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Preliminary Observations on the Diversity and Abundance of Aquatic Macroinvertebrate Fauna of Kashimbila Reservoir and Its Environs, Taraba State, Nigeria

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Abstract

The Kashimbila Reservoir, created through the damming of River Katsina-Ala and commissioned in 2023, represents a major multipurpose water resource project in northern Nigeria. Designed primarily to generate hydroelectric power, it also provides potable water to surrounding communities, supports irrigation, sustains fisheries, promotes tourism, and serves as a safeguard against the potential collapse of Lake Nyos by capturing discharged waters. Understanding the ecological status of this newly established reservoir is crucial, particularly through the study of macroinvertebrates, which play key roles in aquatic food webs and serve as reliable bioindicators of water quality. While extensive information exists on macroinvertebrate assemblages in southern Nigeria, there is a paucity of comparable data for northern freshwater ecosystems, especially the Kashimbila Reservoir. This study investigated macroinvertebrate communities over a six-month sampling period using a 500 µm mesh dip-net. Collected specimens were identified based on morphological characteristics with reference to standard taxonomic keys, and community structure was assessed using diversity indices calculated in PAST3 software. Three invertebrate phyla were recorded: Annelida, Arthropoda, and Mollusca, distributed across four classes. Class Clitellata (Annelida) accounted for 6.6% of the total abundance, Malacostraca (Arthropoda) for 7.4%, Insecta (Arthropoda) for 34.6%, and Gastropoda (Mollusca) dominated the assemblage with 51.3%. Diversity analysis revealed a Shannon–Wiener index of 2.13 and a Margalef's richness index of 1.70, both indicating relatively low species diversity and richness within the reservoir. These findings provide the first baseline ecological data on macroinvertebrate fauna in the Kashimbila Reservoir, establishing a foundation for long-term monitoring and management of the ecosystem. Given the reservoir's socio-economic and ecological importance, future studies should adopt a more comprehensive approach by incorporating seasonal variations and examining the influence of physicochemical parameters on both littoral and benthic macroinvertebrate communities. Such investigations will be critical for informing sustainable management practices and ensuring the ecological integrity of this strategic water resource.

Keywords
Kashimbila,
Macroinvertebrate,
Fauna,
Diversity, Abundance.

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Introduction

Macroinvertebrate fauna are important components of the aquatic ecosystem. In addition to their roles in the aquatic food chain, they have been used extensively to evaluate the overall water quality of aquatic environments. Their preference as environmental indicators is based on their diversity, abundance and ability to respond to changes in a variety of environmental variables such as sediment quality, water quality, hydrological conditions, shading and biological factors. Most importantly, of all macroinvertebrate fauna, aquatic insects are the most commonly used indicators of water quality since they have various environmental disturbance tolerance levels (Amusan *et al.*, 2018).

In Nigeria, biological richness of aquatic macroinvertebrate fauna of lakes/reservoirs and streams has not been extensively documented. The few reports include those of Edward and Ugwumba (2011) for Egbe reservoir, Ekiti State, Asibor and Adeniyi (2017) for Asijire reservoir, Osun State, Olawusi-Peters (2017) for Owena reservoir, Ondo State, Louis, *et al.*, (2017) at Ovia River (Iguoriakhi), Edo State, Ada *et al.*, (2017) for some ponds in Makurdi metropolis, Amusan *et al.*, (2018) for Opa and Ona rivers in Oyo and Osun States respectively and Bonjoru *et al.*, (2020) at Kashimbila River in Taraba State.

Thus, there is a huge gap in our knowledge of these faunas in the vast landmass of the country endowed with numerous water resources. Notably, most of the data available are on water resources in southern Nigeria while there is serious paucity of similar information on water resources in the northern part of the country. Specifically, with the recent commissioning of the Kashimbila dam, there is a dire need to have such information which will serve as a baseline for assessing the impact of various aspects of public use of the facility. Therefore, we report here a preliminary account on the diversity and abundance of macroinvertebrate fauna of Kashimbila reservoir and its environs.

Materials and Methods

Study Area

Kashimbila dam is located in Kashimbila ward of Takum Local Government Area (LGA)(Fig. 1). The dam is located at Latitude 6°52'N and Longitude 9°45'E and it is 59km from Takum town in the southern part of Takum LGA. The natural features of the area are mountains and valleys.The Katsina-Ala River and its tributaries as well as numerous ponds drain the area. It receives an average annual rainfall of about 872mm with an average maximum and minimum temperature of 28.6°C and 22.5°C respectively. The dam whose construction started in 2007 and was commissioned in 2023 was constructed on River Katsina-Ala and has a storage capacity of 500 million $m^3$of water. The major occupation of people inhabiting the area are farming, fishing and cattle rearing. The dam was intended to generate 40MW of hydroelectricity, provide 60,000m^3 daily water supply to about 400,000 people, irrigation of about 2000 hectares of land as well as allow for fishing and promote tourism.

Sampling Stations

Five sampling stations A – E as shown in Fig.2 was selected. Station A and D were at the main reservoir, Station B was at River Katsina-Ala, Station C was a pond adjacent to the river while Station E was a tributary of River Katsina-Ala.

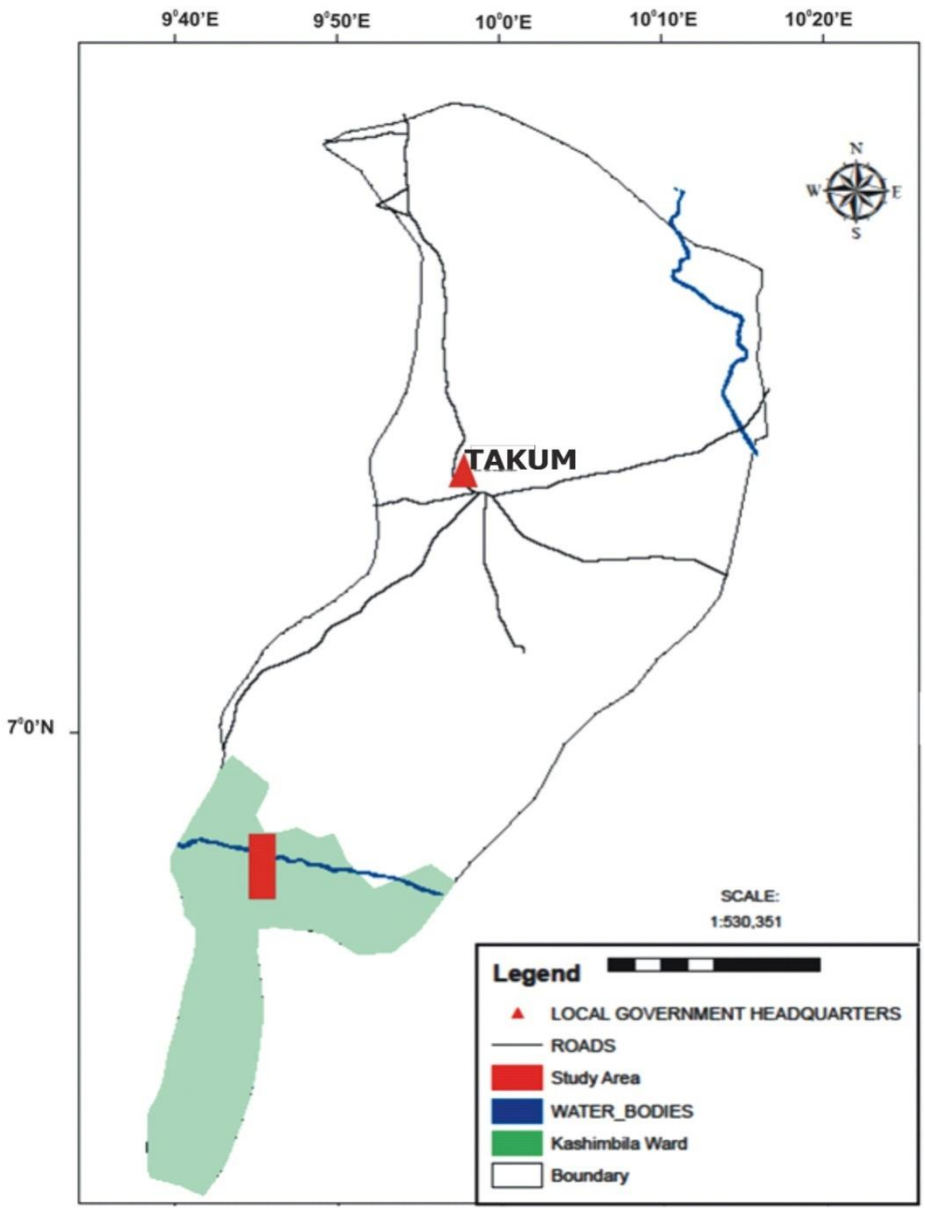

Figure 1: Map of Takum Local Government Area showing location of Kashimbila Ward and Reservoir

Collection and Identification of Macroinvertebrate Fauna

The macroinvertebrate fauna was sampled at the five sites A-E fortnightly for a period of six months spanning from September, 2022 to February, 2023 using a kick method where a stick was used to agitate an area of about $1m^2$of the substratum at the banks of the reservoir and adjoining streams and the dislodged macroinvertebrates were collected with a standard dip-net of 500µm mesh size. Samples were kept in 500ml screw cap plastic specimen bottles and fixed in 10% formalin. Three replicate samples were collected at each sampling station on every sampling occasion.

Samples were then brought to the laboratory where they were sorted in to various taxa.

Each taxon was subsequently identified to species level for the mollusks based on their morphological characteristics with reference to the keys of Brown (1994) while other taxa were identified to family level based on morphological characters as well with reference to the standard keys of Bouchard (2004), Verma (2006) and Umar *et al.* (2013).

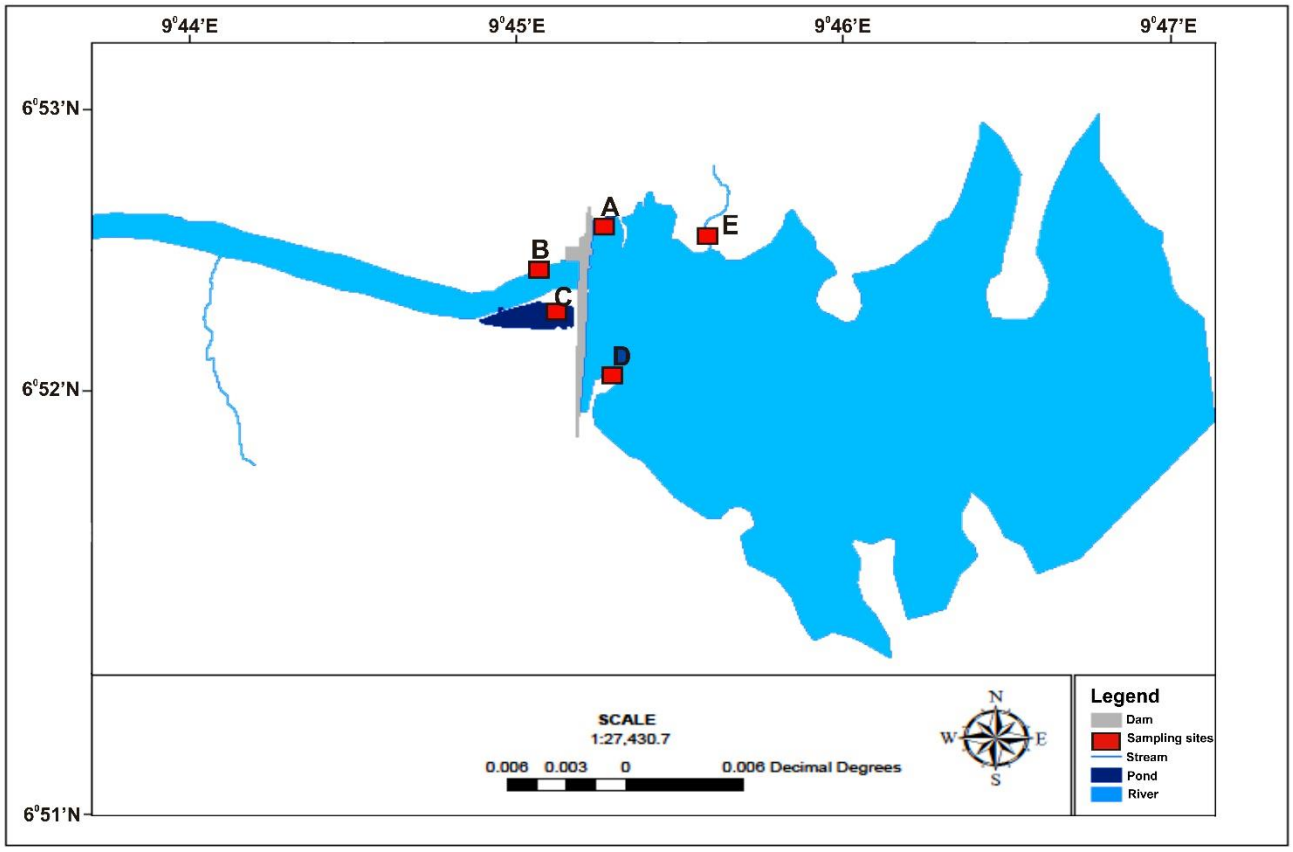

Figure 2: Map of Kashimbila Reservoir Showing Sampling Stations A to E.
Source: Modified satellite imagery using Art GIS Version 10.19

Data Analysis

Diversity indices namely Shannon-Weiner Diversity Index and Margalef's Species Richness Index were computed using the Paleantological Statistical Tool –Past3.

(i) Shannon index (H) = - Σ Pi x ln(Pi)
Where:
Pi = n/N
n = Number of individuals of one species
N = Total number of all individuals in the sample
ln = Natural logarithm

(ii) Margalef's Species Richness (D) = (S-1)/ln(n)
Where:
S = Number of species
n = Number of individuals
ln = Natural logarithm

Results

Diversity of Macroinvertebrates Recovered During the Study

The macroinvertebrates encountered during the study belong to three animal phyla namely Annelida, Arthropoda and Mollusca. The annelids comprise of two classes namely Oligochaeta and Hirudinea. The arthropods comprise of two classes as well namely Crustacea and Insecta while the molluscs all belong to the class Gastropoda. Altogether, five classes of macroinvertebrates were encountered spread across 16 families. Their diversity is shown in Table 1. Of these families, 9 (56.3%) were Arthropods making up the majority, while insects 8(88.9%) made up the overwhelming majority of the Arthropod families. The molluscs came second with 4(25.0%) of the families encountered and the annelids trailed with 3(18.8%) of the fauna recovered during the study.

Table 1: Diversity of macroinvertebrates recovered from Kashimbila reservoir and environs during the study.

Phylum	Class	Subclass	Order	Suborder	Family	Species
Annelida	Oligochaeta	-	-	-	Lumbriculidae	
	Oligochaeta	-	-	-	Naididae	
	Hirudinea	-	-	-	Hirudinidae	
Arthropoda	Crustacea	-	Decapoda	-	Potamonautidae	
	Insecta	-	Diptera	-	Psychodidae	
	Insecta	-	Diptera	-	Simuliidae	
	Insecta	-	Diptera	-	Culicidae	
	Insecta	-	Ephemeroptera	-	Ephemeridae	
	Insecta	-	Lepidoptera	Rhopalocera	Papilionidae	
	Insecta	-	Odonata	Epiprocta	Libellulidae	
	Insecta	-	Plecoptera	Arctoperlaria	Perlidae	
	Insecta	-	Coleoptera	Polyphaga	Staphyliniformia	
Mollusca	Gastropoda	Pulmonata	-	-	Lymnaidae	*Lymnaea natalensis*
	Gastropoda	Prosobranchiata	-		Thiaridae	*Melanoides tuberculata*
	Gastropoda	Prosobranchiata	-		Viviparidae	*Bellamya unicolor*
	Gastropoda	Prosobranchiata	-		Ampularidae	*Lanistes ovum*
	Gastropoda	Prosobranchiata	-		Ampularidae	*Pila ovata*

Diversity Indices of Macroinvertebrate Fauna Recovered

The values of diversity indices obtained across the study period is shown in Table 2. Apparently, similar values for the Shannon-Weiner diversity index were recorded during the six-month study averaging 2.13 while the Margalef's species richness index was also similar during the study with an average of 1.70. Thus, both Shannon-Weiner diversity index and Margalef's species richness index did not reveal any notable differences between the six study sites sampled.

Table 2: Diversity index values for macroinvertebrates obtained in Kashimbila reservoir and environs during the study.

Indices	Sampling Period					
Mean	Sept. 2022	Oct. 2022	Nov. 2022	Dec. Jan. 2022	Feb. 2023	2023
Shannon-Weiner Diversity Index (H)	2.13	2.13	2.13	2.23 2.03	2.13	2.13
Margalef's Species Richness Index(D)	1.71	1.71	1.71	1.73	1.61	1.711.70

Abundance of Macroinvertebrates During the Study

A total of 1,191macroinvertebrates were recovered in Kashimbila reservoir and environs. This is shown in Table 3. The gastropod *Lymnaea spp* was the most abundant macroinvertebrate accounting for 21.1% of total collection followed by another gastropod of the genus *Melanoides spp* accounting for 15.8% of the total collection. The least encountered macroinvertebrate was an insect belonging to the family Simuliidae which accounted for only 0.4% of the total abundance.

Site wise abundance of macroinvertebrates is shown in Fig.3. Site A which was at the bank of the main reservoir had the most abundant fauna accounting for 34.5% of the total followed by Site E accounting for 19.6% of the total. Site B which was on River Katsina-Ala had the least abundant fauna accounting for only 12.8% of the total macroinvertebrate fauna recovery.

Discussion

The composition of macroinvertebrate fauna of Kashimbila reservoir and environs was characterized by low diversity. This is not unusual for some water bodies in Nigeria and is in agreement with previous reports of Edward and Ugwumba (2011) and Olawusi-Peters (2017) who similarly observed low taxa diversity in their studies on macroinvertebrates of Egbe reservoir and in Ekiti State and Owena reservoir in Ondo State respectively. Olawusi-Peters (2017) citing Odum (1971) reported that diversity tended to be low in physically controlled systems such as ponds and reservoirs. In this study, four of the six sites examined were either in the main reservoir or ponds in its vicinity. It is therefore of little wonder that the taxa number was low. The reasons usually adduced to explain low diversity is the effect of physico-chemical conditions such fast flow rate of water, high pH, low dissolved oxygen and low conductivity. These factors act by disrupting the reproduction and lifecycles of the organisms, food chain and forced migration (Adakole and Annune, 2003).

Table 3: Mean abundance of macroinvertebrates recovered at the five sampling sites in Kashimbila reservoir and environs during the study.

Macroinvertebrates		Sampling Sites					Total	% Total Abundance
Class	Family	A	B	C	D	E		
Oligochaeta	Lumbriculidae	7	11	5	25	27	75	6.3
Oligochaeta	Naididae	1	0	2	2	2	7	0.6
Hirudinea	Hirudinidae	7	0	1	0	2	10	0.8
Crustacea	Potamonautidae	33	24	9	0	21	87	7.3
Insecta	Psychodidae		7	0	3	0	9	19 1.6
Insecta	Simuliidae		4	0	1	0	0	5 0.4
Insecta	Culicidae		18	7	21	19	8	73 6.1
Insecta	Ephemeridae		11	5	1	0	15	32 2.7
Insecta	Papillionidae		51	28	21	15	22	137 11.5
Insecta	Libellulidae		29	23	24	21	17	114 9.6
Insecta	Perlidae		11	2	0	0	5	18 1.5
Insecta	Staphyliniformia		13	6	13	11	10	53 4.5
Gastropoda	Lymnaidae	135	22	31	54	10	252	21.1
Gastropoda	Thiaridae	55	13	30	37	53	188	15.8
Gastropoda	Viviparidae	22	0	11	9	13	55	4.6
Gastropoda	Ampularidae	7	12	18	10	19	66	5.5
Total		411	153	191	203	233	1191	

However, in Kashimbila reservoir, the low taxa diversity can't be adduced to the aforementioned factors because the facility is new having been commissioned in 2023 and there is no evidence of pollution yet. Besides, there is no outflow to wash away any fauna. Thus, the low taxa in the reservoir and its environs may be related to food availability. The habitat has not probably matured to support a wider diversity of macroinvertebrates. The action of fishermen with their canoes also disturbs the habitat making habitat selection difficult such that limited shelter is available for the fauna. This has similarly been observed in Egbe reservoir by Edward and Ugwumba (2011).

Typical values for Shannon-Weiner diversity index range from 0 – 4.6. The average value of 2.13 obtained in this study suggest a low

tending towards moderate diversity. Species diversity has been considered as a measure of community stability. Low diversity indicates a stressful environment while high diversity reflects a stress-free environment. The two years old Kashimbila reservoir is just maturing and stabilizing hence it is able to support only lower faunal diversity.

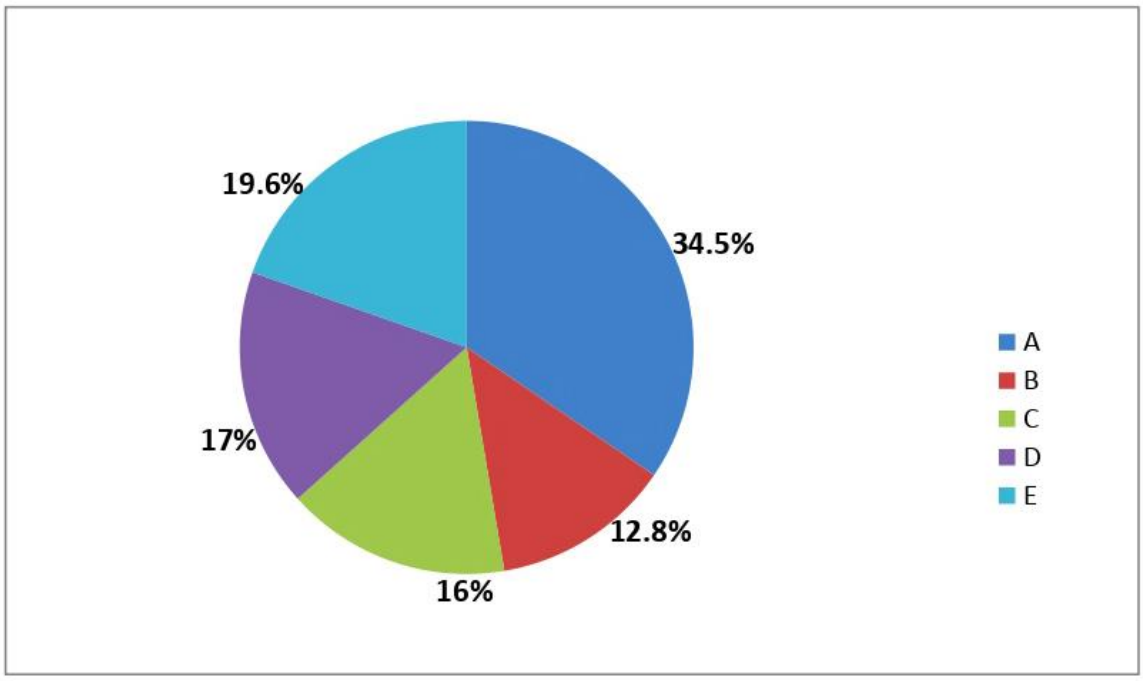

Figure 3: Relative abundance of macro-invertebrates with respect to sampling sites at Kashimbila reservoir and environs.

The Margalef's species richness index recorded in this study being less than two reveals also a low species richness. Thus, both diversity indices recorded in this study underscores the stressful nature of the habitats that are young and immature. The effect of pollution stress as a causal effect to the low diversity indices is not contemplated in this case owing to no evidence of such during the field work. Moreover, clean water insects of the order Odonata and Ephemeroptera were encountered suggesting that the water was not polluted.

The predominance of gastropods among macroinvertebrates encountered in the Kashimbila reservoir and environs is similar to the situation observed by some previous workers such as Edward and Ugwumba (2011) in Egbe reservoir in Ekiti State, Asibor and Adeniyi (2017) in Asejire reservoir in Oyo/Osun State as well as Olawuyi-Peters (2017) in Owena reservoir in Ondo State. Among the gastropods, unlike in these other studies who reported different species as being the most abundant, in our studies, *Lymnaea natalensis* was the most abundant. This is to be expected as the species thrives well in clean water and non-tolerant to polluted water. The occurrence and abundance of the other gastropods has been well documented in a separate but related report by the same authors (Abugbum *et al.*,2025).

The second most abundant aquatic macroinvertebrate in the reservoir and

environs were the insects dominated by pollution sensitive species. Insect larvae especially of the family Ephemeridae and a few others have been known to be good bio-indicators of habitat condition in freshwater ecosystems. Thus, insect orders comprising Ephemeroptera-Plecoptera-Tricoptera (EPT) index is commonly used in assessment of water quality and integrity. The presence in this study of insects that are associated with non-polluted (clean) water is suggestive of the current health status of the Kashimbila reservoir. These insects have commonly been reported in water bodies that aren't heavily polluted in Nigeria (Popoola and Otalekor, 2011; Edward and Ugwumba, 2017; Ada *et al.*,2017 and Amusan *et al.,* 2018).

The low abundance of aquatic annelids in this study is noteworthy and is in conformity with earlier reports like Asibor and Adeniyi (2017) and Amusan *et al.,* (2018). It would appear that aquatic annelids such as members of the family Lumbriculidae, Naididae and Hirudinidae occur sparingly and in low numbers in reservoirs and even in slow flowing streams. They appear to prefer ponds and stagnant ditches. Thus, many studies on macroinvertebrates of reservoirs, rivers and even streams somehow miss them.

Conclusion

This preliminary investigation has demonstrated that the Kashimbila Reservoir provides a suitable habitat for aquatic macroinvertebrates, although only limited variation in their distribution was observed across the surveyed sites. The findings indicate that the reservoir currently supports a relatively low species diversity and richness when compared with reports from older and ecologically more stable freshwater ecosystems in Nigeria. This outcome may reflect the relatively young age of the reservoir, ongoing ecological adjustments, or other environmental factors that influence colonization and community stability.

Despite these limitations, this present study is of considerable importance as it establishes the first ecological baseline for macroinvertebrate assemblages within the Kashimbila Reservoir. Such baseline information is indispensable for monitoring ecological changes, detecting early signs of environmental stress, and informing sustainable management practices.

To build on these initial insights, future research should adopt a more comprehensive approach that integrates seasonal sampling and examines the influence of key physico-chemical parameters on both littoral and benthic macroinvertebrate communities. Long-term monitoring programs are also recommended to capture successional changes as the reservoir ecosystem matures.

Ultimately, such studies will provide the scientific evidence required for effective conservation strategies, sustainable resource use, and the maintenance of ecological integrity in this newly established and strategically important aquatic system.

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