dissolved oxygen. The variations in stations

Table 3. Composition, abundance and distribution of Macroinvertebrates

Phylum/Class	Order/Family	Species	Stn 1	Stn 2	Stn 3	Total	R.A. (%)
Mollusca Gastropoda,	Hygrophila Planorbidae	*Bulinus wrighti*	27	57	45	129	57.1
		Bulinus globosus	22	9	2	33	14.6
	Architaenioglossa Viviparidae	*Viviparus fasciatus*	0	0	11	11	4.9
	Subtotal		**49**	**66**	**58**	**173**	**76.6**
Arthropoda Insecta	Ephemeroptera Baetidae	*Baetis* sp. *larvae*	4	0	0	4	1.77
	Caenidae	*Caenis luctuosa*	0	4	0	4	1.77
		Caenis horaria	0	1	0	1	0.44
	Potamanthidae	*Potamanthus luteus*	0	1	0	1	0.44
	Odonata Libellulidae	*Libellula* sp *larvae*	7	1	0	8	3.54
	Coleoptera Haliplidae	*Haliplus immaculicollis*	5	8	0	13	5.75
	Diptera Tabanidae	*Tabanidae larvae*	0	4	0	4	1.77
	Plecoptera Leuctridae	*Leuctra hippopus*	0	3	1	4	1.77
	Plecoptera Perlidae	*Paragnetina fumosa*	0	2	2	4	1.77
	Subtotal		**16**	**24**	**3**	**43**	**19.02**
Malacostraca	Decapoda Palaemonidae	*Macrobrachium rosenbergii*	2	1	6	9	3.98
		Macrobrachium macrobrachion	0	0	1	1	0.44
	Subtotal		**2**	**1**	**7**	**10**	**4.42**
Grand Total			**67**	**91**	**68**	**226**	**100**

Table 4. Macroinvertebrates Community Structure

Index	Station 1	Station 2	Station 3
Taxa	6	11	7
Individuals	67	91	68
Shannon-Weiner Index	1.435	1.405	1.114
Evenness Index	0.6997	0.3705	0.4351
Margalef Species Richness Index	1.189	2.217	1.422

and months were probably influenced by season (rainfall) rather than human activities. There were no significant differences ($p > 0.05$) in all the parameters evaluated across the stations, except flow velocity.

The water temperatures were moderate and consistent with values commonly recorded in tropical waterbodies and/or adapted to by most tropical aquatic organisms (Amusan *et al*., 2024; Arimoro *et al.,* 2025). The lowest value recorded in Station 2 (June 2023) could be a result of the onset of the wet season, while the highest values in Stations 1 and 2 (May 2023) could be due to the effect of the late dry season. The consistently low values recorded in Station 3 were due to the location and time of sampling. Station 3 was located in a deep valley, which could reduce the intensity of the sun reaching the water, and secondly sampling always started from station 3 early in the morning throughout the study. The values were within 21.0–28.0 °C recorded in Ossah

River in the same watershed (Anyanwu *et al.,* 2019). Water temperature is one of the main abiotic factors affecting the structure and functioning of aquatic ecosystems and its alteration can have important effects on biological communities (Bonacina *et al.,* 2023).

The flow velocity values were moderate and lower than 0.21–0.85m/s recorded in Eme River, Umuahia by Anyanwu *et al.* (2022a). The lowest and highest values recorded in August 2023 and October 2023 respectively in Station 1 could be due to rainfall. August is period of reduced rainfall ("August Break") while October is known for intense rainfall. Flow velocity generally increases with rainfall (Koushali *et al*., 2021). Lower flow velocities recorded in Station 3 could be due to its downstream position, while Station 1 was located at a higher gradient. Water flow in a river is usually slower towards its mouth and causes sediment—solid material carried downstream by currents—to settle to the river bottom (Douglas *et al*., 2025), leading to muddy substrate as observed in Station 3. During extreme high flows, river macroinvertebrates may be swept downstream in large numbers (Stamp *et al*., 2020; Asmamaw *et al*., 2021) as reflected in the lower abundance recorded in Station 1.

The water transparency values were also moderate with the lowest and highest values recorded in station 2 in October 2023 and June 2023 attributed to rainfall. The lowest in October was caused by dirt and other debris introduced into the river during the intense rainfall while the highest in June was just after the onset of wet season with cleaner runoff. Other stations also recorded low values in October 2023. Lower transparency is likely to negatively affect primary productivity, resulting in less secondary growth of benthic macroinvertebrates (Shimba *et al*., 2018).

The water depth values were also moderate, with the lowest and highest values recorded in Station 3 (August 2023 and October 2023 respectively), attributable to rainfall. Reduced rainfall was observed in August due to the August break, while October is one of the high periods of rains in the region. Though Station 2 consistently had higher values throughout the study, higher macroinvertebrate abundance are usually associated to riparian areas of rivers due to habitat availability, light penetration, and nutrient cycling and availability of food (Powell *et al*., 2023).

The pH values ranged between moderate acidic and slight alkaline range, with most values within the optimal water pH (6.5–8.5) for freshwater organisms set by NESREA (2011). The lowest and highest values recorded in Station 3 (June 2023) and Station 1 (September 2023) respectively were influenced by rainfall. Acidic values below the acceptable limits were recorded before the onset of the wet season and in early wet season (May and June 2023), and increased with the rains. The 3 stations had lower acidic values in June 2023; this is attributable to a rainfall event recorded on sampling day. Release of organic and inorganic substances into the river due to runoff during rainfall could lower the pH (Ojok *et al*., 2017). On the other hand, the pH generally increased with the rains in all the stations; attributable to dilution. Increased runoff tends to dilute solute concentrations and in turn increases the pH of a river during the wet season (Huang *et al*., 2020). The values were higher than 4.6–6.3 recorded in Ossah River, Umuahia within the same watershed (Anyanwu *et al*., 2019). pH levels can significantly affect macroinvertebrate survival, community structure, and diversity, with extreme highs or lows acting as stressors to organisms and changing their physiology (Dou *et al.,* 2022).

The electrical conductivity and Total Dissolved Solids were also moderate and exhibited a similar trend, suggesting relatively low salt contents in the water. Higher electrical conductivity values (52.9–110.5 μS/cm) and total dissolved solids values (25.7–55.3) were recorded in Ossah River, Umuahia (Anyanwu *et al.,* 2019). The lowest value recorded in Station 1 (August 2023) could be due to dilution, while the highest in May 2023 could be due concentration caused by the late dry season. Low rainfall and flow velocity, high temperatures, and evaporation that occur in the dry season usually result in the concentration of some parameters (Etesin *et al*., 2013). The distribution of most freshwater invertebrates is influenced by the concentration of Total Dissolved Solids (TDS) and electrical conductivity (Olson and Hawkins, 2017).

The Turbidity values were low and conformed to the acceptable limit. The lowest value recorded in Station 3 (June 2023) could be due to initial dilution caused by the early rains, while the highest recorded in Station 2 (August 2023) could be a result of the August break or allochthonous input as the rain resumed after the break. Highest turbidity values were recorded by Anyanwu *et al* (2022b) in Anya stream in Abia State, Nigeria and Akhere and Kadiri (2023) in Ikoro Stream, Edo State, Nigeria in August. Turbidity has been known to be negatively associated with macroinvertebrate communities (Forio *et al*., 2023) as they can affect transparency and primary productivity (Shimba *et al*., 2018). The Dissolved Oxygen (DO) values did not conform to the acceptable limit, except in Station 3 (June 2023). Higher values were recorded in the 3 stations in June 2023 probably due to the combined effect of more nutrients, good temperature, and transparency that could enhance photosynthesis, as well as the rainfall event on sampling day. The lowest recorded in Station 3 (October 2023) could be due to reduced transparency. Values of the same range (3.2–6.4 mg/l) were recorded in Ossah River, Umuahia (Anyanwu *et al.,* 2019). Ding *et al.* (2016) reported an abnormal macroinvertebrate assemblage dominated by pollution-tolerant groups due to low dissolved oxygen in Ziya River Basin, North China. Tolerant groups were also dominant in this study, especially gastropod molluscs.

Biochemical Oxygen Demand (BOD) values were within the acceptable limit. The lowest recorded in Station 1 (June 2023) could be due to initial dilution from early rains, while the highest value recorded in Station 3 (June 2023) could be due effluent discharge from pig farms and palm oil and cassava processing mills washed into the river by early rains. Studies have shown that effluents contribute to high biochemical oxygen demand in aquatic environment (Cao et al., 2021; Lokman et al., 2021; Izah et al., 2022). The BOD values generally increased with the rains; suggesting that more organic matter was introduced into the river. The values were lower than 2.1–4.2 mg/l recorded in Ossah River, Umuahia (Anyanwu et al., 2019). Extremely high BOD can negatively affect the macroinvertebrate composition by depleting the dissolved oxygen, leading to hypoxia and change in the community composition from sensitive to tolerant groups (Ding et al., 2016; Lee et al., 2025).

The concentrations of the nutrients were low. Phosphate conformed to the acceptable limit. The highest value recorded in Station 1 (September 2023) could be due to allochthonous input, while the lowest values in Station 3 (June and July 2023) could be due to dilution. Phosphate values increased with the rains, suggesting addition through runoff. Nitrate values also conformed to the acceptable limit. The highest value was recorded in Station 1 (May 2023) while the lowest was in Station 3 (October 2023). Nitrate concentration decreased with rains, suggesting dilution (Griffin, 2017). The values of phosphate (0.1–2.7 mg/l) and nitrate (1.1–3.4 mg/l) recorded in Ossah River, Umuahia were higher (Anyanwu *et al.,* 2019). The low nutrient concentrations suggest low input from agricultural activities around the river. Nutrients are essential for maintaining an ecosystem's structure and function (Ouyang *et al.,* 2018).

Macroinvertebrates complement water quality assessment since they serve as crucial bioindicators for aquatic ecosystem health. They have diverse pollution tolerance levels that allow them to reflect the cumulative impact of chemical, physical, and biological disturbances in an ecosystem and integrate multiple stressors into a single biological assessment that cannot be captured by physicochemical measurements (Chen *et al.,* 2019; Arimoro *et al.,* 2025; Mureithi *et al.*, 2025) The number of Macroinvertebrates individuals (226) was higher than the 119 individuals recorded by Anyanwu et al (2019) in Ossah River in the same locality. However, the number of phyla, families and taxa were lower than 5 phyla, 19 families and 20 taxa recorded in Ossah River, Umuahia. Most of the species recorded were pollution tolerant species as observed in Ossah River. The most abundant species was *Bulinus wrighti* (mollusc). The dominance of molluscs in this study is an indication of an unhealthy ecosystem (Nugroho *et al.,* 2025). Chessman (2003) identified gastropod molluscs as a very tolerant group and indictor of disturbed environment. Being the intermediate hosts to several waterborne parasites like *Schistosoma haematobium*, their dominance points to potential public health issues in the area.

Spatially, the highest number of individuals recorded in Station 2 could be due to the rich riparian vegetation despite relatively higher mean depth (Bulto *et al*., 2026). The lowest number of individuals recorded in Station 1 could be due to higher human activities, because the location was the most easily accessible coupled with sparse riparian vegetation, substrate mixed with debris and high flow velocity (Anyanwu *et al*., 2021; 2022b; Asmamaw *et al.,* 2021; Mathers *et al*., 2024). Station 3 was difficult to access with muddy substrate and sparse riparian vegetation. However, it receives effluents from pig farming and palm oil and cassava processing mills, which could negatively affect aquatic organisms (Arimoro *et al*., 2008).

The biodiversity indices were low. All the Shannon-Weiner diversity index and Margalef species richness index values were lower than 3, which is the minimum value for a stable or undisturbed environment as observed in nearby Ossah River (Anyanwu *et al*., 2019). An ecosystem is considered stable and balanced when the values of these indices are higher than 3 (Türkmen and Kazanci, 2010).

The Evenness index values were also low (<0.7) and were well below 1, the maximum for the index. The lowest value recorded in Station 2 was an indication of the dominance of one species (*Bulinus wrighti*). The low diversity as reflected in the Margalef, Shannon-Wiener and Evenness indices was due to the low number of species and individuals recorded in the study, which could be attributed to environmental disturbances caused by human and natural events. However, these impacts were not reflected in the physicochemical parameters evaluated. Macroinvertebrates can integrate changes over time, reflecting the cumulative effects of environmental conditions and human activities in their diversity and community structure because of their sedentary nature (Gouissi *et al*., 2019; Kengne Fotsing *et al*., 2022).

Conclusion

This study showed that all the physicochemical parameters evaluated were moderate or within acceptable limits to support aquatic life, except for some pH and dissolved oxygen values. Rainfall was the major influence on the physicochemical parameters, rather than anthropogenic activities. However, the macroinvertebrate assemblage was poor and dominated by pollution indicators, especially gastropod molluscs, which are indicators of disturbed environment. This was confirmed by the low values recorded in the biodiversity indices. It can be concluded that there may be some stressors of possible human or natural sources acting on the environment which were not captured by the physicochemical parameters. This emphasizes the need to combine physicochemical assessment with biomonitoring.

Conflict of Interest

The authors hereby state that this research work and manuscript production complied with ethical standards, and none of the authors has any potential conflict of interest. We further declare that this research was not funded by any agency.

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