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Original Article

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Benthic Macroinvertebrates as Indicators of Water Quality and Ecological Health in a Tropical Lake, Southern Nigeria

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ABSTRACT. This study assesses the community structure and diversity of benthic macroinvertebrates in Ozomu Lake, Southern Nigeria, to evaluate the water quality and ecological health. Sampling was conducted twice monthly from March to August 2020, at three stations using bottom sediment grabs and bank-root zone sampling. A total of 23 taxa and 427 individuals were recorded. Diptera (25%) and Odonata (22%) were the most abundant, followed by Coleoptera (18%) and Ephemeroptera (12%). In terms of diversity, the stations were ranked as follows: Station 2, Station 1, and Station 3. The Shannon-Wiener index indicated that Station 2 had the highest species diversity (2.896), followed by Station 1 (2.828) and Station 3 (2.472). Pielou's Evenness index revealed that Station 2 had the most even distribution of species (0.7871), while Station 1 had the lowest (0.6235). Pollution-sensitive taxa at station 1 comprised 40.8% of the benthic fauna (58 individuals), indicating relatively good water quality. Moderately tolerant taxa represented 28.9% (41 individuals), while pollution-tolerant taxa accounted for 30.3%. Station 2 recorded similar results for pollution-sensitive taxa at 40.3% (52 individuals). However, moderately tolerant taxa dominated this station, making up 41.1% (53 individuals), with pollution-tolerant taxa at only 18.6%, suggesting lower environmental stress. Pollution-tolerant taxa predominated at 40.4% at station 3 (65 individuals), indicating greater environmental disturbance. Moderately tolerant taxa constituted 33.5%, while pollution-sensitive taxa were reduced to 26.1%, reflecting the most stressed environment among the stations. Overall, the lake's ecological health appears stable, but localized stressors may require targeted management.

Keywords: Benthic macroinvertebrates, Pollution tolerance, Bioindicators, Species diversity, Ozomu Lake

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1. Introduction

Freshwater ecosystems are increasingly threatened by anthropogenic activities, which pose significant risks to their biodiversity and ecological processes essential for human well-being (Meng et al., 2016; Niba and Sakwe, 2018). Among these ecosystems, lakes are particularly vulnerable due to their role in collecting runoff and pollutants from their catchments. Assessing and monitoring the health of these aquatic systems is crucial for sustainable management and conservation efforts. Understanding the structure and composition of benthic communities in lakes is imperative for assessing ecosystem health and water quality (Gawad, 2019).

Benthic macroinvertebrates fauna (often referred to as benthic fauna, bottom fauna, zoobenthos or benthic macrofauna) are visible to the unaided eye and frequently used to assess water quality in freshwater ecosystems. (Osuinde and Olomukoro, 2023). They are usually defined as aquatic organisms that live in, crawl or attached to stones or other submerged objects or to the bottom substrate of a body of water and are retained by a net of sieve with an aperture of 0.6mm 'a smaller aperture of 0.25mm may be necessary for special purposes, to ensure the capture of early instars' (Olomukoro and Ezemonye, 2000). Benthic macro-invertebrates are most commonly used tool in biomonitoring (Olomukoro and Osuinde, 2015; Fekadu et al., 2022).

Benthic Macroinvertebrates forms an integral part of an aquatic environment and are of ecological and economic importance (Raphahlelo et al., 2022). They also play a key role in mineralization of organic matter and serve as food for economically important fish and shellfish species in most aquatic environments (Min et al., 2019). The relative stability of benthic com-

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munities and their sensitivity to changes in the aquatic environment have made many species as bio-indicators of water quality (Gawad, 2019; Jonah et al., 2022). Their long larval life cycles allow studies conducted by aquatic ecologists to determine any decline in environmental quality (Ajao and Fagade, 2002).

Benthic characteristics can reveal sites subject to chronic pollution. The diverse assemblage of invertebrate organisms inhabiting the bottom sediments of aquatic ecosystems play a crucial role in maintaining ecological balance and supporting the functioning of freshwater environments (Raphahlelo et al., 2022). The health and sustainability of aquatic ecosystems are facing unprecedented challenges due to anthropogenic activities (Andem et al., 2012). They integrate the effects of various stressors over time, reflecting both short-term and long-term impacts on the ecosystem. Their limited mobility and close association with sediments make them susceptible to contaminants, habitat degradation. By monitoring the responses of benthic macroinvertebrates to pollution, scientists can assess the severity of environmental stressors and develop strategies for mitigating their impacts on aquatic ecosystems (Hakobyan and Jenderedjian, 2016). They also influence sediment characteristics and water quality through their burrowing, feeding, and other activities (Azrina et al., 2006).

In tropical regions, particularly in developing countries like Nigeria, there is a pressing need for robust bioassessment tools to monitor freshwater ecosystems. Despite the ecological significance of these regions, studies on the use of benthic macroinvertebrates as bioindicators in lakes remain limited. This gap in research is especially pronounced in tropical lakes, where unique environmental conditions may influence macroinvertebrate communities differently compared to other freshwater systems.

This study aims to investigate the community structure and diversity of benthic macroinvertebrates in a tropical lake in Southern Nigeria, thereby providing critical insights into the water quality and ecological health of the lake. The findings from this study will enhance the understanding of the ecological dynamics in tropical freshwater ecosystems and inform management practices aimed at preserving these vital resources.

2. Materials and methods

2.1. Study area

Ozomu Lake, located within Ozomu Village in the southern Nigerian rainforest region of Edo State, is a small water expanse positioned between latitude 5°26'9"E and longitude 6°15'3" N (Fig. 1). The lake primarily receives water from groundwater sources, with additional runoff during the rainy season. To retain water during the dry season, artificial structures such as small earthen dams and levees have been constructed around the lake. These structures are designed to manage water levels, preventing excessive drainage during dry periods and ensuring a consistent aquatic environment. The presence of these artificial structures could influence the benthic fauna by altering the natural hydrological and sedimentation patterns of the lake.

In addition, sediment analysis revealed that the mean total organic carbon for the lake is 3.89 g/kg, while the total organic matter is 6.72 g/kg. The sediment composition was predominantly sandy, with mean percentages of 82.90% sand, 10.80% clay, and 6.31% silt (Olomukoro and Enabulele, 2024).

The region experiences a tropical climate, with average temperatures ranging between 25°C and 28°C, depending on the season. The southern parts of the state have a humid tropical climate, while the northern parts

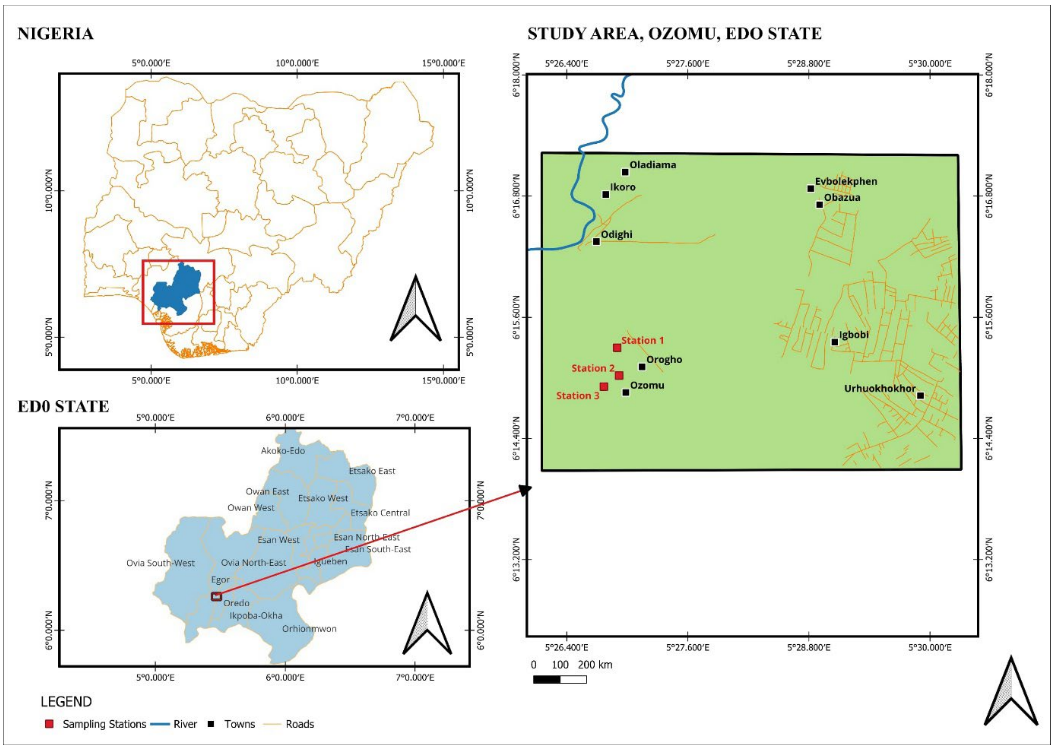

Fig.1. Map of Study area showing the three stations sampled during the period of study

have a sub-humid climate. April is the warmest month with an average temperature of 27.5°C, while July is the coldest with an average of 24.5°C. Precipitation is lowest in January, with only 9mm, and highest in September, with an average of 338mm.

2.2. Sampling stations

For sampling purposes, three locations were chosen based on their accessibility and water availability. These stations provide valuable insights into the ecological dynamics of Ozomu Lake and help assess the impact of human activities and natural variations on its biodiversity and water quality.

Station 1

Station 1 is located in an area with an average depth of 2.45 meters. The vegetation at this station is diverse, featuring species such as *Bambusa* sp., *Alchomelaxiflora* sp., *Azolla* sp., and *Nephrolepsis biserrate*. Additionally, there is an accumulation of decomposing organic material, which may influence nutrient levels in the lake. These plant types contribute to a complex aquatic habitat that supports a variety of organisms. Domestic activities such as bathing, washing, and traditional practices indicate significant use of the lake's resources, potentially affecting water quality and ecological balance. Station 1 also serves as a major source of water supply for local communities.

Station 2

Station 2 is located 520 meters away from Station 1, with an average depth of 3.19 meters. The vegetation at this station includes *Bambusa* sp., *Pistia* sp., *Azolla* sp., *Salvinia* sp., and *Alchomelaxiflora* sp. There is also decomposing organic material present, contributing to the nutrient dynamics of the lake. Human activities at Station 2 are more varied, involving bathing, washing, and dredging. Additionally, the influence of palm oil mill effluent (POME) and dredging activities suggests a higher level of anthropogenic impact, potentially affecting both water quality and ecological conditions.

Station 3

Station 3 is positioned 380 meters away from Station 2, with an average depth of 4.50 meters. The vegetation at this station consists of *Bambusa* sp., *Alchomelaxiflora* sp., and *Elaeis guineensis*, along with decomposing organic material. The relatively deeper water and different vegetation types suggest distinct ecological characteristics compared to the other stations. Human activities at Station 3 include bathing, washing, and the discharge of palm oil mill effluent (POME), indicating a substantial impact on the lake's environment. Dredging activities are also reported, potentially altering sediment composition and water quality at this station.

2.3. Benthic macroinvertebrates sampling and identification

For this study, benthic macroinvertebrates samples were systematically collected twice a month from March to August 2020 at three designated sampling station. This frequent sampling approach is essential for accurately assessing the community dynamics and diversity within Ozomu Lake. By sampling every two weeks, we aimed to minimize any potential bias that could arise from temporal variability in species abundance and distribution. Bottom sediment samples were collected from all sampling stations and composited in a small bucket. A 6-inch metal container, modified as a grab with extended arms to enable deeper penetration into compacted sediments, was used to manually sample the lake substratum, reaching an average depth of 3.38 meters. The area captured by the grab is approximately 0.023 square meters per sample, this design allowed for more effective collection of bottom sediment samples. Water was added to facilitate gentle hand-mixing, and the sediment slurry was separated using a 500μm mesh-size sieve. The sediment was washed through the sieve with a low-pressure stream of water to avoid damaging organisms, particularly oligochaetes. The sieve was gently agitated to rinse out fine sediment, and the slurry was sieved in small portions to prevent mesh clogging. In addition to bottom sediment sampling, macroinvertebrates were also collected from the bankroot zones and vegetation using the kicking method. This technique involved disturbing the substrate and vegetation along the lake's edges to dislodge organisms into the water column. A fine-mesh net was positioned to capture any dislodged macroinvertebrates (Olomukoro and Osuinde, 2015). The loosened organisms were collected in labeled benthic bottles and preserved in 10% formalin to maintain taxonomic features (Osuinde and Olomukoro, 2023). Each bottle was labeled with sampling details for identification. Benthic macroinvertebrates identification was conducted to the species or genus level using provided identification keys and guides (Olomukoro and Ezemonye, 2000; Gerber and Gabriel, 2002).

2.4. Statistical analysis

Statistical analysis was conducted using Microsoft Excel 2021 and Paleontological Statistics (PAST) software. Biotic indices, including, Shannon-Wiener diversity index (H), Pielou's evenness index (J'), and Simpson's dominance index (D), were analyzed using the PAST software. The total number of individuals and their corresponding percentages for various groups of benthic fauna observed in the study area were analyzed. The benthic fauna were classified into three main groups based on their tolerance to pollution and environmental disturbances: Sensitive Taxa, Moderately Tolerant Taxa, and Tolerant Taxa. Aquatic biological indicators of Benthic Macro-invertebrates based on their tolerance level as defined by the United States Environmental Protection Agency (USEPA) derived from Gawad (2019).

3. Results

3.1. Benthic macroinvertebrates community structure

The overall taxonomic composition, distribution, and abundance of Zoobenthos collected during the study period are summarized in Table 1. A total of 23 taxa and 427 individuals were recorded, including 2 species of Oligochaeta, 4 species of Odonata, 3 species of Ephemeroptera, 3 species of Hemiptera, 2 species of Coleoptera, 1 species of Trichoptera, 4 species of Diptera, 1 species of Mollusca, 1 species of Araneida, and 2 species of Decapoda. Among these taxa, Diptera accounted for 25% of the total individuals, followed by Odonata (22%), Coleoptera (18%), Ephemeroptera (12%), Decapoda (5%), Araneida (5%), Hemiptera (4%), Mollusca (4%), and Trichoptera (3%) as shown in Figure 2. Station 3 exhibited the highest species richness and individual count compared to Stations 1 and 2 (Table 1, Fig. 3).

3.2. Spatial Variation of Benthic Macroinvertebrates in Ozomu Lake

Station 1 was dominated by Diptera (35 individuals) and Ephemeroptera (26 individuals), followed by Coleoptera (22 individuals) and Odonata (19 individuals). Other groups like Trichoptera, Mollusca, Decapoda, and Araneida were present in smaller numbers, with 6 individuals each, except for Decapoda which had 13 individuals.

Station 2 exhibited the highest abundance of Coleoptera (33 individuals) and Odonata (29 individuals), followed by. However, Diptera showed a decline in this station compared to Station 1, with 15 individuals recorded. Ephemeroptera (15 individuals) and Hemiptera (9 individuals) also showed a moderate presence, while Mollusca (7 individuals), Decapoda (6 individuals) and Trichoptera (4 individuals) were relatively less abundant.

Station 3, which had the highest species richness, was characterized by a significant presence of Diptera (56 individuals), making it the most dominant group at this station. Odonata (36 individuals) and Coleoptera (32 individuals) were also prominent. In contrast, Ephemeroptera and Hemiptera were less represented, with 14 and 6 individuals, respectively. The number of Trichoptera (2 individuals) was the lowest compared to other stations, indicating spatial variation in the habitat preferences of this group.

In terms of diversity, the stations were ranked in the following order: Station 2, Station 1, and Station 3. The Shannon Weiner's index indicated that Station 2 had the highest species diversity (2.896), followed by Station 1 (2.828) and Station 3 (2.472). Pielou's Evenness index revealed that Station 2 had the most even distribution of species (0.7871), while Station 1 had the lowest (0.6235) (Table 2).

3.3. Distribution of Benthic Fauna Groups and Their Pollution Sensitivity in Ozomu Lake

The analysis of benthic macroinvertebrate communities across the three stations in Ozomu Lake revealed notable differences in the proportions of pollution-sensitive, moderately tolerant, and pollution-tol-

Table 1. Composition, distribution and abundance of Zoobenthos in Ozomu Lake

Species	Station 1	Station 2	Station 3	Total
OLIGOCHAETA				
Nais sp.	2	2	1	5
Naidium sp.	1	0	1	2
ODONATA				
Enalagma sp.	10	2	12	24
Cordulid sp.	0	3	1	4
Aeschna sp.	4	0	8	12
Libellula sp.	5	24	15	44
EPHEMEROPTERA				
Baetis bicaudatus	14	7	6	27
Cloeon simplex	5	5	5	15
Centroptilum sp.	7	3	3	13
HEMIPTERA				
Epicordulia sp.	6	5	4	15
Plea striola	0	4	2	6
COLEOPTERA				
Dytiscus marginalis	12	16	17	45
Hydrophilus sp.	8	13	6	27
Coleopteran larvae	6	4	3	13
TRICHOPTERA				
Ablabesmyia sp.	6	4	2	12
DIPTERA				
Chironomus sp.	20	10	43	73
Cricotopus sp.	5	2	2	9
Chironomus travalensis	7	3	5	15
Tanytarsus sp.	3	0	6	9
MOLLUSCA				
Lymaea natalensis	6	7	8	12
ARANEIDA				
Agyroneta aquatica	3	9	7	21
DECAPODA				
Gammarus sp.	3	4	4	11
Caridina africana	10	2	1	13
Total number of individuals	143	129	162	427
Total number of species	21	20	23	

Table 2. Diversity of Benthic macroinvertebrates in Ozomu Lake

Indices	Station 1	Station 2	Station 3
Taxa_S	21	20	23
Individuals	143	129	162
Simpson's Dominance (D)	0.0787	0.0714	0.1362
Shannon-Weiner (H)	2.828	2.896	2.472
Pielou's Evenness (J')	0.902	0.9237	0.8395

erant taxa, highlighting the ecological variability of the lake (Fig. 4).

At Station 1, benthos sensitive taxa accounted for 40.8% of the total benthic fauna, indicating relatively good water quality. This group, comprising Ephemeroptera, Trichoptera, and Coleoptera, had a combined total of 58 individuals. Moderately tolerant taxa made up 28.9% of the community, with a total of 41 individuals represented by Odonata, Hemiptera, Decapoda, and Araneida. Benthos tolerant taxa, which include Oligochaeta, Diptera, and Mollusca, constituted 30.3% of the community, reflecting the presence of species that can withstand higher levels of environmental stress.

At Station 2, benthos sensitive taxa contributed 40.3% of the total fauna, which is comparable to Station 1, with a total of 52 individuals from Ephemeroptera, Trichoptera, and Coleoptera. Moderately tolerant taxa were the dominant group at this station, accounting for 41.1% of the community, with a total of 53 individuals. Benthos tolerant taxa, on the other hand, represented only 18.6% of the total fauna, reflecting lower environmental stress at this station compared to others.

At Station 3, benthos tolerant taxa dominated the community, comprising 40.4% of the total fauna, with 65 individuals. This high percentage of pollution-tolerant species suggests that this station experiences greater environmental disturbance or pollution. Moderately tolerant taxa contributed 33.5% of the fauna, while benthos sensitive taxa accounted for 26.1%, the lowest proportion across all stations. This indicates that Station 3 has the most stressed environment, with fewer sensitive species present.

Overall, benthos sensitive taxa made up 35.7% of the total community across all stations, moderately tolerant taxa accounted for 34.9%, and benthos tolerant taxa comprised 29.0%. (Table 3). These variations in community structure reflect differing levels of environmental pressure across the stations, with Station 1 showing better water quality, Station 2 reflecting moderate environmental conditions, and Station 3 indicating higher levels of disturbance.

4. Discussion

The comprehensive investigation conducted in Ozomu Lake, Southern Nigeria, provided valuable insights into the benthic macroinvertebrate communities and the overall ecological health of the aquatic ecosystem. Through a combination of taxonomic identification, composition, abundance, diversity indices calculation, and pollution tolerance assessment, a detailed understanding of the lake's biotic integrity and water quality was achieved. The results shed light on the potential impacts of pollution on benthic communities and underscore the significance of this research for ecological conservation and environmental management. Ephemeroptera, Odonata, and Diptera were among the most abundant orders, these taxa are known to be sensitive to environmental changes and are commonly used in biomonitoring programs due to their rapid response to pollutants.

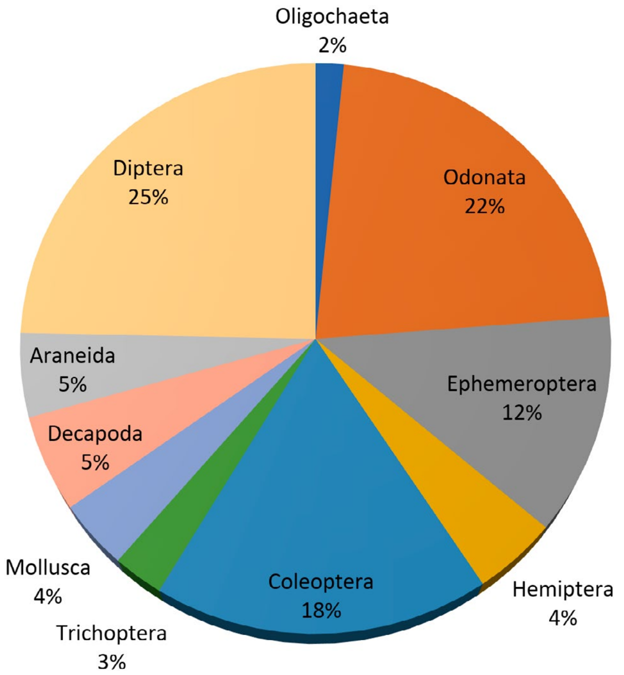

Fig.2. Percentage composition of benthic macroinvertebrates in Ozomu Lake

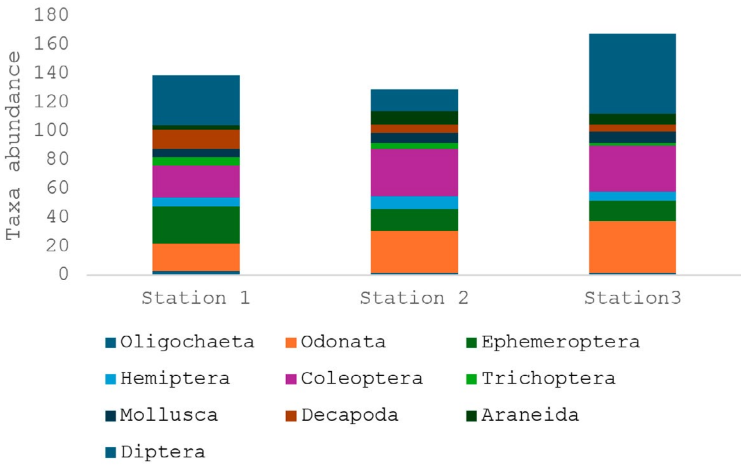

Fig.3. Total abundance of benthic macroinvertebrates per stations in Ozomu Lake

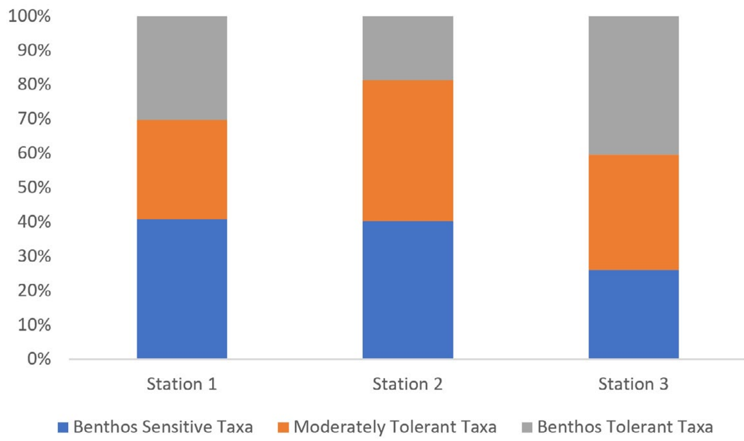

Fig.4. Comparison of Pollution Tolerance Levels among Benthic Macroinvertebrates at Different Stations in Ozomu Lake

The order Diptera was the most abundant taxon in the study, recording one family and four species: *Chironomus* sp., *Chironomus travalensis*, *Cricotopus* sp., and *Tanytarsus sp.* Among these, *Chironomus* sp. had the highest occurrence, particularly in stations 3 and 1, making it the most abundant species within this taxon. In contrast, the other species such as *Chironomus travalensis*, *Cricotopus* sp., and *Tanytarsus* sp. were present at lower densities. The dominance of dipterans could be attributed to their wide range of ecological adaptations, enabling them to thrive across varying environmental conditions (Abhilash et al., 2024).

In the order Ephemeroptera, the family Baetidae was represented by three species, including *Baetis* sp. and *Cloeon simplex*. *Baetis* sp. was notably abundant across the stations. Similarly, the order Coleoptera accounted for 19.7% of the total species abundance, comprising the families Dytiscidae and Hydrophilidae. The species *Dytiscus* sp. and *Hydrophilus* sp. were evenly distributed across the stations, with 45 and 27 individuals, respectively. The Hemiptera order included two species, *Epicordulia* sp. and *Plea striola*. *Epicordulia* sp. was most abundant in station 1, with a total of 15 individuals, while *Plea striola* was absent at station 1 and recorded only 6 individuals in total. Hemiptera accounted for 4% of the total species abundance.

The presence of *Chironomus* sp., a known pollution-tolerant species, suggests degrading water quality at certain stations (Caires et al., 2013; Olomukoro and Oviojie, 2015). Its high occurrence in stations 3 and 1 further reflects the potential impact of environmental stressors, such as organic pollution. However, despite the dominance of pollution-tolerant dipterans, the occurrence of sensitive taxa provides a contrasting indication of the lake's overall condition.

Sensitive taxa, including *Ephemeroptera*, *Trichoptera*, *Coleoptera*, and *Odonata*, were present across the study stations, indicating generally unpolluted water with low levels of organic waste (Goedkoop and Johnson, 1996; Olomukoro and Oviojie, 2015). Species such as *Baetis* sp. from the Ephemeroptera family and *Libellula* sp. from the Odonata order were widely distributed and served as indicators of good water quality. According to Olomukoro and Ezemonye (2007), Ephemeroptera is typically restricted to cool, clean aquatic environments with high dissolved oxygen content, which suggests favorable conditions in the lake.

The occurrence of Oligochaetes is generally associated with muddy, organic-rich substrates, which provide favorable conditions for their proliferation. However, their low abundance in this study, despite the presence of such substrates, indicates that additional factors may be at play. While it remains unclear why Oligochaetes are sparse in this case, potential explanations could include competition with other benthic fauna, the timing of seasonal variations, or specific local conditions, such as water chemistry, that may not favor their proliferation (Olomukoro and Odigie, 2019). This is an area that requires further investigation to determine the precise causes of their reduced numbers. Species of Annelid recorded in this study have been documented elsewhere by Olomukoro and Ezemonye (2007), Omoigberale and Ogbeibu (2010) and Olomukoro and Odigie (2019). Trichoptera were sparsely recorded in this study, with only one species, *Ablabesmyia* sp. Trichoptera are typically more abundant in upland streams and rivers, where oxygen levels are higher compared to lakes like Ozomu. Similarly, Mollusca were underrepresented, with only one species, *Lymnaea natalensis*, which was evenly distributed across all study stations.

Table 3. Biological indicators of Benthic Macroinvertebrates based on their tolerance level

Types of benthic fauna	Total number	Percentage (%)
Benthos Sensitive Taxa		
Ephemeroptera (Mayflies)	55	12.8%
Trichoptera (Caddisflies)	12	2.8%
Coleoptera (Beetles)	85	19.7%
Total	152	35.3%
Moderately Tolerant Taxa		
Odonata (Dragonflies and Damselflies)	84	19.5%
Hemiptera (True Bugs)	21	4.9%
Decapoda (Shrimp and Crabs)	24	5.6%
Araneida (Spiders)	21	4.9%
Total	150	34.9 %
Benthos Tolerant Taxa		
Oligochaeta (Aquatic Worms)	7	1.6%
Diptera (True Flies)	106	24.6%
Mollusca	12	2.8%
Total	125	29.0%

These findings are consistent with previous studies that have utilized benthic macroinvertebrates as indicators of water quality (Sudarso et al., 2021). Ephemeroptera, Trichoptera, and Coleoptera, which are classified as pollution-sensitive taxa, were present in moderate to high proportions across all stations. Their abundance indicates a relatively low level of pollution in Ozomu Lake, as these taxa are known to decline in response to organic pollution and habitat degradation, a trend similarly observed in other studies (Wimbanngrum et al., 2016; Sudarso et al., 2021). However, differences were noted in the abundance of moderately tolerant taxa, suggesting localized areas of slightly degraded conditions.

Conversely, the presence of taxa such as Odonata, Hemiptera, and Decapoda, which are considered moderately tolerant to pollution, suggests that while the lake maintains a good biological quality overall, there may be localized areas or stressors that contribute to slightly degraded conditions. Continued monitoring of these taxa and their abundance patterns can provide valuable information for identifying and mitigating potential sources of pollution in the lake.

The diversity patterns observed across the stations suggest variations in species distribution and community structure, reflecting the influence of environmental conditions at each site. While Station 3 displayed the highest species richness, the dominance of a few taxa led to lower overall diversity, as seen in the lower Shannon-Weiner and Simpson indices. This pattern, where a few species dominate, can indicate favorable conditions for certain taxa, allowing them to outcompete others (Poikane et al., 2016). Such imbalances, where dominant species suppress others, suggest localized environmental factors, possibly linked to anthropogenic disturbances like dredging that skew the community structure (Johnson et al., 2004).

In contrast, Station 2 demonstrated the highest overall diversity and evenness, suggesting a more balanced and resilient macroinvertebrate community. This evenness is essential for maintaining ecosystem functions, as more evenly distributed communities tend to be more stable and capable of withstanding environmental changes (Suurkuukka et al., 2012). The high Pielou's evenness index in Station 2 suggests fewer competitive interactions, allowing a wider range of taxa to coexist. This station's diversity is likely influenced by a range of factors, including the balance between organic inputs and suitable habitat complexity, which has been noted to improve diversity in benthic communities (Cai et al., 2012).

Although Station 1 ranked second in species diversity, it showed lower evenness compared to Station 2. The relatively higher dominance of certain taxa, such as Diptera, suggests that environmental factors such as competition or localized stressors, including human activities like washing and bathing, may have reduced the balance within the community (Weatherhead and James, 2001). This reflects the findings of other studies that highlight the impact of anthropogenic pressure on the structure of benthic communities (Abhilash et al., 2024).

Station 3, where Diptera consistently dominated, exhibited the lowest evenness, pointing to the substantial impact of palm oil mill effluent (POME) and dredging activities. Diptera, particularly Chironomidae, are known for their high tolerance to organic pollution and degraded water quality (Johnson et al., 2004). The dominance of pollution-tolerant taxa at this station, coupled with a lack of sensitive groups such as Ephemeroptera, suggests that POME significantly influences the water quality, reducing oxygen availability and altering the habitat conditions for more sensitive species (Cai et al., 2012).

The co-occurrence of Diptera and Ephemeroptera in Station 1 indicates moderate water quality, as Diptera are pollution-tolerant, while Ephemeroptera are sensitive to pollution and require higher oxygen levels (Abhilash et al., 2024). This suggests that the station experiences lower pollution levels compared to Station 3, where pollution-tolerant taxa dominated. Similarly, Station 2's balanced mix of pollution-sensitive taxa like Coleoptera and Odonata, alongside moderately tolerant Diptera, points to fluctuating water quality conditions, possibly influenced by seasonal or localized inputs of organic matter such as decaying vegetation or POME (Poikane et al., 2016).

The comparative analysis of taxa ratios across the stations underscores the varying impacts of pollution and environmental stressors on the lake's ecosystem. Station 1 and Station 2 support a more diverse mix of pollution-sensitive and moderately tolerant taxa, indicating lower levels of pollution and healthier ecological conditions (Suurkuukka et al., 2012). On the other hand, Station 3's dominance by Diptera and reduced presence of sensitive taxa like Coleoptera and Ephemeroptera reflect a more stressed environment, heavily influenced by continuous POME inputs and dredging activities (Cai et al., 2012). These findings demonstrate the need for ongoing monitoring and management efforts to mitigate the impact of human activities on Ozomu Lake's water quality and biodiversity.

By incorporating these comparisons of taxa ratios and the presence of pollution-tolerant species, this study provides critical insights into how POME and other anthropogenic pressures affect the water quality and community dynamics in Ozomu Lake. These results align with similar studies on the effects of pollution on benthic communities, emphasizing the importance of integrating pollution-sensitive and tolerant taxa data for effective water quality assessments (Poikane et al., 2016; Johnson et al., 2004).

5. Conclusion

In conclusion, the findings of this study contribute to our understanding of benthic macroinvertebrate communities in Ozomu Lake and provide valuable baseline data for future research and conservation initiatives. This comprehensive assessment provides valuable insights into the diversity and abundance of zoobenthos in the study area, facilitating a better understanding of the ecological dynamics and water quality conditions of the ecosystem By employing a multidisciplinary approach encompassing taxonomic, ecological, and pollution tolerance assessments, this study highlights the importance of holistic approaches in evaluating the ecological integrity and water quality of freshwater ecosystems.

The presence of diverse benthic macroinvertebrate communities suggests that the lake provides suitable habitat conditions to support a variety of aquatic organisms, with habitat heterogeneity playing a key role in sustaining these communities. Ongoing monitoring and adaptive management strategies are essential to ensure the long-term health and sustainability of Ozomu Lake, as well as to provide a more comprehensive understanding of its ecological dynamics. Future studies should aim to increase the temporal and spatial scope of sampling to capture seasonal variability and provide a more detailed assessment of the lake's biodiversity and ecological status.

Conflict of Interest

The authors declare no conflicts of interest.

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