Assessment of Functional Feeding Group Dynamics within the Community Structure of Macroinvertebrates in the Owena River, Southwestern Nigeria

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Abstract- This study assessed the community structure of macroinvertebrates in the Owena River, Southwestern Nigeria, to evaluate its ecological status. Sampling was conducted across six designated stations four times over 2024 and 2025, capturing data from both the wet and dry seasons. Water quality was evaluated using a Multi 3630 IDS digital meter to measure surface temperature, pH, total dissolved solids (TDS), dissolved oxygen (DO), and electrical conductivity (EC), while remaining physicochemical parameters were analyzed using standard laboratory techniques. Macroinvertebrates were collected via handpicking and long-handled D-frame nets, preserved in 70% ethanol, and classified into Functional Feeding Groups (FFGs) using taxonomic keys. Statistical analyses, including two-way ANOVA and paired T-tests, evaluated spatial and seasonal variations, while Spearman's rank correlation determined relationships between macroinvertebrate abundance and environmental variables. A total of 1,197 macroinvertebrates spanning two phyla and four classes were identified, with Arthropoda displaying the highest diversity. FFG analysis revealed a dominance of predators and a scarcity of shredders. Significant negative correlations between macroinvertebrate abundance and specific physicochemical indicators pointed toward severe environmental stress. Elevated levels of biochemical oxygen demand (BOD), EC, TDS, and nitrates, alongside the notable rarity of pollution-sensitive species, collectively demonstrate that the Owena River is experiencing a substantial pollution load. Consequently, proactive management and conservation measures are urgently recommended to control anthropogenic inputs and prevent further deterioration of the river's water quality and aquatic biodiversity.

Keywords: Community Structure, Functional Feeding Guilds, Macroinvertebrates

I. INTRODUCTION

Aquatic macroinvertebrates are essential, backbone-less organisms visible to the naked eye that inhabit freshwater ecosystems, forming a diverse group including aquatic insects, annelids, oligochaetes, crustaceans, mollusks, and gastropods. They display varied habitat adaptations such as clingers on rocky substrates, crawlers without holdfast structures, climbers amid plant debris, and burrowers in fine sediments (Li et al., 2020). These organisms hold ecological and economic significance by driving nutrient cycling, energy flow, and organic matter transformation as primary processors. They function as detritivores, consuming decaying matter, predators of smaller animals, and key prey for vertebrates like fish, amphibians, and birds (Karim et al., 2021). Importantly, macroinvertebrates serve as bioindicators for evaluating waterbody health and pollution levels, integrating cumulative stressors due to their limited mobility and varying tolerant species prevail in polluted sites, while sensitive ones indicate pristine conditions (Gao et al., 2023). Their diversity, ease of sampling, and environmental associations make them preferred for biomonitoring, providing accurate, long-term insights into ecosystem integrity (Suhaila et al., 2017).

Community structure refers to the composition, organization, and interactions of macroinvertebrates in a waterbody, influenced by abiotic and biotic factors, offering signs to historical and current conditions (Bagalwa et al., 2019). The richness of macroinvertebrate community, composition and distribution can be used in determining the health status of a waterbody (Olalekan, 2017). Macroinvertebrates are categorized into feeding guilds based on their feeding habits and the way they obtain their food. Categorizing functional feeding among aquatic organisms enhances our understanding of trophic interactions within aquatic ecosystems by organizing the macroinvertebrates community into distinct trophic Functional Feeding Groups (FFGs). Assessing feeding behaviors and trophic dynamics through these FFGs offers understanding into the distribution of feeding strategies within the macroinvertebrate community (Gholizadeh and Heydarzadeh, 2019).

Owena River, a major Southwestern Nigerian waterbody, provides drinking water, fisheries, irrigation and hydropower through a dam by the Benin-Owena River Basin Development Authority (Oyhakilome et al., 2012). The anthropogenic activities received by the river include agricultural runoff, domestic waste dumping, open defecation and tool washing (Olaniyan and Akinkuolie, 2016). Despite these pressures, there is a dearth of information regarding the ecological status of the River, hence this study which seeks to assess the macroinvertebrate community structure to precisely evaluate the ecological status of Owena River.

II. MATERIAL AND METHODS

2.1 Study Area

The study focused on the Owena River in the Idanre/Owena Local Government Area of Ondo State, Southwestern Nigeria. Situated between latitudes 7°17' and 8°15' N, and longitudes 5°01' and 5°45' E, the town has an elevation of 249 meters above sea level. It is located 21.6 km from Akure, the state capital, and 23 km from Ondo town. The region falls within the tropical rainforest zone, featuring distinct wet and dry seasons. The vegetation consists of woody trees that reach heights of 20-40 meters, characterized by small, evergreen leaves. The wet season lasts for about seven months (May to October) with annual rainfall averaging around 100±40 cm and temperatures around 28°C. The heaviest rainfall occurs from July to October, while the dry season spans from November to April.

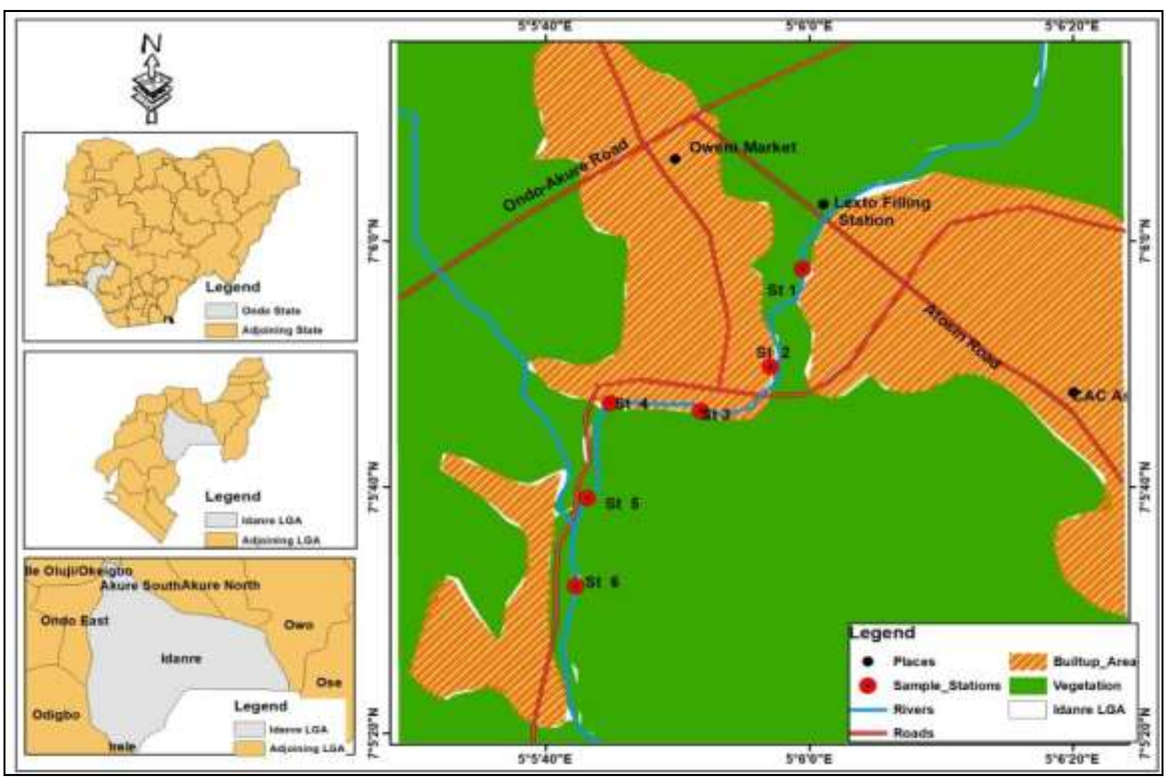

Figure 1: Map of the study area showing the location of the six sampling stations (St1-St6) on Owena River, Southwestern Nigeria

2.2 Water Sample Collection

Six sampling stations were selected along Owena River for the purpose of this study to assess water quality. Water samples were collected four times: twice in the dry season (December 2024 and March 2025) and twice in the wet season (June 2025 and September 2025). To reduce diurnal variations, sampling took place between 8:00 and 11:00 a.m. at each station. Samples were collected using a 1 L sterilized plastic bottle submerged mouth-first against the water flow, following standard procedure (APHA, 2017). Each sample was labeled with the station number and collection date. In situ measurements assessed temperature, depth, and transparency. Electrical conductivity (EC), pH, dissolved oxygen (DO), and total dissolved solids (TDS) were measured using a Multi 3630 IDS digital meter. Laboratory analyses for various parameters, including nitrate, phosphate, sulfate, alkalinity, magnesium, calcium, and water hardness, were conducted according to standard procedures. Water samples for determination of Biological oxygen demand (BOD) were collected in 250 mL amber bottles to exclude light, incubated in darkness for five days and calculated by subtracting the final DO from the initial DO to get the BOD.

2.3 Macroinvertebrate Collection and Identification

Macroinvertebrates were sampled concurrently using a long-handled D-frame net and direct hand-picking methods. Collected specimens were transferred to a white tray for sorting and screening with forceps, then preserved in labeled bottles containing 70% ethanol. Identification to species level was performed under a VZE/VZF series trinocular zoom stereo microscope, using taxonomic keys and guides such as De Moor et al. (2003), Umar (2013) and Suhling et al. (2014). All identified taxa were classified into Functional Feeding Groups (FFGs) (Cummins, 2016).

III. DATA ANALYSIS

Data collected in the study were analyzed using both inferential and descriptive statistics. Two-way ANOVA was employed to assess spatial and Seasonal variations in physico-chemical parameters and macroinvertebrates . Taxa diversity was evaluated using the Simpson, Shannon-Weiner, and Margalef indices, while community structure was analyzed through Functional Feeding Groups (FFG). Spearman's rank correlation coefficient was used to establish the relationships between physico-chemical parameters and macroinvertebrate abundance. Statistical analyses were conducted using Microsoft Excel, SPSS (Version 20) R and PAST (version 4.03).

IV. RESULTS AND DISCUSSION

4.1 Physicochemical Properties of Owena River

The spatial variation of these parameters across the river is shown in Table 1. Notably, except for sulfate and alkalinity, no significant variations were observed ($p>0.05$) among the physicochemical parameters. The highest concentration of dissolved oxygen (DO) was recorded at Station 1 (7.02±0.53 mg/L), while the lowest was observed at Station 4 (6.45±1.05 mg/L). Temperature readings across sampling stations ranged from 28.20±4.30°C to 28.83±3.60°C, with the maximum temperature at Station 4 and the minimum at Station 1. The highest pH (8.19±0.46) and magnesium concentration (4.75±1.24) were also recorded at Station 1, whereas the minimum values were found at Stations 5 (pH: 7.93±0.23) and 3 (magnesium: 3.79±0.28). Total Dissolved Solids (TDS) across the stations ranged from 85.00±5.60 mg/L to 86.75±3.30 mg/L, while Electrical Conductivity (EC) values ranged from 129.65±4.86 µS/cm to 127.30±7.88 µS/cm, with maximum values occurring at Station 3 and minimum values at Station 1. Biological Oxygen Demand (BOD) peaked at Station 3 (2.85±0.40 mg/L), while the lowest BOD value was found at Station 6 (1.61±1.98 mg/L). The highest calcium concentration (8.75±0.28 mg/L) was also noted at Station 3, with the lowest value at Station 6 (7.74±0.55 mg/L). Phosphate levels remained relatively constant throughout the year across all stations. The maximum sulfate concentration (5.52±0.01 mg/L) and nitrate concentration (7.9±5.55 mg/L) were found at Station 5, while the minimum values were recorded at Station 4 (sulfate: 4.58±0.01 mg/L; nitrate: 2.82±1.23 mg/L). Station 4 exhibited the highest alkalinity (287.00±7.39 mg/L) and water hardness (40.47±2.56 mg/L), while the lowest alkalinity (236.00±25.56

mg/L) and water hardness (36.95±5.37 mg/L) were observed at Stations 3 and 2, respectively.

Table 1: Spatial variation in the physico-chemical parameters of Owena River at each station, Southwestern Nigeria

Parameter	MEAN±SD						ANOVA	
	UPPER REACH		MID REACH		LOWER REACH			
	ST1	ST2	ST3	ST4	ST5	ST6	F	P
DO (mg/l)	7.02±0.53	6.79±0.34	6.88±0.47	6.45±1.05	6.52±1.30	6.71±0.36	0.316	0.896
PH	8.19±0.46	8.10±0.37	8.06±0.31	8.01±0.20	7.93±0.23	8.01±0.26	0.309	0.900
TDS (mg/l)	85.00±5.60	85.50±5.60	86.75±5.74	86.00±3.30	85.75±6.02	85.75±6.02	0.043	0.998
Temp (^{0}C)	28.20±4.30	28.53±4.69	28.32±5.48	28.83±3.60	28.28±3.99	28.30±4.43	0.010	0.999
BOD (mg/l)	1.85±2.44	1.99±2.18	2.85 ± 0.40	2.50 ± 0.68	2.05 ± 0.45	1.61±1.98	0.013	0.999
EC (µS/cm)	127.30±7.88	127.83±8.67	129.65±4.86	128.03±8.56	128.98±9.50	128.93±8.71	0.044	0.998
PO_4^{3-} (mg/l)	0.08±0.02	0.08±0.02	0.08±0.02	0.08±0.01	0.08±0.01	0.08±0.01	0.027	0.999
Mg^{2+} (mg/l)	4.75±1.24	4.1±0.76	3.79±0.28	4.74±0.54	4.55±0.88	4.54±0.34	1.056	0.416
Ca^{2+} (mg/l)	8.03±0.55	8.05±0.90	8.75±0.28	8.41±0.15	7.93±0.51	7.74±0.55	1.798	0.164
SO_4^{2-} (mg/l)	5.16±0.01^a	5.16±0.01^a	4.89±0.52^{ab}	4.58±0.01^{ab}	5.52±0.01^{bc}	5.51±0.01^c	11.810	0.000***
NO_3^- (mg/l)	5.73±3.65	6.98±4.89	4.90±3.03	2.82±1.23	7.90±5.55	6.92±5.50	0.735	0.606
Alkalinity (mg/l)	271±14.17^a	266.25±11.56^{ab}	236±25.56^{ab}	287±7.39^b	238.25±22.04^b	246±20.26^b	5.185	0.004**
Water Hardness (mg/l)	39.53±6.46	36.95±5.37	37.39±1.71	40.47±2.56	38.48±4.83	37.94±2.52	0.388	0.850

** indicates significant difference ($p < 0.01$), *** indicates significant difference ($p < 0.001$), and different superscript letters on the same row indicate significant difference based on Tukey's HSD Post-Hoc Test.

4.2 Taxonomic Composition of Macroinvertebrates in Owena River

A total of 1,197 specimens of macroinvertebrates distributed in Two (2) phyla (Arthropoda and Mollusca), Four (4) classes (Gastropoda, Malacostraca, Arachnida and Insecta), Ten (10) orders (Architaenioglossa, Lymnaeida, Sorbeoconcha, Decapoda, Araneae, Coleoptera, Ephemeroptera, Hemiptera, Odonata and Plecoptera), Twenty-seven (27) and Fifty-eight (58) genera were recorded in Owena River during the study (Table 2). Arthropoda was the dominant phylum as it accounted

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for three (3) Classes and seven (7) Orders, twenty-four (24) families, and Fifty-two (52) genera. Mollusca accounted for one class (Gastropoda), Three (3) orders, Three (3) families, and Six (6) genera. The Insecta class is the most diverse Class as it was represented by Five (5) orders , Twenty-one (21) families, and Forty-nine (49) genera, while Malacostraca was the least diverse class, represented by One (1) order , One (1) family, and One (1) individual . Spearman's rank correlation analysis revealed significant relationships between some of the recorded macroinvertebrates and physico-chemical parameters of the water (Table 3). Total dissolved solids (-0.469), Biological Oxygen Demand (-0.034), Electrical Conductivity (-0.438), Phosphate (-0.432), Magnesium (-0.454) and Water hardness (-0.562) were significantly correlated ($p < 0.05$ and $p < 0.01$) with the abundance of macroinvertebrates.

Table 2: Abundance of macroinvertebrates in Owena River, Southwestern Nigeria

Order	Families	Genus/species	Total Abundance	% Composition
Araneae	Pisauridae	Dolomedes sp.	15	1.25
		Thalassius sp.	22	1.83
	Tetragnathidae	Tetragnatha sp.	5	0.40
Architaenioglossa	Ampullaridae	Lanistes varicus	8	0.66
Coleoptera	Gyrinidae	Orectogyrus sp.	128	10.69
		Orectogyrus sp. B.	11	0.91
Decapoda	Potamonautidae	Sudanonautes aubryi	2	0.16
Ephemeroptera	Heptageniidae	Afronurus sp.	3	0.25
		Notonurus sp.	5	0.40
	Leptophlebiidae	Adenophlebiodes sp	3	0.25
	Oligoneuriidae	Elassoneuria candida	3	0.25
	Tricorythidae	Tricorythus sp.	1	0.08
Hemiptera	Belostomatidae	Sphaerodema sp.	45	3.94
		Limnogeton sp.	2	0.16
	Gerridae	Eurymetra sp.	1	0.08
		Limnogonus sp.	4	0.32
	Hebridae	Hebrus sp.	1	0.08
	Hydrometridae	Hydrometra sp.	8	0.64
	Naucoridae	Laccocoris sp.	14	1.12
		Neomacrocoris sp.	6	0.48
	Nepidae	Laccotrephes sp.	1	0.08
		Ranatra sp.	22	2.09
	Notonectidae	Erithares sp.	5	0.40
	Veliidae	Rhagovelia sp.	9	0.72
Odonata	Calopterygidae	Phaon iridipennis	10	0.80
	Chlorocyphidae	Chlorocypha curta	8	0.64
		Chlorocypha pyriformosa	25	2.17
	Coenagrionidae	Agriocnemis maclachlani	11	0.88
		Agriocnemis sp. B	3	0.24
		Ceriagrion sp.	4	0.32
		Elattoneura sp.	4	0.32
		Pseudagrion glaucum	47	3.78
		Pseudagrion hamoni	230	19.30

		Pseudagrion melanicterum	60	5.06
	Gomphidae	Lestinogomphus sp.	1	0.08
		Paragomphus sp.	1	0.08
		Phyllomacromia sp.	3	0.24
	Libellulidae	Brachythemis leucosticte	21	1.68
		Crocothemis erythrae	5	0.40
		Neodythemis sp.	1	0.08
		Olpogastra lugubris	14	1.12
		Orthetrum chrysostigma	16	1.28
		Orthetrum Julia	1	0.08
		Palpopleura lucia	1	0.08
		Palpopleura Portia	1	0.08
		Trithemis annulata	6	0.48
		Trithemis arteriosa	47	3.94
		Urothemis assignata	12	1.04
		Zygonoides sp.	5	0.40
		Zygonyx natalensis	4	0.32
	Macromiidae			
	Platycnemididae	Atoconeura sp.	1	0.08
		Mesocnemis singularis	65	5.71
Plecoptera	Perlidae	Neoperla spio	20	1.60
Lymnaeida	Planorbidae	Biomphalaria sp.	1	0.08
		Bulinus sp.	8	0.64
Sorbeoconcha	Thiaridae			
		Helisoma sp.	15	1.20
		Lymnaea sp	6	0.48
		Melanoides tuberculata	210	17.69

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Table 3: Spearman rank correlation analysis of relationship between macroinvertebrates and the physico-chemical parameters of Owena River, Southwestern Nigeria

Parameters	Correlation Coefficient(r)	p-value
DO-Abundance	0.427	0.0372
PH-Abundance	0.290	0.1692
TDS-Abundance	-0.469	0.0207*
Temperature-Abundance	0.267	0.2078
BOD-Abundance	-0.034	0.8733*
EC-Abundance	-0.438	0.0324*
Phosphate-Abundance	-0.432	0.0352*
Magnesium-Abundance	-0.454	0.0258*
Calcium-Abundance	-0.367	0.0777
Sulphate-Abundance	0.308	0.1433
Nitrate-Abundance	-0.079	0.7145
Alkalinity-Abundance	0.154	0.4714
Water Hardness-Abundance	-0.562	0.0042**

*Implies $p < 0.05$, ** Implies $p < 0.01$, Negative (r) values imply negative correlation between the parameters.

4.3 Community Structure of Macroinvertebrates in Owena River

Community structure of macroinvertebrates in terms of their functional feeding groups (FFGs) in Owena River is presented in Table 4. The macroinvertebrates were categorized into five (5) Functional Feeding Groups (FFGs), which include: Scrapers, Shredders, Predators, Collector–gatherer and Collector–filterers . Predators were the most abundant species in this group while shredders were the least abundant. Based on the mode of locomotion/microhabitat preference (ML/MP), the macroinvertebrates were also classified into six (6) categories: Clingers, Crawlers, Climbers, Skaters, Swimmer and Sprawlers. The climbers dominated this group as they were the most abundant, while swimmers were the least abundant in this group.

Table 4: Community structure of macroinvertebrates based on the Functional Feeding Groups/Mode of Locomotion/Microhabitat preference in Owena River, Southwestern Nigeria

Genus/species	FFG
Lanistes varicus	Scraper
Biomphalaria sp.	Scraper
Bulinus sp.	Scraper
Helisoma sp.	Scraper
Lymnaea sp.	Scraper
Melanoides tuberculata	Scraper
Sudanonautes aubryi	Shredder
Dolomedes sp.	Predator
Thalassius sp.	Predator
Tetragnatha sp.	Predator
Orectogyrus sp.	Predator

Orectogyrus sp. B.	Predator
Afronurus sp.	Scraper
Notonurus sp.	Scraper
Adenophlebiodes sp	Collector-Gatherer
Elassoneuria candida	Collector-Filterer
Tricorythus sp.	Collector-Filterer
Sphaerodema sp.	Predator
Limnogeton sp.	Predator
Eurymetra sp.	Predator
Limnogonus sp.	Predator
Hebrus sp.	Predator
Hydrometra sp.	Predator
Laccocoris sp.	Predator
Neomacrocoris sp.	Predator
Laccotrephes sp.	Predator
Ranatra sp.	Predator
Erithares sp.	Predator
Rhagovelia sp.	Predator
Phaon iridipennis	Predator
Chlorocypha curta	Predator
Chlorocypha pyriformosa	Predator
Agriocnemis maclachlani	Predator
Agriocnemis sp. B	Predator
Ceriagrion sp.	Predator
Elattoneura sp.	Predator
Pseudagrion glaucum	Predator
Pseudagrion hamoni	Predator
Pseudagrion melanicterum	Predator
Mesocnemis singularis	Predator
Lestinogomphus sp.	Predator
Paragomphus sp.	Predator
Phyllomacromia sp.	Predator
Atoconeura sp.	Predator
Brachythemis leucosticte	Predator
Crocothemis erythraea	Predator
Neodythemis sp.	Predator
Olpogastra lugubris	Predator
Orthetrum chrysostigma	Predator
Orthetrum Julia	Predator
Palpopleura lucia	Predator
Palpopleura Portia	Predator
Trithemis annulata	Predator
Trithemis arteriosa	Predator
Urothemis assignata	Predator

Zygonoides sp.	Predator
Zygonyx natalensis	Predator
Neoperla spio	Predator

The spatial distribution of the Functional Feeding Groups (FFGs) is presented in Figure 1. The highest number of Scrapers was recorded in Station 2 while the least was recorded in Station 4. Shredders were recorded only in Station 3 while Collector-gatherers were collected in only two stations (Station 1 and 4). The highest number of Collector-filterers was recorded in Station 1 but none were recorded in Stations 5 and 6. The highest number of predators was recorded in Station 1 while the lowest number was recorded in Station 6. The Seasonal variations of the functional feeding groups are presented in Figure 2. Predators were the most abundant specimens and had their highest number in dry season. The highest number of scrapers was recorded in dry season, while the lowest number was recorded in wet season. Shredders, collector-gatherer and collector-filterers were recorded in dry season while none were observed in the wet season.

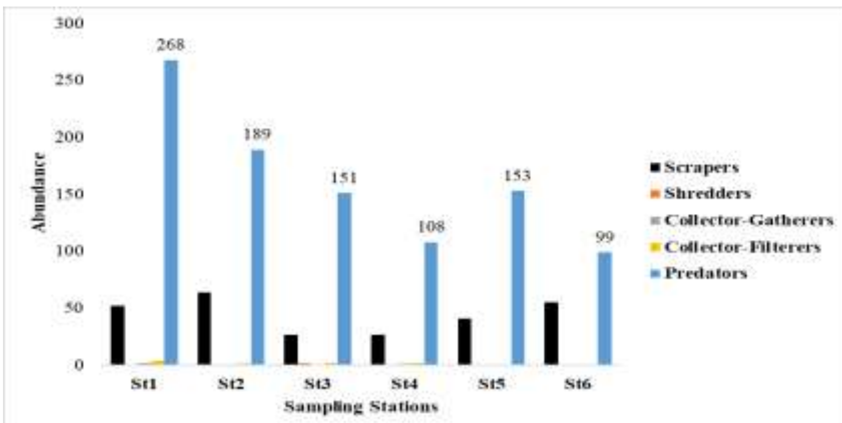

Figure 1: Spatial distribution of the Functional Feeding Groups (FFGs) in Owena River, Southwestern Nigeria

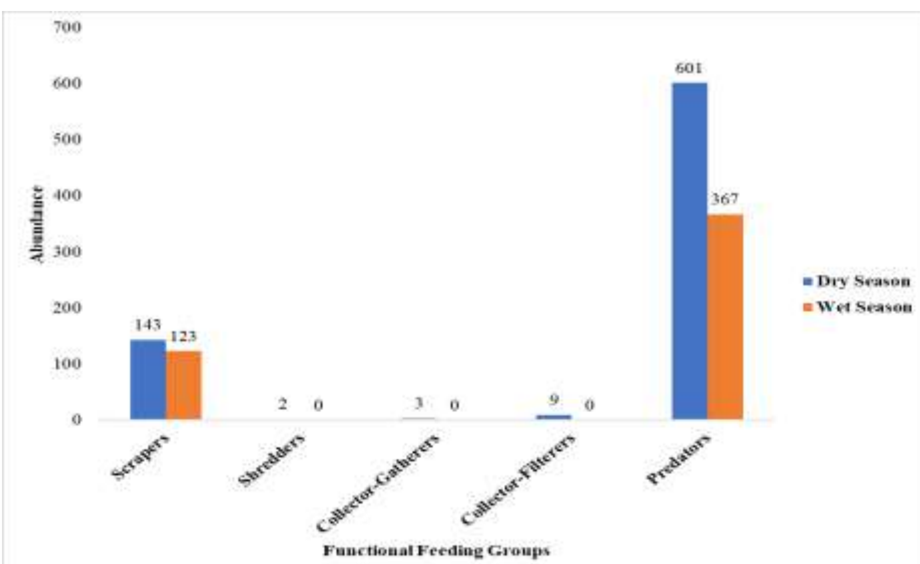

Figure 2: Seasonal distribution of the Functional Feeding (FFGs) Groups in Owena River, Southwestern Nigeria

V. DISCUSSION

5.1 Physicochemical parameters

The values of the physico-chemical parameters recorded in this study are consistent with those reported in similar tropical inland waterbodies in Nigeria, such as Awomeso et al. (2019), Aliu et al. (2020) and Amusan (2023). The results also compare favourably with studies conducted in different parts of the world such as Madilonga et al. (2021) on Mutangwi River, South Africa and Masime et al. (2022) on Athi River Basin Area, Kenya. The relatively lower concentration of DO in Station 4 as compared to other stations in this study may be attributed to higher temperature values recorded in the station. This is because temperature has been identified as a major determinant of the level of DO in water (Adu et al., 2019). Another possible factor for the relatively lower concentration of DO in Station 4 could be the lack of riparian vegetation around the station (Poff et al., 2021). Riparian vegetation provides shade and reduces the intensity of solar radiation that hits the surface of water, thus reducing water temperature. The relatively higher concentration of DO in the wet season may possibly be attributed to higher photosynthetic activities and drop in temperature in the wet season (Aduwo et al., 2019). Rainfall increases water mixing, which in turn increases the available DO during the wet season. Increased wind activity could also account for higher dissolved oxygen levels dusring the wet season (Okoro and Diejomaoh, 2020). Wind action could cause changes in water circulation, potentially replenishing oxygen and increasing its concentration in the water body. Similarly, higher DO concentration in the wet season has been reported in some freshwater bodies in Nigeria, such as Awomeso et al. (2019) on Ogun River and Amusan (2023) on Ara River.

The relatively low values of TDS recorded in this study may be attributed to the dense riparian vegetation and tree cover surrounding the river. These natural features have the capacity to absorb nutrients, thereby diminishing the influx of dissolved solids into the waterbodies (Olaniyan and Akinkuolie, 2016). Another possible reason for low TDS values recorded in this study could be due to the absence of industrial discharge within the study area, because higher organic matter contents present in wastewater discharge by industries directly into waterbodies increase the concentration of TDS (Saidu et al., 2020). These relatively low TDS values recorded in this study are consistent with Fubara et al. (2022) on Orashi River and Chukwujindu et al. (2023) on Bomadi River, Niger Delta.

Low value of BOD recorded across the sampling stations and along the three reaches of the river can be attributed to higher levels of salts and runoff containing pesticides and fertilizers from nearby farmlands into the water body . Excessive nutrient inputs into waterbody can inhibit the growth and activity of micro-organisms, leading to low concentration of BOD in waterbody. This finding does not support earlier report on the closest and most similar river in Ondo (River Oluwa), in which high level of BOD was reported (Ayandiran et al., 2018). This finding is also in contrast with the report on similar inland waterbodies, such as Yusuf et al. (2017) on Saba River, Osun State, and Bilewu et al. (2022) on selected waterbodies in Oyo and Lagos state in which high BOD was reported. The higher BOD values recorded in the dry season in this study could be due to the increased activity of decomposers while breaking down dead organic materials in the water body.

The Phosphate values recorded in this study were consistent across all the sampled stations. This indicates the presence of eutrophication, which is typically caused by an increase in the nutrient content of water (Ubuoh et al., 2022). The application of pesticides and fertilizers, which have the corresponding potential to contaminate waterbodies and indiscriminate waste disposal and agricultural runoff into rivers, are all associated with an increase in the amount of phosphate in waterbodies (Bronowicka-Mielniczu, 2020). This observation is in contrast to the values reported by Shokunbi et al. (2021) on some selected rivers and Adeosun (2019) in Ogun River. Low values of phosphate were recorded in the studies.

5.2 Taxonomic Composition of Macroinvertebrates in Owena River

Owena River can be considered rich in terms of macroinvertebrate taxa when compared with previous studies on similar freshwater bodies, such as Akindele et al. (2019) on Osun River, Anyawu et al. (2019) on Ossah River, Iyiola and Asiedu (2020) on Ogunpa River, Omovoh et al. (2022) on Wupa River, Amusan and Abubakar (2023) on Aro and Ewure Rivers, and Gao et al. (2023) on urban rivers in China. The relatively high abundance and diversity of macroinvertebrates obtained in this study may be attributed to factors such as water quality, nutrient availability, the presence and abundance of predator species, and the level of effective competition (Aliu et al., 2020). The dominance of Odonata in this study is not surprising because this group has been reported to be dominant in studies in waterbodies in Nigeria (Akawo et al., 2021, and Amusan, 2023). Odonata abundance may have resulted from their ability to successfully colonize new habitats before other groups could arrive (Mohammed et al., 2020). This is because they were good habitat colonizers. Odonata are able to establish themselves quickly and flourish in favorable conditions due to their adaptability and efficient reproductive strategies (Adu et al., 2019).

The abundance of Sorbeoconcha sp which are known to be pollution tolerant specie, could be an indication of pollution possibly brought about by decaying organic waste in water body (Iyiola and Asiedu, 2020). These organisms are mostly found in contaminated environments and are able to tolerate pollution. The low abundance of sensitive species of insects, such as members of Ephemeroptera, Plecoptera and Trichoptera (EPT) suggested an element of pollution load in the water body . The sensitive orders of insects are known to be abundant and well diverse in clean waters (Mohammed et al., 2020). Low abundance of these sensitive Orders of insects has also been reported in studies in similar landscapes (Karim et al., 2021). The high abundance of members in Libellulidae in the present study is similar to the observation in previous studies, such as Kemabonta et al. (2019), Adu et al. (2019), Mafuwe (2020) and Manu et al. (2022), in which Libellulidae was reported as the most abundant family in the various studies. The abundance of this family is not surprising because it has widespread representation globally and is known to be tolerant of polluted waterbodies. The abundance of Pseudagrion hamoni in this study is not surprising, as it has been reported to be widespread and common in West and East African freshwater bodies (Adu et al., 2022). This study supported Kemabonta et al. (2019), who reported Pseudagrion hamoni as the most abundant species on Akwa Ibom River. However, this finding does not support earlier observations on a similar river in Ondo (River Aponmu) in which few specimens of Pseudagrion hamoni were reported (Adu et al. 2022).

The abundance of macroinvertebrates in Owena River was found to be strongly negatively correlated with various physico-chemical parameters. This implies that high concentrations of these factors impede the diversity and abundance of macroinvertebrates. It also suggested that these markers of water quality might directly affect the freshwater body's capacity to sustain the diversity and abundance of macroinvertebrates, which are crucial elements of aquatic ecosystems and markers of a body of water's general health (Akawo et al., 2021).

5.3 Macroinvertebrates community structure

The community structure of macroinvertebrates has been widely used in bio-monitoring of water quality because their distribution reflects their tolerance to environmental variables. Due to their high food flexibility, tropical macroinvertebrates are generally known to adapt easily to a variety of environments (Sara et al. 2023). Availability of food resources in the river is reflected in the number of functional feeding groups and mode of locomotion/habitat preference found in this study (Cummins et al., 2022). The dominance of predators in this study is not surprising because they have been reported in abundance in Nigerian inland waterbodies (Adedapo et al., 2023). The availability of food has been cited as the main reason for the dominance of predators, which reflects less competition among them (Ono et al., 2020). Their abundance serves as a reported sign of declining water quality, typically resulting from human activities (Adeleke et al., 2024). The spatial distribution of these groups varied among the sampled stations, but these differences were not statistically significant. This suggests that there was a similar pattern in the distribution of predators in the sampled stations. This corroborates Benjamin (2021), who reported that Predators typically have similar distribution gradients along freshwater bodies. It is also not unusual for this kind of waterbody to have few shredders. This is because the shredder's importance in the breakdown of organic materials tends to diminish with altitude, allowing for faster microbial breakdown, particularly at high temperatures (Nahli et al., 2023). This finding is in consonance with Doong et al. (2021) and Makgoale et al. (2022), who reported few species of shredders in their various studies.

More feeding groups were recorded in the dry season as compared to wet season in this study. A decrease in the flow rate of the water body may be the cause of seasonal variations in the physico-chemical parameters, which could affect the macroinvertebrates' structural organization. This finding compares favorably with Aduwo et al. (2019) and Addo-bediako (2020), who reported higher feeding group abundance in the dry seasons. It can also be attributed to the abundance of preferred prey found in the waterbody, such as smaller aquatic macroinvertebrates and juvenile fish (Cummins, 2021).

VI. CONCLUSION

Findings in this study revealed similarities between Owena River and other previously investigated inland waterbodies in Southwestern Nigeria. The significant negative correlation between the macroinvertebrate composition and the physico-chemical parameters of the waterbody implied that the community structure at Owena River was determined by variations in the concentrations of the parameters. The rarity of sensitive macroinvertebrate taxa, the abundance of the generalist group, and pollution-tolerant species, as well as the values obtained for the water quality variables, suggested that the river was being constantly subjected to certain stress factors. As such, Owena River can be considered to be fairly polluted at the time this study was carried out.

VII. RECOMMENDATIONS

In order to properly manage water resources, it is important to assess the ecological status of waterbodies because the information gathered will offer reliable information on these waterbodies allowing for predictions to be made about their future water quality. Therefore, this study makes the following recommendations;

1. Given the gradual impact of human activities on Owena River it is imperative to establish continuous monitoring of the river and its macroinvertebrate community. This will help in tracking any further changes and ensuring the river's well-being.
2. Urgent measures should be taken to reduce anthropogenic activities in the vicinity of the river. Specifically, efforts should be made to curtail practices such as open defecation and the dumping of waste into the waterbody which are contributing to its pollution.
3. Government authorities should take proactive steps to educate the local communities surrounding the river about their activities and practices that may have detrimental effects on the river and its macroinvertebrate population. Raising awareness can lead to more responsible and sustainable behaviors that protect the river's ecosystem.

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