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Macro-Invertebrates Status of Oluwa River in Ondo State, Southwest, Nigeria

Olaniyan RF[1*], Ugwumba AO[2] and Ayoade AA[2]

[1]Department of Biology, Adeyemi Federal University of Education, Ondo, Ondo State, Nigeria

[2]Department of Zoology, University of Ibadan, Oyo state, Nigeria

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*For Correspondence

Department of Biology, Adeyemi Federal University of Education, Ondo, Ondo State, Nigeria.

E-mail: olaniyan4real_06@yahoo.com

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ABSTRACT

The macroinvertebrate fauna of Oluwa river, Ilaje Local Government Area, Ondo State, Nigeria were investigated for eighteen months (June 2014-November 2015) covering both the rainy and dry seasons. The major objective of the study was to provide baseline information on aspects of the biology (taxonomic composition, occurrence, distribution, and abundance) of the benthic macroinvertebrates. A total of six sampling stations were established to represent the various sections and regime of the river. Sediment samples were collected from each station at monthly intervals using an improvised Van-veen grab. Altogether a total of one hundred and sixty-two composite samples were collected and analyzed and assessed. The benthic macro-invertebrates made up of seventeen species belonging to three phyla; Arthropoda, Annelida, and Mollusca. They consisted of five classes: Crustacea, Gastropoda, Insecta, Oligochaeta, and Polychaeta.

Altogether a total abundance of 2,264 individual macro-invertebrates species were collected from the bottom sediment. The gastropods were the most abundant and constituted 50% of the total benthic macro-invertebrates organisms encountered in Oluwa river. *Pachymelanin aurita* had the highest percentage (12.9%). The least amongst this group was *Lanistes varicus* (5.1%). Polychaeta accounted for 27% of the total benthic macro-invertebrates organisms in Oluwa river. *Glycera capitata* had the highest percentage (8.7%) abundance. The least amongst this group was *G. convolute* (4.1%). The class Insecta accounted for 12% of the benthic macro-invertebrates in Oluwa river, *Chironomus* larvae had the highest percentage (4.5%) abundance, while *Chaoborus* larvae accounted for the least value (3.1%). The class Crustacea accounted for 7% of the total benthic macro-invertebrates in Oluwa river. Amongst the groups, *Nototropis swamidami* accounted for the highest percentage (3.8%), while *Iphinoe tripanosa* accounted for the least value (3.4%) of the total composition. Oligochaetae accounted for 4% of the total benthic macro-invertebrates organism in Oluwa river. *Ophinidomais serpentina* was the only species recorded and accounted for 3.8% of the abundance.

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In conclusion, on the basis of benthic macroinvertebrate taxa composition and abundance, Oluwa river can be inferred to be rich in fauna composition and therefore fairly polluted.

INTRODUCTION

Oluwa river winds through many communities in Ilaje Local Government Area in south-south of Ondo State, has a coastline of about 80 km with about 50 settlements scattered around the river (tributaries that empty directly into the coast), with an increasing population size of 2.2% annually [1]. Oluwa river is used for artisanal fishing activities, transportation, domestic purposes as well as mining of silica and sand. Despite the increasing anthropogenic influences occasioned by the rapid development of Ilaje communities as one of Niger Delta areas, there is a dearth of information on the composition, abundance, and diversity of benthic macroinvertebrates of the river. Macro-invertebrate organisms form an integral part of an aquatic environment and are of ecological and economic importance as they maintain various levels of interaction between the community and the environment [2], Knowledge of the structure of benthic macro-invertebrates community provides precise and local information on recent events, which can be seen in their structuring [2]. This study report for the first time the composition and diversity of benthic macroinvertebrates of Oluwa river, in Ilaje local government area, Ondo State.

MATERIALS AND METHODS

Study Area

The study was conducted on Oluwa river at Ilaje Local Government Area (ILGA), Ondo State, Nigeria. The river lies on latitude 40.40/-50.00//N and longitude 60.00/-60.20//E **(Figure 1)**. The annual rainy season occurs from April to October with a characteristic 'August break' during which rainfall abates, while the annual dry season occurs from November to March. Meteorological conditions within ILGA are as follows: mean daily minimum temperature (22.1-24.4°C); mean daily maximum temperature (24.9-36.8°C); total precipitation (125.2-278.5 mm) and mean relative humidity (76-88 mm) [3]. ILGA is in south-south of Ondo State with a coastline of about 80 km which runs in a northwest to southeast direction. The vegetation of the study area is mangrove forest with small evergreen broadleaves trees. The tallest trees are emergent about 40 m in height followed by the upper canopy about 20 m. Common mangrove trees include *Avicennia* sp., *Rhizospora* sp. and *Pandanus* sp. [4].

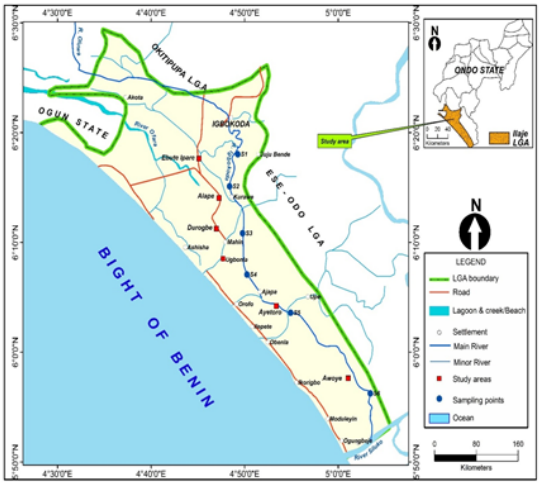

Figure 1. Map of ilaje communities in Ondo state, Nigeria.

Six sampling stations (1-6) were chosen on the Oluwa river. The distance between the stations was 500-1500 m and they were purposively selected based on the human activities in the area.

• **Station 1:** at Ebute-Ipare had less human activities. There were farming activities involving oil palm trees (*Elaeis guineensis*) plantations and planting of cassava crops in the area

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• **Station 2:** Alape, which was about 500 m from Station 1. The major activities in this area were the construction of canoes and mat-making. Stations 1 and 2 represent the upstream

• **Station 3:** This was at Durogbe Park, which was about 700 m from Station 2. Passengers board the canoes and engine boats to their various destinations on the river. Some of the vehicular wastes from engine boats were released into the river. There was a market around this station where the fishermen and fish sellers sold their fishes on the terminus under which were the dumpsites. This served as a source of organic wastes into the river. Some of the passengers also used the shores of the river as their public toilets

• **Station 4:** This was at Ugbonla; about 500 m from Station 3. There was deposition of wastes in this place. The inhabitants used this water for bathing, washing and also release wastes, such as cassava peels and palm kernel into the river. Also, sand mining activities were not left out around this station. Stations 3 and 4 represent the midstream stations

• **Station 5:** Ayetoro Town is about 600 m from Station 4 with residential buildings; business activities such as selling of fish, baskets, mats, and local gins take place. The market men and women use the shore of the river as their public toilets, as most of the houses around this place lacked toilet facilities

• **Station 6:** Awoye was about 1500 m from Station 5. There are farming activities and local gin production. Floating plants, such as water hyacinth (*Eichhornia crassipes*), covered the station during the rainy season. Stations 5 and 6 represent the downstream stations

Samples of benthic macroinvertebrates were collected monthly from the six sampling stations from June 2014 to November 2015 using a Van Veen grab (0.6 m^2 surface area). Three random replicate hauls of sediments were taken from each station. Each sediment sample was diluted with water and sieved with a 0.5mm mesh size sieve in the field [5,6]. The sorted benthic macroinvertebrates were preserved in 4% formalin in small glass jars. The individual organisms were identified macroscopically with the following guides and keys [7-11]. Spatial variations in benthic macro-invertebrates abundance were determined using the one-way Analysis of Variance (ANOVA). Shannon-Wierner diversity index and evenness were determined using PAST software

RESULTS

Benthic Macro-Invertebrate Composition

The benthic macroinvertebrate species identified in Oluwa river are listed in **Table 1**. The benthic macro-invertebrates organisms identified during the period of study were made up of seventeen species belonging to three phyla; Arthropoda, Annelida, and Mollusca. They consisted of five classes: Crustacea, Gastropoda, Insecta, Oligochaetae, and Polychaeta. The gastropods were the most abundant and constituted 50% of the total benthic macro-invertebrates organisms encountered in Oluwa river **(Figure 2)**. *Pachymelanin aurita* had the highest percentage (12.9%). The least amongst this group was *Lanistes varicus* (5.1%) **(Table 2)**. Polychaeta accounted for 27% of the total benthic macro-invertebrate organisms in Oluwa river. *Glycera capitata* had the highest percentage (8.7%) abundance. The least amongst this group was *G. convolute* (4.1%). The class Insecta accounted for 12% of the benthic macroinvertebrates in Oluwa river; *Chironomus* larvae had the highest percentage (4.5%) abundance, while *Chaoborus* larvae accounted for the least value (3.1%). The class Crustacea accounted for 7% of the total benthic macroinvertebrates in Oluwa river **(Figure 2)**. Amongst the groups, *Nototropis swamidami* accounted for the highest percentage (3.8%), while *Iphinoe tripanosa* accounted for the least value (3.4%) of the total composition. Oligochaeta accounted for 4% of the total benthic macro-invertebrates organism in Oluwa river **(Figure 2)**. *Ophinidomais serpentina* was the only species recorded and accounted for 3.8% of the abundance. Pollution indicator species formed a greater proportion (46.5%) of the benthic macro-invertebrates encountered in the Oluwa river **(Table 2)**.

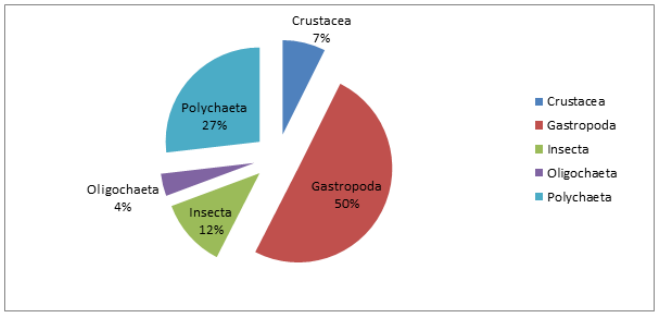

Figure 2. Percentage composition of benthic macroinvertebrates in Oluwa river.

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Table 1. A checklist of benthic macro-invertebrates recorded from Oluwa river from June, 2014 to November, 2015.

Phylum	Class	Species
Arthropoda	Insecta	*Chironomus larvae*
		Chaoborus larvae
		Phrganea larvae (caddis fly)
	Crustacea	*Nototropis swamidami*
		Iphinoe tripanosa
Annelida	Oligochaeta	*Ophidonais serpentina*
	Polychaeta	*Arenicula maina*
		Eunice haressi
		Glycera capitata
		Glycera convolute
		Nereis diversicolor
Mollusca	Gastropoda	*Pachymelania aurita*
		Pachymelania fuscatus
		Pachymelania fuscatus.var.quard
		Tympanotomus fusca
		Melanoides tuberculata
		Lanistes varicus

Table 2. Relative abundance of benthic macroinvertebrates in Oluwa river.

Species	Total number	Percentage abundance
Insecta		
* *Chironomus* larvae	103	4.5
Chaoborus larvae	72	3.1
Phryganea larvae (caddis fly)	95	4.1
Sub total	270	11.9
Crustacea		
Nototropis swamidami	88	3.8
Iphinoe tripanosa	79	3.4
Sub total	167	7.3
Oligochaeta		
* *Ophidonais serpentine*	87	3.8
Polychaeta		
Arenicula maina	105	4.6
Eunice haressi	107	4.7

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Glycera capitata	197	8.7
Glycera convolute	94	4.1
Nereis diversicolor	102	4.5
Sub total	605	26.7
Gastropoda		
Pachymelania aurita	294	12.9
P. fuscatus	213	9.4
P. fuscatus.var.quard	148	6.5
Tympanotomus fusca	182	8
* *Melanoides tuberculata*	182	8
Lanistes varicus	116	5.1
Sub total	1135	50.1
Grand Total	2,264	
*Pollution indicators species		

Spatial Variations in Benthic Macro-Invertebrates Abundance in Oluwa River

The highest number of individuals of benthic macro-invertebrates organisms was recorded for upstream (915 individuals), while the lowest value (736 individuals) was recorded for midstream station during the study period **(Table 3)**.

Table 3. Spatial variations in benthic macro-invertebrates abundance in Oluwa river.

Family	Upstream station	Midstream station	Downstream station
Crustacea	60	57	70
Gastropoda	455	353	327
Insecta	161	92	57
Oligochaeta	34	31	52
Polychaeta	205	203	237
Total Abundance	915	736	743

The Diversity of Benthic Macro-Invertebrates in Oluwa River

The highest Margalef (d) value (0.61) was recorded for the downstream station while the lowest value (0.58) was recorded for the upstream station during the study period. The highest (1.33) Shannon (H) value was recorded for downstream and lowest (1.28) was recorded for an upstream station. The highest Evenness (E) (0.75) was recorded in the downstream station, while the least value (0.72) was recorded for the upstream station **(Table 4)**.

Table 4. The diversity of benthic macroinvertebrates in Oluwa river.

Diversity indices	Upstream station	Midstream station	Downstream station
d	0.58	0.6	0.61
H	1.28	1.29	1.33
E	0.72	0.73	0.75

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DISCUSSION

Benthic Macro-Invertebrate Composition of Oluwa River

Seventeen species and 14 genera of benthic macro-invertebrates belonging to five families reported in this study are low compared to benthic macro-invertebrates abundance and diversity of some Nigerian environment. For example; Emere and Nasiru [12] recorded 1,304 organisms belonging to 8 class and 27 species in the urbanized bamawa Stream in Kaduna; George et al. [6] recorded 19 species belonging to 6 classes in okpoka creek in the niger delta area; Esenowo and Ugwumba [13] recorded 10,799 organisms belonging to 18 species in majidun river in lagos State, Adeogun and Fafioye [14] recorded 1,013 macro-invertebrates belonging to 4 taxa in Awba Stream and Resesrvoir in Ibadan; and Akindele and Liadi [15] recorded 19 taxa of macro-invertebrates in Aiba Stream, Iwo, south-western Nigeria. However, the taxa richness of Oluwa river is relatively higher than those of the works of Chukwu and Nwankwo [2], who recorded 8 species in port novo creek; and Nkwoji et al. [16], who reported 13 species in Lagos Lagoon and attributed the low abundance to organic pollution and dredging activities.

Higher relative abundance of pollution indicator species (including *Pachymelanin aurita* and *P. fusca*) encountered in Oluwa river could be attributed to organic pollution from dump sites along the shore of the river. Perhaps, these are not unconnected with a decline in the water qualities observed in the area, such as low DO Esenow and Ugwumba [13]. The organic pollution tolerant species found in this river are morphologically and physiologically adapted to surviving conditions of low water quality. These forms of include possession of pigment hemoglobin, which gives affinity for oxygen even at very low concentration Pertet et al. [17]. Gastropods are known to be relatively tolerant of physical and chemical variations in the environment and are usually present in a broad range of habitats [18]. Ajao and Fagade [19] also recorded gastropods as the dominant benthic fauna in Lagos Lagoon. *Pachymelania aurita* recorded the highest percentage abundance during the study period. A similar observation was made by Chukwu and Nwankwo [2] in Port Novo Creek. This is not unconnected with their ability to cope with decline water quality.

Species abundance and diversity were low, especially when compared with the other studies in Nigerian inland water. This study recorded the lower Margalef index of 0.58 in the study area. Conversely, Sikoki and Zabbey [20] recorded Margalef index of 2.39 and Ogbuagu [21] recorded 1.13 in the same Imo river; also Akindele and Liadi [15] recorded Margalef index of 2.89 for macro-invertebrates in Aiba stream, Iwo, south-western Nigeria. Other than from natural processes, anthropogenic perturbation has been known to threaten and exacerbate biological diversity losses [22]. Global biodiversity in freshwaters has also been reported to be on the decline [23]. Harrison and Stiassny [24] have identified habitat modification as exerting the most influence on aquatic biodiversity richness. Spaak and Bauchrowitz, [22] view sand mining as a major habitat modifier for aquatic biota. In-stream sand mining could impoverish aquatic sediment of essential nutrients necessary for a healthy and thriving biological community. The sand-mining activity could have contributed to the low value recorded in this study area.

Shannon-Weiner diversity index values above 3.0 indicate that the structure of the habitat is stable, while values less than 1.0 indicate that there are pollution and degradation of the habitat structure [25,26]. Margalef's water quality index values less than 1.0 indicate severe pollution and intermediate values indicate moderate pollution [27]. Based on the diversity indices values (0.58, 0.60 and 0.61) obtained in this study, Oluwa river can be regarded as being slightly polluted.

Some important factors governing the abundance and distribution of macrobenthic communities include water quality, immediate substrates for occupation and food availability [28]. Any ecological imbalance arising from any severe alterations of these factors may affect the macrobenthos. Therefore, it appears that the macrobenthic community abundance, composition, and diversity might have been greatly affected by stress imposed by land-based pollutants, as well as substrate instability possibly arising from frequent deposition of organic wastes in the river.

One important macro-invertebrate community indicator is EPT richness, or the total number of Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) taxa in a sample. An increasing EPT richness value correlates with increasing water quality [29] and many studies have indicated that Ephemeroptera, Plecoptera, and Trichoptera show a strong negative response to anthropogenic disturbances in aquatic ecosystems [30]. Although caddisfly was present in all the stations with low abundance, the absence of Ephemeroptera and Plecoptera throughout this study period is an indication that the river is of low biological water quality.

CONCLUSION

Gastropoda were the predominant taxa at Oluwa river during the period of study; followed by Polychaeta>Insecta>Crustacea>Oligochaeta. Pollution indicators species, such as *Chironomus* larvae, *Glycera capitata*, *Nereis diversicolor,* and *Pachymelania aurita*, were encountered in all the stations, suggesting pollution in the stations.

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