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Ecological Status of a Tropical Inland Water Using Macroinvertebrate Feeding Groups and Sediment Characteristics

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Authors' contributions

This work was carried out in collaboration among all authors. Author AS collected the data and did the statistical analysis. Author AB designed the study, read and approved the final manuscript. Author AA managed the literature searches and wrote the first draft. All authors read and approved the final manuscript.

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ABSTRACT

Changing environmental conditions have an important influence on the functional and structural organization of macroinvertebrates in water. The involvements of macroinvertebrates in Bio-monitoring have focused largely on their distribution pattern in water while neglecting the functional and feeding structure. This study aims to use the structure and habitat preferences of macroinvertebrates to provide reliable information on the ecological integrity of Atori Reservoir.

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Macroinvertebrates were sampled once every two months from selected sample stations in Atori Reservoir for a period covering both wet and dry seasons of an annual cycle. The collected macroinvertebrates were categorized into functional groups using feeding patterns, habitat preferences and mode of locomotion. The reservoir sediment was also analyzed for selected physico-chemical characteristics. Predators (feeding pattern) and Skaters (locomotion and habitat preference) were dominant in the collection. Many of the functional feeding groups were more abundant in the dry season. In fact, Collector-gatherers and shredders were recorded only in the dry season. There was no significant difference in the seasonal variation in the distribution of the macroinvertebrates in the reservoir. The physico-chemical parameters of the sediment did not vary significantly across the sample stations but paired samples T-test showed significant differences in the seasonal variations of physico-chemical parameters of the sediment in the reservoir The dominance of predators and skaters, which are known tolerant species have implications for the ecological integrity of the water. The dominance of tolerant species and the physico-chemical characteristics of the sediment suggested the presence of mild pollution in Atori Reservoir. Proactive conservative measures should be taken in order to prevent further degradation of the water quality as well as prevention of loss of biodiversity in the waterbody.

Keywords: Macroinvertebrates; feeding guild; diversity; abundance; pollution.

1. INTRODUCTION

Over the years, understanding the distribution patterns of macroinvertebrates in aquatic environments has been a major goal for aquatic ecologists. This is because macroinvertebrates have become the most common bio-indicators of water pollution in tropical water bodies [1]. They also occupy a central position in the aquatic food web by linking food sources with top trophic level consumers [2]. The immature stages of aquatic macroinvertebrates serve as a vital link between primary producers and consumers. They are also known to be important in ecological dynamics as they play critical roles in nutrient and materials cycling as well as trophic transfer in aquatic environments [3]. Furthermore, macroinvertebrates are useful surrogates of ecosystem attributes and the relative abundance of functional feeding groups (FFG) usually reflects anthropogenic impacts [4]. As such, they have been known to be important animal organisms both economically and ecologically.

The status of aquatic life is considered the most direct and effective measure of a waterbody's overall ecosystem health [5]. However, water monitoring schemes that consider the presence or absence and abundance of an indicator organism may overlook important components of the food web. Therefore, besides the composition and diversity of aquatic biota, quantitative studies of feeding relationships among FFGs of macroinvertebrates are essential in detecting allochthonous material and nutrient loads in water bodies. Recently, a functional feeding approach, based on macroinvertebrate functional feeding groups (FFGs) has emerged to assess the ecological integrity of aquatic habitats. Thus, functional groups like shredders and scrapers are designed to be more susceptible to environmental changes while collector-gatherers and collector -filterers are considered pollution resistant [6].

The sediment environment also functions as the major storage and recycling compartment for virtually all material that flows in the aquatic system while the biological processes that take place there are interesting models for identification of the different macroinvertebrate functions [4]. The accurate way of assessing species functioning includes evaluation of the effects of abiotic as well as the biotic properties of the habitats on the organism. Sediment forms a crucial part of the nutrient economy as it acts as the sink or source of nutrients depending on the redox conditions. The sediments are constantly heterogeneous as a result of changes in the hydrological and geomorphological regimes within and around the catchment area. Heavy metals in sediment have significant biological toxicity and persistence and may enter the human body through the food chain, resulting in harm to human health. It has also been reported that heavy metals such as Cu, Pb, Cd and Zinc pose serious risks to the health of aquatic ecosystems due to their short and long-term toxicity [7]. These elements find their way into the aquatic environments through various anthropogenic activities such as agricultural practices, domestic sewage disposal, mining, construction activities and industrial effluents. As such, monitoring of water quality has become highly necessary as a result of these constant increases in anthropogenic and other stress factors.

Several studies have used the feeding relationships among the FFGs of macroinvertebrates and sediment characteristics in the temperate region [8,9]. Little is known about how feeding interactions and sediment qualities are altered by by human activities in tropical Africa. Therefore, investigating feeding interactions among macroinvertebrates concerning sediment characteristics can improve our understanding of nutrient loading and ecological integrity in aquatic ecosystems. As such, this study aims to assess the sediment characteristics and the structure of the functional feeding groups as indicators of water quality of Atori Reservoir, Southwestern Nigeria.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

Atori Reservoir is located in Iseyin, Southwestern Nigeria. The reservoir lies between Longitude 003^{0}36'E and Latitude 07^{0}58'N and at an altitude of 329m amsl (Fig 1). The reservoir capacity is about 580 million m^3 with a surface area of 4.7 km^2 and a mean depth of 5.2m. The embankment of the reservoir is about 120m in length and 40m in width. The dam wall comprised a mechanical spillway which automatically spills water once it is above the maximum operational capacity. Atori Reservoir is a unique reservoir as its source of water is through seepage from the ground. The reservoir provides potable water and other ancillary functions to the people in Iseyin and neighboring communities. Iseyin is an ancient city in the Oyo state and it is approximately 100 km north of Ibadan. It has a total land mass of 1,419 km^2 (548 sq mi) [10]. The reservoir is subjected to varying degrees of anthropogenic disturbances mainly from runoff from agricultural lands, fishing and domestic wastes. The predominant land use in the area is mainly agricultural. There are a number of extensively cultivated expanses of lands within the reservoir catchment. The farming practices on the lands include cultivation of food and cash crops as well as animal husbandry with abundance of grassland to support the animals. Notable trees found in the area include; *Elaeis guineensis* (Oil palm), *Cocos nucifera* (Coconut) *Adonsonia digitata* (Baobab), *Albizia lebbeck* (Ayunre) while Crops grown in the farm include Maize, Cassava, Yam, Citrus, Cashew and Cocoa.

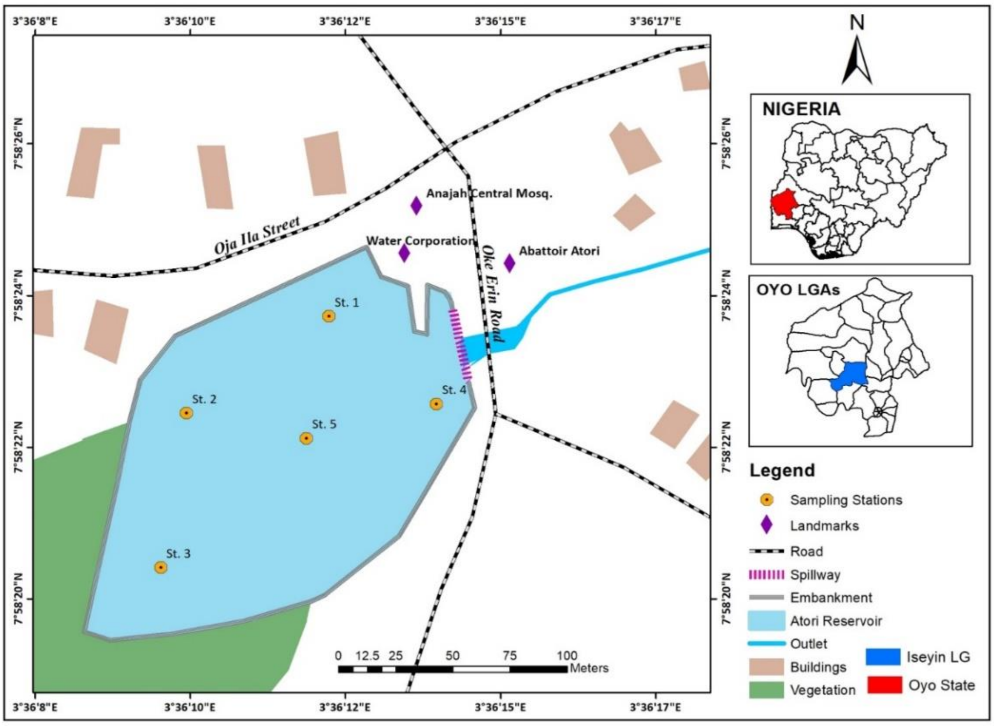

Fig. 1. Map of Atori Reservoir showing the sampled stations numbered St1 – St5

2.2 Sampling Programme and Selection of Sampling Stations

The study area lies within the tropical monsoon climate zone characterized by two distinct seasons; the wet (May – October) and the dry season (November – April). As such, the sampling programme was designed to cover both wet and dry seasons of an annual cycle. Sampling was carried out between December 2019 and October 2020. The Reservoir was visited once in every two months, thus making a total of six sampling periods for the collection of macroinvertebrates and water samples. Five (5) sampling stations were chosen based on the reservoir reaches, anthropogenic impacts and to ensure that the various microhabitats within the reservoir are covered (Fig. 1). Information on the grid location, elevation and mean depth for the sampling stations are presented in Table 1.

2.3 Collection, Sorting and Identification of Macroinvertebrates

Sampling of macroinvertebrates and sediment was carried out aboard a canoe using an improvised Van Veen grab sampler of $0.04m^2$ area (0.2m x 0.2m). The sediment samples were then bagged and labeled in a sediment bag and taken to the Laboratory for analysis of its characteristics, such as; Nitrate, Phosphate, Chloride, Magnesium, Calcium, Organic carbon/matter, Heavy metals (Cu, Pb, Zn Mn and Ni) and particle size (%Sand, %Silt and %Clay). The duplicate sediment samples taken were gently sieved through a 0.5 mm mesh sieve using the reservoir water [11]. The macroinvertebrates retained in the sieve were picked up using a pair of long forceps. Apart from this method, macroinvertebrates were also collected using long handled D-frame net. This net was used to scoop the open water, submerged and emerging vegetation zone in the reservoir. Sorting of the collected specimens was done in a white enamel tray. Sorted specimens were preserved in specimen bottles containing 70% ethanol solution APHA*,* [12] and appropriately labeled. The specimens were identified in the Laboratory using appropriate taxonomic keys and guides such as Madsen [13]. Schneider [14], WRC [15] and Verma [16]. Classification into functional groups was done using the designation and criteria of Merrit and Cummins [17] Rempel *et al*. [18] and Mandaville [19].

2.4 Sediment Sample Preparation

Analysis of sediments was based on air-dried samples. The wet samples were spread out in a flat tray and allowed to dry at room temperature in the laboratory. The air-dried samples were gently crushed with a pestle in a porcelain mortar and sieved through a 2 mm sieve. The analysis was carried out using Laboratory manuals and guides by Adepetu et al. (1984), I. I. T. A. (1999) and APHA et al*.* (2005).

2.5 Sediment Analysis

This was determined using the hydrometer method with sodium hexametaphosphate $\{Na_6(PO_3)_6\}$ as a dispersing agent [20]. The various particle grades (sand, silt and clay) and their percentage proportions already determined in the particle size analysis were used to classify the sediments into textural classes using the soil texture triangular graph method. The sediments were classified into textural classes as thus; Sand (0.063mm – 2mm in diameter), Silt & Clay (0.004mm – 0.063mm in diameter) [20].

The heavy metals (Cu, Pb, Zn, Mn and iron) were extracted using 0.05N Na_2 EDTA. Metals in the final solutions were determined using Flame Atomic Absorption Spectrophotometry (FAAS) (Perkin-Elmer Spectrophotometer Model 460). Standard stock solutions for the elements were bought as well as prepared in the Laboratory following the procedures described in APHA [12]. The glassware used was Pyrex which was washed severally with soap, distilled water and nitric acid to remove impurities.

Table 1. Summary of the sampled stations with their grid locations, elevations and mean depth

S/No	Latitude (N)	Longitude (E)	Elevation (m)	Mean Depth (m)
1	0758.393	003 36.203	300	4.7
2	0758.378	003 36.171	298	4.2
3	0758.331	003 36.161	299	7.1
4	0758.373	003 36.228	298	5.3
5	0758.367	003 36.202	294	4.2

2.6 Data Analysis

All the data sets were subjected to normality test. Based on the normality test, an appropriate parametric and non-parametric statistical test was used to analyse the data. Physico-chemical parameters were analysed with One-way Analysis of Variance (ANOVA) while Kruskal-Wallis test was used to analyse the community structure of the macroinvertebrates. Paired samples T-test was used to test for significant differences in the seasonal variations of physico-chemical parameters of the sediment in the reservoir. Canonical Correspondence Analysis (CCA) was used to determine the relationship between the community structure of macroinvertebrates and physico-chemical parameters. All statistical tests were carried out using Microsoft Excel and PAST (version 3.0).

3. RESULTS

3.1 Variations in the Physico-Chemical Parameters of the Sediment

Except for Zinc (Zn), the physico-chemical parameters of the sediment did not show significant spatial variations (0.02077, $p > 0.05$). The highest mean values for sediment temperature, sand (%) and Lead (Pb) were recorded in Station 5 while the lowest were recorded in Stations 1 and 3 respectively (Fig 2). The highest concentrations of Organic Carbon (OC), Organic matter (OM), nitrate and magnesium were recorded in Station 2 while the lowest concentrations were recorded in Stations 5 and 3 respectively. The highest mean values for clay (%), chloride and Iron (Fe) were recorded in Station 3 while the lowest mean values were recorded in Stations 5, 1 and 2 respectively. The highest values for silt (%), calcium, zinc, and manganese were recorded in Station 4 while the lowest values were recorded in Stations 3, 1 and 2 respectively. The highest concentrations of phosphate and Copper (Cu) were recorded in Station 1 while the lowest concentrations were recorded in Stations 4 and 3 respectively.

One Way Analysis of Variance (ANOVA) revealed no significant differences in the temporal variations of the physico-chemical parameters of the sediment (ANOVA, $p>0.05$) except for sediment temperature which showed significant temporal variation in its values (4.73E-8, $p<0.001$). The highest mean values for sediment temperature (29.74±0.82) and Mn were recorded in December while the lowest values were recorded in October and February respectively (Fig 3). Similarly, the highest mean values for OC, OM and magnesium were recorded in June while the lowest mean values were recorded in December and April respectively. Furthermore, the mean values for silt (%), Cu and Fe were highest in February while their mean values were lowest in June, August and April respectively. Moreover, the concentrations of chloride and calcium were considerably higher in October than in the other sampling periods.

Paired samples T-test showed significant differences in the seasonal variations of physico-chemical parameters of the sediment in the reservoir (T-test, $p<0.05$, $p<0.01$ and $p<0.001$). The physico-chemical parameters of sediment that varied significantly include; sediment temperature ($p<0.001$), OC ($p<0.01$), OM ($p<0.01$), sand ($p<0.05$) and clay ($p<0.05$). Temperature, clay, silt, Zn and Cu were higher in the dry season while OC, OM, sand, nitrate phosphate, chloride, calcium, magnesium, Fe, Pb and Mn were higher in the wet season (Fig 4)

3.2 Community Structure of Macroinvertebrates

The aquatic macroinvertebrates recorded in Atori Reservoir were categorized into four (4) functional feeding guilds; collector-gatherers, predators, scrapers and shredders and six (6) based on the mode of locomotion/micro-habitat preferences; burrowers, climbers, clingers, crawlers, skaters and swimmers (Table 2). Based on the functional feeding groups, the predatory species occurred as the dominant group as they were the most abundant in the reservoir (Fig. 5). The order of abundance of the macroinvertebrates based on the mode of locomotion/micro-habitat preference was as follows; skaters > swimmers > crawlers > climbers = clingers > burrowers (Fig. 6). Although there were variations in the occurrence and assemblage of macroinvertebrates, the observed variations were not statistically significant (Table 3; Kruskal – Wallis $p >0.05$). The highest number of scrappers, collector-gatherers, shredders and predators were recorded in Stations 1, 4, 2 and 3 while the lowest numbers were recorded in Stations 3, 5, 1 and 2 respectively. Similarly, clingers and climbers were most abundant in Stations 2 and 5 respectively while the least abundance was recorded in Station 3. The highest numbers of swimmers and skaters were recorded in Station 3 while the least were recorded in Stations 4 and 1 respectively.

Burrowers and crawlers were most abundant in Stations 4 and 1 respectively while the least numbers were recorded in Station 5. There was a significant difference (Kruskal-Wallis, $p<0.001$) in the temporal distribution of the predator species (Table 4). The highest number of predators was recorded in October while the least number was recorded in April. The highest percentage of clingers was recorded in April while the lowest was recorded in October. A very high number of burrowers was recorded in October while none was recorded in February, June and August. There was no significant difference ($p > 0.05$) (Mann-Whitney, $p >0.05$) in the seasonal variation in the distribution of the macroinvertebrates in the reservoir (Table 5). Scrappers, clingers, burrowers and swimmers were more abundant in the dry season but predators, crawlers, skaters and climbers were recorded in greater numbers in the wet season. It is also worth noting that collector-gatherers and shredders were recorded only in the dry season.

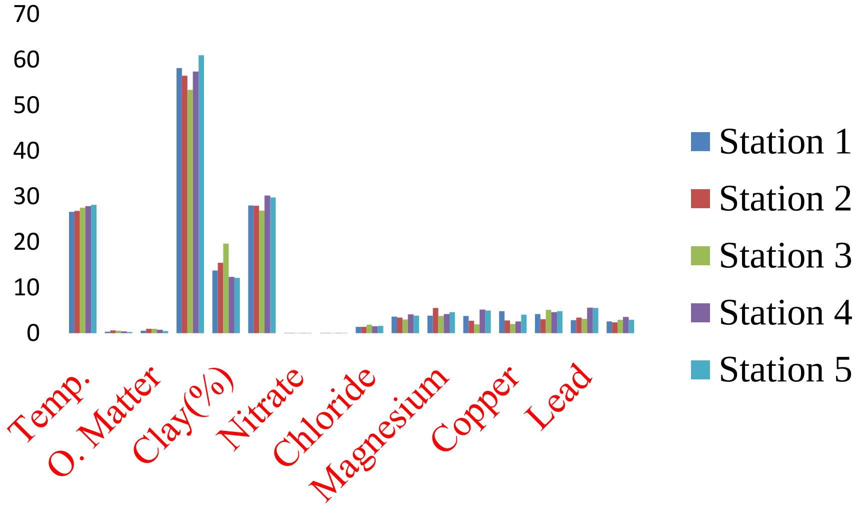

Fig. 2. Spatial variation in the sediment characteristics of Atori Reservoir, Iseyin, Southwestern Nigeria (December 2019 – October 2020)

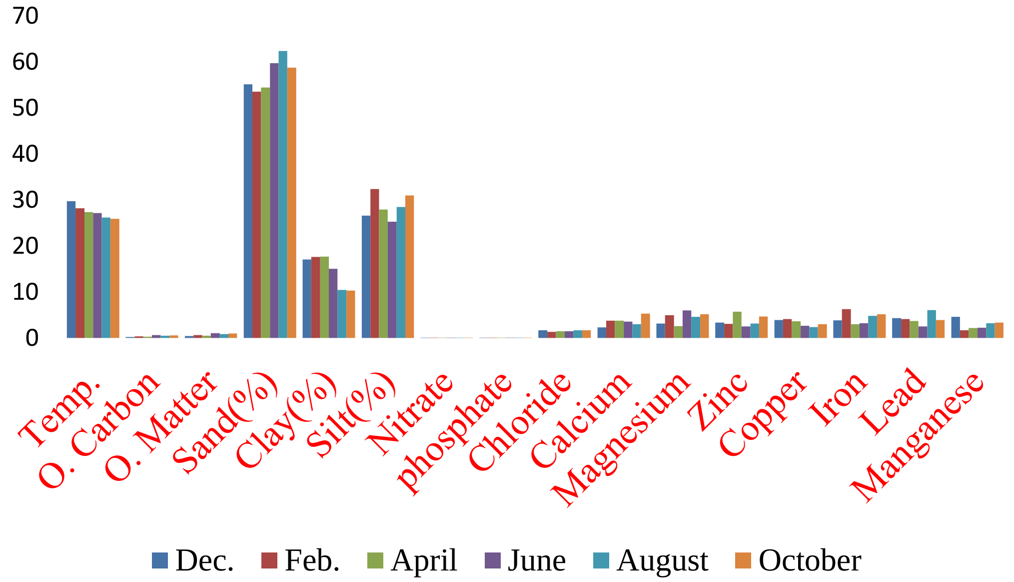

Fig. 3. Temporal variation in the sediment characteristics of Atori Reservoir, Iseyin, Southwestern Nigeria (December 2019 – October 2020)

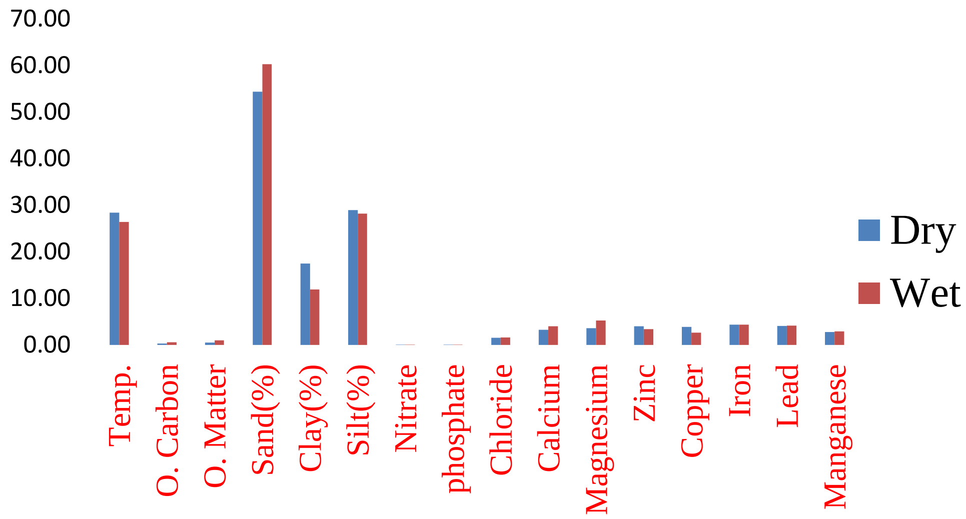

Fig. 4. Seasonal variations in the sediment characteristics of Atori Reservoir, Iseyin, Southwestern Nigeria (December 2019 – October 2020)

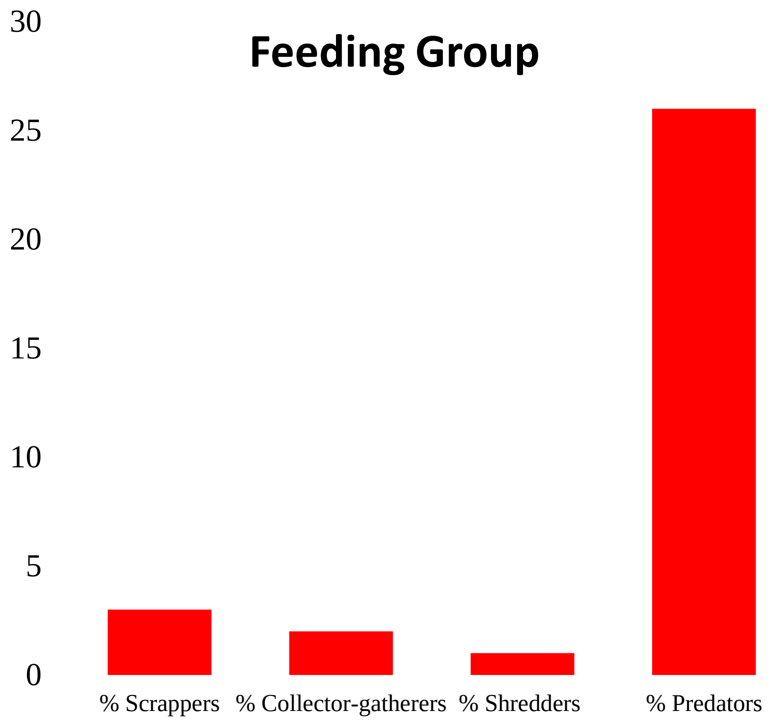

Fig. 5. Functional Feeding Groups (FFGs) in Atori Reservoir, Iseyin, Southwestern Nigeria (December 2019 – October 2020)

4. DISCUSSION

Most of the physico-chemical characteristics and nutrient values determined for the sediment of Atori Reservoir were within the standard guideline values. The values equally compare favourably with reported values for similar studies on waterbodies in Nigeria such as; Amusan *et al.* [21], Aliu *et al*. [22] and Amusan and Adu (2020). Major anthropogenic activities witnessed around the reservoir basin which could have impacted the sediment and water quality is Agricultural practices. One of such impacts was the significant spatial variation in Zinc (Zn) concentration. The observed variation could be attributed to intense farming activities around the reservoir. The observed Zn concentration can be traced to its relatively high composition in fertilizers [23]. As such, sampling stations that receive direct effluents from the farmlands are likely to have elevated concentrations of Zn.

Table 2. Community structure of macroinvertebrates in Atori Reservoir, Iseyin, Southwestern Nigeria (December 2019 – October 2020)

Taxon	Functional Feeding Guild	Mode of Locomotion/Habitat Preference
Hirudo sp	Predator	Burrower
Biomphalaria sp	Scraper	Clinger
Bulinus sp	Scraper	Clinger
Melanoides tuberculata	Scraper	Clinger
Dolomedes sp.	Predator	Climber
Appasus sp..	Predator	Swimmer
Limnogonus sp..	Predator	Skater
Limnoporus sp..	Predator	Skater
Neogerris sp..	Predator	Skater
Rhagadotarus sp..	Predator	Skater
Tenagogonus sp..	Predator	Skater
Macrocoris sp..	Predator	Swimmer
Naucoris obturatus	Predator	Swimmer
Neomacrocoris sp..	Predator	Swimmer
Ranatra sp..	Predator	Crawler
Anisops sp..	Predator	Skater
Enithares sp..	Predator	Skater
Notonecta sp..	Predator	Skater
Agasicles sp..	Shredder	Crawler
Laccophilus sp..	Predator	Swimmer
Orectogyrus sp..	Predator	Skater
Amphiops sp..	Predator	Swimmer
Hydrophilus sp..	Predator	Swimmer
Chironomus sp..	Collector-Gatherer	Burrower
Potamocloeon sp..	Collector-Gatherer	Clinger
Anax sp..	Predator	Crawler
Acisoma sp..	Predator	Crawler
Diplacodes sp..	Predator	Crawler
Tetrathemis sp..	Predator	Crawler
Agriocnemis sp..	Predator	Climber
Ceriagrion sp..	Predator	Climber
Pseudagrion sp..	Predator	Climber

Table 3. Spatial variation in the distribution of macroinvertebrates in Atori Reservoir, Iseyin, Southwestern Nigeria (December 2019 – October 2020)

Community Structure	ST. 1	ST. 2	ST. 3	ST. 4	ST. 5	H	P
% Scrappers	52.76	62.18	39.05	59.28	49.32	0.3333	0.9876
%Collector-gatherers	0.50	0	0	1.20	0.45	3.818	0.4312
% Shredders	0.50	1.28	0	0	0	-	-
% Predators	46.23	36.54	60.95	39.52	50.23	3.563	0.4683
% Clingers	52.76	62.18	39.05	59.88	49.77	0.3036	0.9896
% Burrowers	0.50	0	0	0.59	0.45	1.636	0.8022
% Swimmers	11.56	1.28	19.52	0.59	9.95	7.207	0.1253
% Crawlers	5.53	3.20	5.24	3.59	2.26	1.225	0.874
% Skaters	24.62	29.49	34.28	28.14	26.69	1.122	0.8908
% Climbers	5.025	3.85	1.90	7.18	10.85	0.125	0.9981

Table 4. Temporal variation in the distribution of macroinvertebrates in Atori Reservoir, Iseyin, Southwestern Nigeria

Community Structure	Dec.	Feb.	April	June	Aug.	Oct.	H	P
% Scrappers	42.08	57.33	69.53	52.89	59.50	27.67	2.971	0.705
% Collector-gatherers	0.99	0	0.99	0	0	0	7.385	0.196
% Shredders	0	0	1.43	0	0	0	-	-
% Predators	56.93	42.68	28.10	47.12	40.50	72.33	23.42	0.003***
% Clingers	42.57	57.33	70	52.89	59.50	31.51	1.69	0.892
% Burrowers	0.50	0	0.48	0	0	0.63	2.077	0.834
% Swimmers	27.23	3.18	3.19	0.95	0	15.72	8.881	0.119
% Crawlers	4.950	0.64	3.33	0.96	0	11.95	7.93	0.161
% Skaters	15.35	38.22	21.43	44.23	40.50	26.42	3.637	0.628
% Climbers	9.41	0.64	3.81	0	0	17.61	9.357	0.095

*Implies $p<0.001$****

Table 5. Seasonal distribution of macroinvertebrates in Atori Reservoir, Iseyin, Southwestern Nigeria (December 2019 – October 2020)

Community Structure	Dry Season	Wet Season	U	P
% Scrappers	56.42	44.53	3	0.6625
% Collector-gatherers	0.70	0	0	0.2453
% Shredders	0.53	0	-	-
% Predators	42.36	55.47	255	0.1311
% Clingers	56.77	44.53	6	0.665
% Burrowers	0.35	0.26	1.5	0.9999
% Swimmers	10.90	7.03	23.5	0.9491
% Crawlers	3.163	5.21	6	0.4233
% Skaters	23.90	35.68	27.5	0.2697
% Climbers	4.92	7.29	4	0.3123

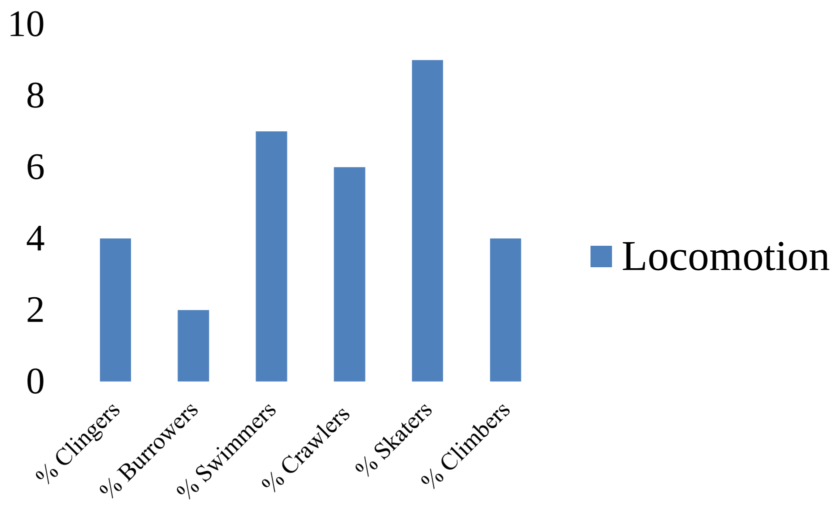

Fig. 6. Mode of locomotion/microhabitat preference of aquatic macroinvertebrates in Atori Reservoir, Iseyin, southwestern Nigeria (December 2019 – October 2020)

The higher nutrient load observed in the wet season is not unusual as nutrient values have been known to generally increase in the wet season due to discharge and flooding [24]. Run-off from adjacent farmlands, domestic sewage and remains of dead aquatic animals has been reported to be the main source of nutrients in reservoirs. These factors may equally account for the highest values of Organic carbon (OC) and Organic matter (OM) obtained in station 2, which is located close to farmland. The higher concentrations of most of the heavy metals in the wet season could also be attributed to run-off effect and turbulence of water in this period. Turbulence can produce greater oxygenation of sediment per revolution and this could bring about an increased flow of heavy metals in the reservoir in this period (Amusan and Adu, 2020). Chloride concentration was observed to be relatively lower in the wet season and this may be attributed to the dilution effect brought about by a significantly higher amount of rainfall in the wet season [1]. Aside from this, a higher rate of evaporation and mineralization of accumulated organic matter at the bottom of the reservoir tends to release more chloride ions. As such, chloride ion concentrations tend to increase in the dry season. The exchangeable cations were observed to be relatively higher in the wet season but did not show significant variations ($p > 0.05$) in their spatial, temporal and seasonal concentrations. Factors such as; low temperature and reduced rate of evaporation have been mentioned to favour higher concentrations of cations in man-made lakes and tropical reservoirs [25]. Thus, the observed relatively higher concentrations of cations in the wet season may be partly attributed to the increased rate of evaporation brought about by elevated temperatures in the season.

The pattern of functional feeding groups gives an idea of resource distribution and use while it equally facilitates the understanding of organic matter processing in waterbodies [26]. Accordingly, the distribution of aquatic organisms also reflects their tolerance to environmental variables, as such community structure of these organisms has been widely used in bio-monitoring of water quality. The abundance of functional feeding groups and trophic guild components in this study could be said to be a reflection of the availability of specific food resources in the reservoir [27]. Tropical macroinvertebrates are generally known to adapt easily to various environments because of their high food flexibility [6]. Aside from this, many taxa are known to have the ability to vary their diet concerning their developmental stages. The availability of a given food type is determined by the presence of microhabitats, the hydrological regime, micro basin characteristics and anthropogenic activities.

The abundance and dominance of skaters and predators in this study are not surprising as they have been reported to be abundant and widely distributed in tropical inland waters. The dominance of these groups has been mostly attributed to the availability of food (prey) and less competition [28]. Although there were variations in the spatial distribution of these groups across the sampled stations, the variations were not statistically significant. This indicates that the distribution of the skaters and the predators followed a similar pattern in the sampled stations. This supports the earlier assertion that predators and skaters usually have similar distribution gradients along waterbodies [2].

The low number of shredders is also not strange for this type of waterbody. This is because a similar pattern has been previously reported in many tropical and sub-tropical waterbodies [29] Magoale *et al*., [24]. One of the reasons attributed to this is the fact that the significance of shredders in the decomposition of organic materials tends to decrease with low altitude, this allows for faster microbial decomposition, especially at elevated temperatures [30]. Furthermore, it has also been established that the presence of secondary compounds in the leaves of tropical trees has the potential to reduce the palatability and nutrient content of such leaves, thus making them less nutritious and unattractive to the prospective macroinvertebrates [31].

Our study observed that seasonal differences in water quality and habitat characteristics brought about seasonal influence on the functional and structural organization of the macroinvertebrates. Many of the feeding group's taxa were relatively higher in the dry season. It is worth noting that collector-gatherers and shredders were recorded only in the dry season. This may be attributed to flow reduction in the dry season. The reduction in the flow rate of the water brings about seasonal variability in physico-chemical conditions that could influence the structural organization of aquatic organisms. Similarly higher abundance of taxa in dry seasons has been reported in some studies such as; Arimoro et al. [32] Aduwo et al. [33] and Addo-bediako [34]. The relatively higher occurrences in the dry periods were attributed to improved water quality and increased algal availability as a result of reduced turbidity. Another implication of this is that alga food sources for scrapers would be limited during the wet season and this may also account for the relatively lower abundance of scrapers collected in this study during the wet season. The greater number of shredders in the dry season may be attributed to more food, probably from fallen leaves from riparian vegetation. The dominance of predators and skaters in this study implies the ecological integrity of the reservoir. Predators and scrappers are known to increase their abundance in areas impacted by urban activities. Their presence has been reported as an indication of deteriorating water quality usually brought about by anthropogenic activities.

The abundance and relative proportion of the functional feeding groups varied insignificantly across the sampled stations. The fact that changing environmental conditions influenced the structural and functional organization of the macroinvertebrates confirms that functional feeding groups could be an effective tool in the assessment of the ecological integrity of water bodies. The dominance of the predators and skaters, which are known tolerant species, suggested the presence of mild pollution in the Atori Reservoir. As such, we suggest proactive conservative measures be taken to prevent further degradation of the water quality as well as prevention of loss of aquatic biodiversity in the reservoir and other similar water bodies.

5. CONCLUSION

The abundance and relative proportion of the functional feeding groups varied insignificantly across the sampled stations. The fact that changing environmental conditions influenced the structural and functional organization of the macroinvertebrates confirms that functional feeding groups could be an effective tool in the assessment of the ecological integrity of water bodies. The dominance of the predators and skaters, which are known tolerant species, suggested the presence of mild pollution in the Atori Reservoir. This poses a great threat to the biodiversity in the waterbody. As such, proactive conservative measures need to be taken to prevent further degradation of the water quality as well as prevention of loss of aquatic biodiversity in the reservoir and other similar water bodies.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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