https://dx.doi.org/10.4314/dujopas.v10i2a.6
ISSN (Print): 2476-8316
ISSN (Online): 2635-3490
Dutse Journal of Pure and Applied Sciences (DUJOPAS), *Vol. 10 No. 2a June 2024*

Macroinvertebrates Diversity of a Municipal River Landzun, Bida, Nigeria

[1,2]Ndana, T. K., [2]Arimoro, F.O., [1,2]Usman, H. & [2]Ayanwale, V. O.

[1]Department of Biological Sciences,
IBB University,
Lapai,

[2]Department of Animal Biology,
Federal University of Technology,
Minna

Email: kedigi@ibbu.edu.ng

Abstract

This study evaluates the anthropogenic impacts of the River Landzun in Nigeria by analyzing macroinvertebrate data collected over a 6-month period. Benthic macroinvertebrates were collected using the Kick Seine method at four stations along the river, with station 1 serving as the reference point and stations 2, 3, and 4 experiencing varying levels of human activity. A total of 694 macroinvertebrates individuals representing 40 taxa were collected, with coleopterans being the most common across all stations, followed by odonates and dipterans at stations 2, 3, and 4 respectively. Canonical correspondence analysis (CCA) revealed strong relationships between species abundance and environmental parameters, indicating a significant impact on the ecosystem. The low abundance of Ephemeropteran – Plecoptera – Trichoptera (EPT) taxa suggests environmental disturbance across all sampling stations. Despite this, pollution-tolerant species, particularly in the odonate and coleopteran groups, were well-represented, likely due to the availability of diverse habitats and nutrients in the River Landzun.

Keywords: River Landzun, Pollution, Macroinvertebrates, EPT, Bida

INTRODUCTION

Rapid human population growth, industrialization, and the resulting urbanization have placed significant strain on freshwater resources worldwide, particularly in developing countries like Nigeria (Aliyu *et al.,* 2019). This strain is readily apparent in the state of our rivers and streams (Kun Li *et al.,*, 2014; Arimoro *et al.,*, 2015, Edegbene *et al.,*, 2015, Ndana, 2016, Arimoro and Keke, 2021; Mohammed *et al.,* 2020; Adama *et al.,* 2023).

River Landzun, a crucial river system in Niger State, Nigeria, serves as a tributary of the Niger River and is essential to maintaining local livelihoods while providing ecological benefits. It is a waterway that receives a considerable amount of waste and effluent from the surrounding catchment, which has a negative impact on the water quality. In developing nations like Nigeria, rivers and streams face considerable pressure due to a variety of pollutants entering

Author for Correspondence

water systems either directly or indirectly as a consequence of human activities. These activities include agriculture, transportation, domestic life, as well as sewage and waste disposal. The collective impact of these activities poses a threat to the aquatic ecosystem and contributes to the deterioration of water quality (Arimoro and Ikomi, 2007, Dadi-Mahmud *et al.,* 2014, Ndana, 2016). David (2008) identified aquatic stressors such as agrochemical residues from agricultural activities, domestic sewage disposal, anthropogenic wastes, organic waste and plant litter, and allochthonous organic inputs.

Despite the threats facing River Landzun, it is home to a diverse range of flora and fauna, including a variety of macrobenthic organisms. These organisms, which include insects, molluscs, and oligochaetes, play a crucial role in the ecological health and functioning of the river ecosystem. They serve as important water quality indicators, habitat conditions, and the overall ecological integrity of the river (Ndana, 2016 and Arimoro and Keke, 2021).

However, the available information on the macrobenthic assemblage of River Landzun is limited. Understanding the taxonomic composition, abundance, and diversity of macrobenthic organisms is crucial for assessing the ecological health and functioning of the river system. Therefore, this study aims to assess the macrobenthic assemblage of River Landzun, including taxonomic composition, abundance, and diversity.

METHODS

Description of the Study Area

The River Landzun serves as a prominent municipal watercourse flowing through the historic city center of the Nupe kingdom in Bida, Nigeria. Bida lies within the middle Niger Basin, commonly referred to as the Bida Basin. The town's geographic location is marked by its latitudes 09° 03' 8" N and 09° 06' 40" N and longitudes 06° 0' 0" E and 06° 02' 42" E (Figure 2.1). Bida is located about 35km from the tributary of River Kaduna called Wuya River along Mokwa-Bida road and 84km southeast of Minna, the capital of Niger State (Adekola and Saidu, 2005, Olagoke *et al.,* 2014, Ndana, 2016). Bida has two distinct seasons: the dry season spanning from November to March and the rainy season spanning from April to October. The dry season reaches its peak in March while the rainy season peaks between the months of July and September, which are the periods of highest rainfall (Olagoke *et al.,* 2014, Ndana, 2016). The River maintains a year-round flow and is situated on the outskirts of Bida town within Pici village, via the Edozhigi district of Gbako Local Government Area (LGA), Niger State. Originating from Pici, it traverses through Dokodza, Etsu Musa, and Darachita before converging with River Cike (known colloquially as 1990 River) at Cirico Area. Exiting the town, it merges with the Chanchaga River in Badeggi, Katcha LGA, Niger State, before linking with the Gbako River in Katcha. Eventually, it feeds into the Baro River, which in turn empties into River Niger (Ndana, 2016).

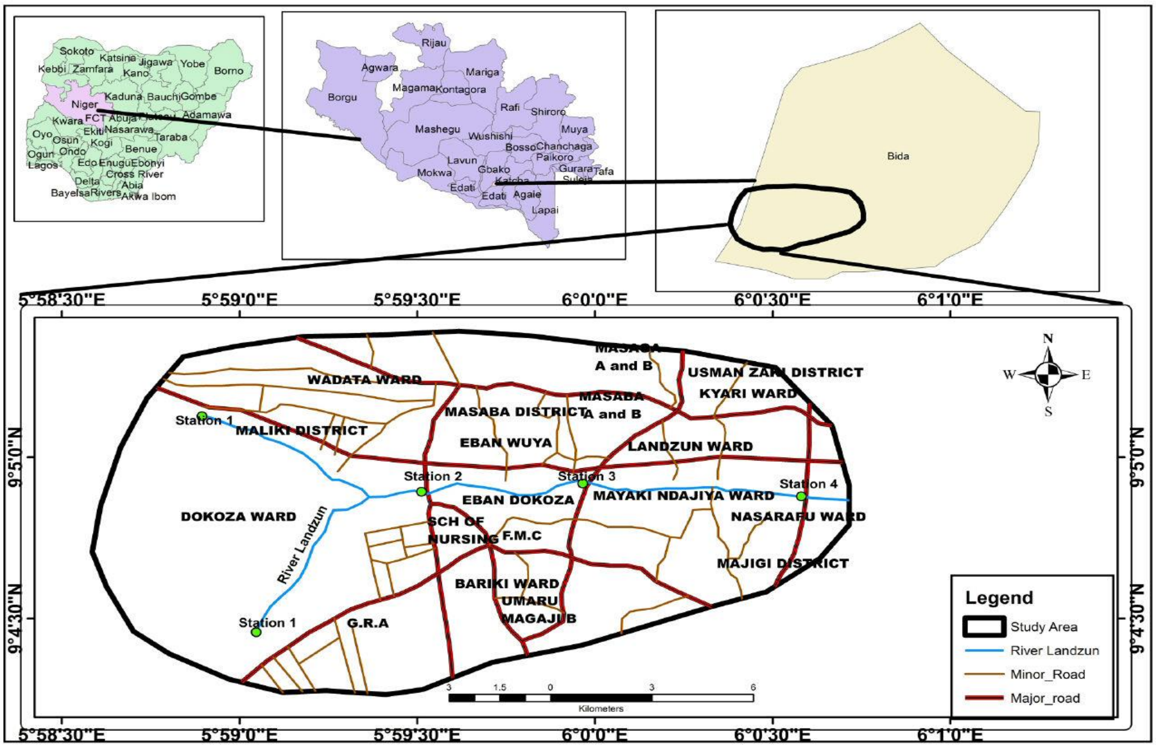

Figure 2.1 Map of Bida showing Study Stations

Sampling Stations

The sampling stations were randomly chosen based on the degree of the different activities by humans. The stations were labelled as stations 1, 2, 3 and 4 respectively. Also different kinds of vegetation common to each station were identified.

Station 1 was marked as river head/source (latitude 9° 3' 49.752" N and longitude 5° 59' 12.052" E) which is characterized by low flow velocity and shallow sediment. Plant vegetation common here includes bananas. Palm trees, coconut trees, Gmelina trees and other native trees and grasses. The predominant activity here is farming (Ndana, 2016).

The Station 2 (latitude 9° 04' 53.0" N and longitude 5° 59' 32.4" E), is located within the mix of people and approximately 3 km away from Station I. The flow speed was a bit high and deep. Several anthropogenic activities were seen taking place here. The activities that contribute to the pollution of the water body include washing clothes (laundry), bathing animals, car washing centres, human defecation, and the discharge of heavy drainage (Ndana, 2016). The plant life in this area is characterized by scattered growth, featuring species like Palm trees, Mahogany trees, Daniella trees, and neem trees, alongside other sparse native trees and grasses (Ndana, 2016).

Station 3 (latitude 9° 04' 52.5" N and longitude 6° 00' 35.6" E) is positioned at the heart of the city, approximately 1.3 km from station II, this site witnesses a range of human activities. These include laundry, washing of cement and flour bags, irrigation along the riverbank, drainage discharge into the river, and waste dumping. Additionally, a fresh fish market operates here, resulting in the disposal of gut and other waste products directly into the river. Consequently, this location bears significant disturbance from human intervention. The riparian zone is dominated by residential structures, resulting in the scarcity of native vegetation (Ndana, 2016).

Station 4 (latitude 9° 05' 07.9" N and longitude 6° 01' 04.7" E) is positioned approximately 4.2 km downstream from station III, this area is primarily dedicated to farming. An abattoir is also in close proximity to this location. Drainages are directed into the water body, contributing to human activities such as fishing, bathing, and irrigation farming, which includes vegetable gardens and serving as a water source for the nearby block industry (Ndana, 2016).

Macroinvertebrates Sampling and Analysis
The Kick Sein sampling method was utilized for the monthly collection of macroinvertebrates. A D-frame net with a mesh size of 250 µm was employed within a wadeable section of the river spanning approximately 25 m (Ndana, 2016). Each sampling station required about 60 minutes to cover various substrata (vegetation, sand, and gravel) and flow regimes (riffles, runs, and pools) inhabited by macrobenthic fauna. To ensure comprehensive sampling, four replicates were established. Collected samples were preserved in 75% ethanol and then transported to the laboratory for sorting and identification. In the laboratory, samples were rinsed through a 250 µm mesh sieve to eliminate substrate, and macroinvertebrate taxa were subsequently isolated using forceps and examined under a microscope (Ndana, 2016). The macroinvertebrates were identified at genus level with the aid of a stereomicroscope, following specific references, (Merritt and Cummins (1996); de Moor and Day (2002); Gerber and Gabriel (2002) and Robertson *et al.,* (2006). Also, reference was made to taxonomic lists of species known to be present in Africa such as de Moor *et al.,* (2003); Stals *et al.,* (2008); Arimoro and James (2008); Arimoro *et al.,* (2012); Umar *et al.,,* (2013) and Ndana, (2016).

Data analysis
Taxa richness (Margalef’s index), diversity (Shannon index) and evenness indices were calculated using the PAST statistical package (Hammer *et al.,* 2001 and Ndana, 2016). Canonical Correspondence Analysis (CCA) was used to determine the relationships between macroinvertebrate communities and the environmental parameters using PAST statistical package (Hammer *et al.,* 2001 and Ndana, 2016). CCA is a powerful tool for simplifying complex data sets, and, being a direct gradient analysis, it allows integrated analysis of both taxa and environmental data (ter Braak and Smilauer, 2002 and Ndana, 2016). Before conducting the final CCA, parameters exhibiting high correlations were excluded. Additionally, rare species, occurring in less than 1% of sampling events at each station, were omitted from the analysis.

RESULTS AND DISCUSSION

Macroinvertebrate Assemblages
Following sorting and identification, a total of 694 macroinvertebrate individuals comprising 40 taxa, distributed across 8 orders and 21 families, were documented during the study (see Table 3.1) (Ndana, 2016). The analysis of mean taxonomic abundance reveals the ubiquity of coleopterans across all sampling stations. Dipterans emerged as dominant taxa at stations 2, 3, and 4 (see Figure 3.1). Ephemeroptera and Trichoptera groups were sparsely encountered, primarily at station 2. Odonata were consistently present across all four sampling stations, with station 1, 2, 3, and 4 recording 54 (7.78%), 196 (28.24%), 294 (42.36%), and 150 (21.61%) individuals, respectively.

Table 3.1: Collected and identified Benthic Macroinvertebrate in the River Landzun, Bida, Nigeria from January to June 2016.

Order	Family	Taxa	Station			
			1	2	3	4
Oligochaeta	Lumbriculidae	*Lumbricoides* sp.	10	0	0	0
	Hirudinae	*Hirudina* sp.	3	0	0	0
Gastropoda	Physidae	*Physa fontinalis*	1	2	1	1
Ephemeroptera	Baetidae	*Baetis* sp.	0	4	0	0
Trichoptera	Rhyacophilidae	*Rhyacophila* sp.	1	0	0	0
Odonata	Libellulidae	*Libellula* sp.	2	25	7	13
		Brachythemis sp.	2	4	0	2
		Celithemis sp.	6	7	4	2
		Erethemis sp.	2	0	0	0
		Tremea lacerata	0	0	2	0
	Corduliidae	*Cordulia* sp.	3	10	0	0
		Epitheca sp.	1	0	0	0
	Gomphidae	*Ophiogomphus* sp.	1	1	1	0
	Aeshnidae	*Anax junius*	1	7	7	6
		Coryphaeschna ingens	2	0	1	0
	Coenagrionidae	*Coenagrion* sp.	2	8	7	6
	Lestidae	*Lestes* sp.	0	2	5	5
Hemiptera	Belostomatidae	*Lethocerus* sp.	0	0	0	1
	Nepidae	*Nepa cenerea*	7	1	0	2
		Ranatra linearis.	6	1	1	2
		Laccotrephes sp.	2	0	0	0
	Naucoridae	*Naucoris* sp.	2	0	0	4
Coleoptera	Hydrophilidae	*Helophorus* sp.	0	5	13	3
		Hydrobius sp.	0	10	28	10
		Ametor scabrosus	0	25	30	10
		Crenitis digesta	1	24	66	20
		Cymbiodyta acuminate	0	13	42	25
	Amphizoidae	*Amphizoa* sp.	0	0	0	1
	Scirtidae	*Scirtes* sp.	0	13	19	10
	Hydraeniidae	*Hydraena* sp.	0	0	1	0
Diptera	Chironomidae	*Chironomus transvaalensis*	0	36	58	26
	Syrphidae	*Eristalis* sp.	0	0	1	2
			54	**196**	**294**	**150**

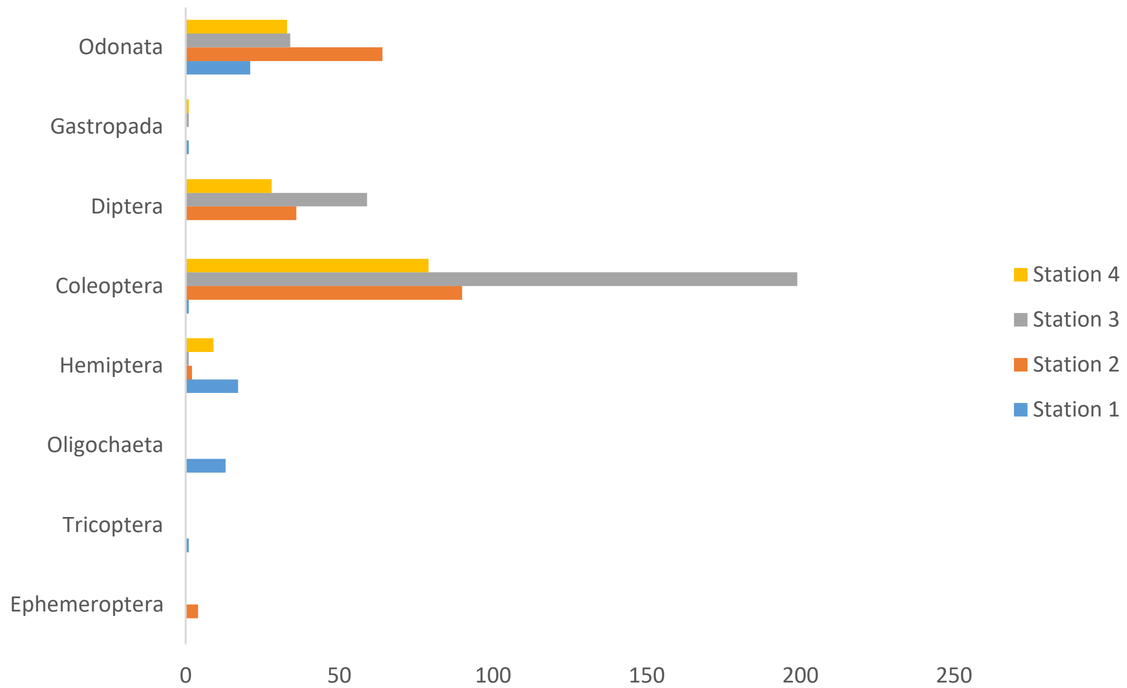

Figure 3.1: Average Distribution and abundance of the sorted group of macroinvertebrates in the sampling stations of Landzun stream, Bida, Nigeria, during the study periods (January – June, 2016).

Spatiotemporal dynamics in population density

Throughout the study duration, 55.7% of individual macroinvertebrates were observed during the dry season (January - March), while the remaining 44.3% were documented in the rainy season (April - June). Stations 2, 3, and 4 exhibited the highest population sizes in March, February, and January, corresponding to the months of the dry season, as well as in May and June during the rainy season. Overall, slightly greater abundances were noted in the dry season (January - March) compared to the rainy season (April - June).

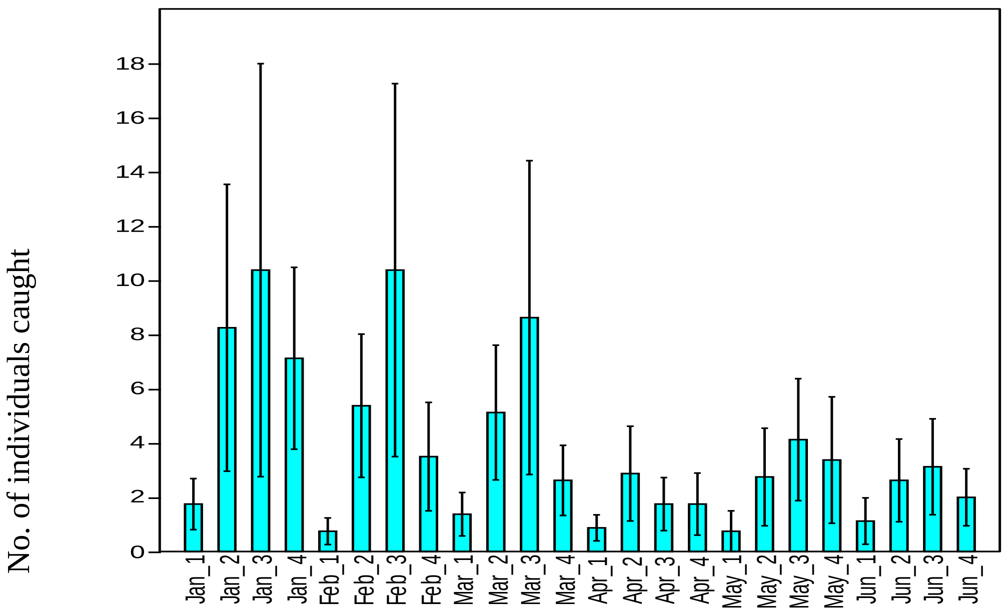

Figure 3.2: Average macroinvertebrates abundance within the research region in both dry (January – March) and rainy (April – June) seasons of the year 2016. The sampling stations are denoted by numbers 1, 2, 3, and 4, while the months are abbreviated

The Abundance indices (Diversity, Evenness, dominance and similarity)
A comprehensive overview of the biological indices, encompassing abundance, taxa count, Shannon-Weiner diversity, evenness, and Margalef's indices, computed for the four stations, is detailed in Table 3.2. The analysis indicates a significant disparity in mean abundance (individual count) across the stations, with station 3 exhibiting the highest, succeeded by stations 2, 4, and 1, respectively, with station 1 displaying the lowest overall mean abundance. Furthermore, Shannon-Weiner diversity (H') is notably diminished at station 3 compared to stations 1, 2, and 4. Margalef's index (d) peaks at station 1, followed by station 4, while a notably lower value is observed at station 3. Lastly, the mean evenness (E) value is markedly lower at station 3 in comparison to the other stations.

Table 3.2: Abundance Indices of the identified benthic macroinvertebrates of the Municipal stream, Landzun, Bida, Nigeria.

	Station 1	Station 2	Station 3	Station 4
Taxa_S	18	18	19	20
Individuals	55	198	294	145
Simpson_1-D	0.9005	0.9	0.8624	0.8991
Shannon_H	2.556	2.512	2.25	2.545
Evenness_e^H/S	0.716	0.6848	0.4994	0.6369
Margalef	4.242	3.215	3.167	3.818

The Shannon-Weiner diversity (H') was found to have a low value at station 3, whereas the Margalef richness index (d) reached its maximum at station 1. The mean evenness (E) value experienced a notable decline at station 3. The dry season accounted for a majority of over 55.7% of macroinvertebrates, while the rainy season saw less than 44.3% recorded.

The identified Macroinvertebrates and the Environmental correlation
The CCA plot exhibited notable correlations between species abundance and the assessed environmental parameters. Particularly, the first canonical axis shows over 60.92% (p=0.0396) of the variation within the data, as listed in Table 3.3. Axis 1, shows strong association with *Celethemis sp.* (drogon fly), *Ametor scabrosus* (water beetle), *Crenitis digesta* (water beetle), *Scirtes sp.* (water beetle), *Lumbricoides* (earth worm), *and Ranatra linearis* (water skaters), was principally influenced by factors such as depth, conductivity, phosphate, and nitrate (see Figure 3.2, Table 3.3). Samples from stations 1 and 2 were principally positioned on the left of the plot, while those from stations 3 and 4 were on the right. *Rhyacophila* (stone fly) and *Baetis* (may fly), not commonly found in other sampling stations, exhibited strong associations with stations 1 and 2 on the CCA plot. Furthermore, Axis 2 of the CCA plot was mainly associated with factors negatively impacted by dissolved oxygen (DO) and total dissolved solids (TDS) (Figure 3.2, Table 3.3).

In general, according to the CCA plot, stations 3 and 4, which house benthic macroinvertebrates including *Chironomus transvaalensis, Hydrobius sp., Ametor scabrosus, Crenitis digesta, Scirtes sp., Amphizoa sp., and Eristalis sp.*, were influenced (indicated) by factors such as depth, conductivity, phosphate, and nitrate. The abundance of these species served as indicators of nutrient concentration, depth, and conductivity. In contrast, organisms found in stations 1 and 2, including *Coryphaeschna ingens*, *Ophiogomphus sp.*, *Corduilia sp.*, *Rhyacophila sp.*, *Nepa cenerea*, *Ranatra linearis*, *Hydreana sp.*, *Physa sp.*, and *Lumbricoids* (for station 1), *Baetis sp.*, *Lestes sp.*, *Celethemis sp.*, *Coenagrion sp.*, *Libellula sp.*, *Anax junius.*, and *Cymbiodyta acuminate* (station 2), were affected by DO and TDS, reflective of the prevailing environmental conditions in those areas. Moreover, these species showed a preference for less organically-polluted environments. The occurrence of organic-tolerant species like *Lumbricoids, Hirudina, and Physa sp.* suggests the presence of stress in those particular stations.

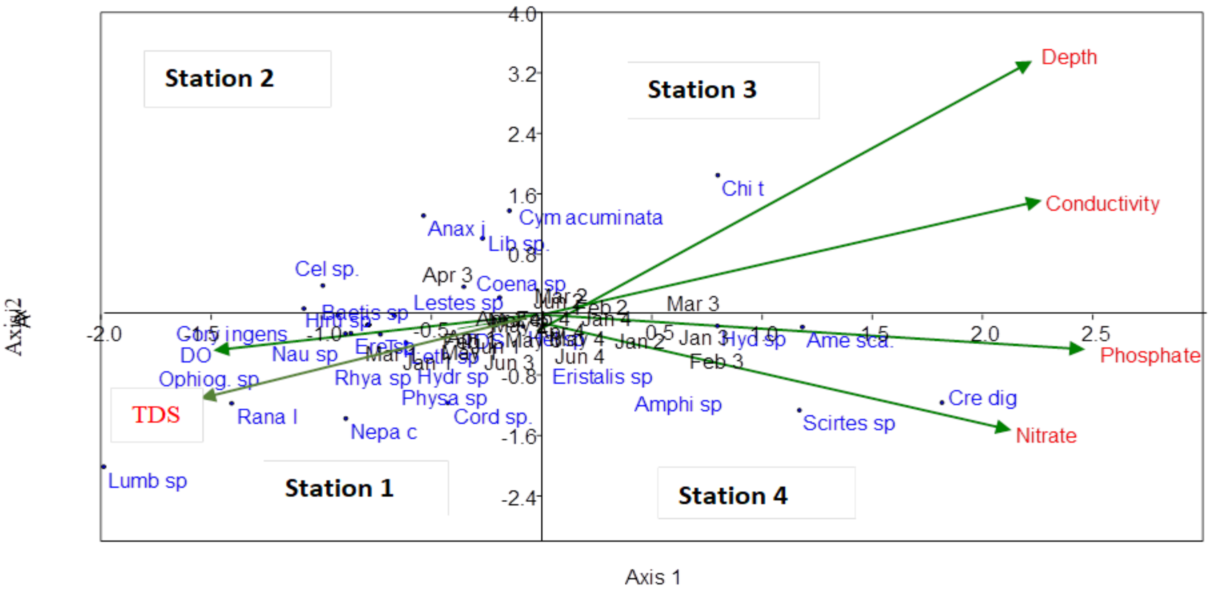

Figure 3.2 illustrates a tri-plot diagram featuring the first and second axes of CCA representing macroinvertebrate taxa, environmental variables, and sampling stations. The macroinvertebrate taxa are abbreviated as follows: *Ame. Sca. (Ametor scabrosus), Amphi. Sp (Amphizoa species), Anax j (Anax junius), Cel. Sp. (Celethemis species), Chi. t. (Chironomous transvaalensis), Cord. Sp. (Corduilia species), Cory. ingens (Coryphaeschna ingens), Cym. a (Cymbiodyta acuminata), Coena. Sp. (Coenagrion species), Cre. Dig. (Crenitis digesta), Hel. Sp. (Helophorus species), Hiru. Sp (Hirudina species), Hyd sp (Hydrobius species), Hydr. Sp (Hydraena species), Lib. Sp (Libellula species), Leth (Lethocerus species), Lumb. Sp (Lumbriculus species), Nauc (Naucoris species), Nepa c (Nepa cenerea), Rana (Ranatra linearis), Rhya. Sp (Rhyacophila species), Scirtes sp. (Scirtes species), and T L (Tramea lacerata).*

Table 3.3: CCA Data showing correlations between environmental parameters and the axes in Landzun stream, Bida, Nigeria.

Environmental Parameters	Axis 1	Axis 2	Axis 3
Eigen value	0.089	0.022	0.017
% of species Variation	60.4	14.52	11.34
Depth	0.366	**-0.594**	-0.235
TDS	-0.064	0.029	0.233
Conductivity	0.372	-0.270	-0.132
DO	-0.134	0.026	-0.393
Phosphate	**0.419**	0.061	0.269
Nitrate	0.354	0.239	-0.297

Bolded values represent a significant difference at $p<0.05$

Discussion

A total of 694 macroinvertebrate individuals, consisting of 32 taxa from 8 orders and 21 families, were gathered throughout the course of this investigation. This figure greatly surpasses the count of 676 benthos species reported by Arimoro and Keke (2016) from the Gbako River in North central Nigeria, the 101 species identified in the perturbed and severely contaminated Chanchaga River in Niger State, Nigeria by Edegbene *et al.,* (2015), and was lower when compared with count of 4461 macrobenthos fauna found in River Ndakotsu, Lapai, Niger State by Dadi-Mamud *et al.,* (2014). Still, it was lower when compared with the count of 1304 individuals of benthos fauna in the Urbanised Stream, Kaduna reported by Emire and Nasiru (2009), and the 4451 species in River Benue, Makurdi reported by Akaahan *et al.,* (2014), and the 2882 macrobenthic fauna in Ogba River, Niger Delta by Arimoro *et al.*, (2015).

The average high diversity of macroinvertebrates recorded in this study could be attributed to the heterogeneous habitat and availability of nutrients that favours high abundance of coleopterans and dipterans. Also, presence of patchy nature of vegetation and sandy substrates in the river system, may be attributed for favouring diverse groups of macroinvertebrates (Arimoro *et al.,*, 2015; Mohammed *et al.,* 2020; Mohammed *et al.,* 2021; Mohammed *et al.,* 2023). It is also safe to argue that the organic inputs into the river favoured the propagation of coleopterans: like hydrophilidae, oligochaetes and certain dipteran groups including chironomids and syrphinids which are usually dominants in organically polluted rivers (Arimoro, 2008). The abundance of these taxa is indicative of grossly polluted water body (Arimoro, 2008; Andem *et al.,*, 2014; Olomukoro and Dirisu 2014; Ikomi and Arimoro 2014; Arimoro *et al.,*, 2015; Mohammed *et al.,* 2023).

From this study, oligochaeta were represented by the Lumbriculidae and Hirudinidae, and are mostly found in grossly polluted water bodies such as Landzun stream in tropics. The annelids are group to class 4 (very tolerant of pollution) and the hirudinea are group to class 3 (fairly tolerant of pollution) organisms in the fresh water environment. The findings of this study was in conformity with the works of Arimoro and Ikomi (2008), who reported various types of oligochaetes excluding hirudinidae from their study on a municipal stream in the Niger Delta, Nigeria. Similarly, Emere and Nasiru (2009), also reported the group of Annelida and Hirudinea from the study of Urbansied stream in Kaduna, Nigeria, different species were reported in their work. The findings of this study were in disagreement with the findings of Arimoro and Keke (2016), for Gbako River, North central Nigeria, Dadi-Mamud *et al.,* (2014), for River Ndakotsu, Lapai, Niger State, and Edegbene *et al.,* (2015) for Chanchaga River Niger State, in which all reported absence of the oligochaeta from their studies.

Gastropoda represented only by physidae (5 individuals) and was group to class 4 (very tolerant of pollution) organisms, and was similar to the gastropod group reported by Arimoro and Ikomi (2008), Arimoro and Keke (2016), Dadi-Mamud *et al.,* (2014) and Arimoro *et al.,* (2015). The above submission, was contrary to the findings of Edegbene *et al.,* (2015), who reported absence of gastropods in the study for Chanchaga River, Niger State.

Baetis sp. was the only encountered species in the group of ephemeroptera throughout the sampling period. This may likely be attributed to the deteriorated state of the water body by the anthropogenic impacts of the riparian users. Plecoptera was totally absent throughout the study period. However, this is not strange as Dobson *et al.,* (2002) and Arimoro and Keke (2016) had earlier reported the scarcity of stonefly nymphs (plecoptera) in tropical African streams. The encountered Trichoptera species in this study was represented by *Rhyacophila* sp.

(caseless caddisfly) was in low diversity. The submission above was in contrary to the findings of Arimoro and Keke (2016), from the study of Gbako River, North central Nigeria, who reported high abundance and diversity of ephemeroptera and very low abundance of plecoptera and reported absence of trichoptera. From another study of Arimoro *et al.,*, (2015), who reported high abundance and diversity of ephemeroptera and trichoptera and recorded absence of plecoptera from their work for the Ogba River, Niger Delta, Nigeria. Similarly, Edegbene *et al.,*, (2015), reported low abundance and diversity of ephemeroptera and low abundance of plecoptera and recorded absence of trichoptera, from the study conducted for the Chanchaga River, Niger State. Dadi-Mamud *et al.,* (2014), reported absence of EPT from the study conducted for Ndakotsu River, Lapai, Niger State. However, these findings of this study agreed with Emere and Nasiru (2009) study of an Urbanised stream in Kaduna, Nigeria, where very low abundance of ephemeroptera was recorded and reported absence of plecoptera and trichoptera. Ephemeroptera: mayfly nymph, plecoptera: stonefly nymph and trichoptera: caddisfly nymph (EPT) are the group of the most sensitive and intolerant of pollution species. They are group as class 1 (very intolerant of pollution). Still, the presence of *Baetis* sp. (ephemeroptera) and *Rhyacophila* sp. (trichoptera) in very low number, and absence of plecoptera simply indicated that the Landzun stream is grossly polluted by the anthropogenic impacts at all stations, since similar studies have reported higher abundance and diversity of this group of benthic macro fauna to clean and free polluted water bodies in Nigeria (Arimoro and Ikomi, 2008; Arimoro *et al.,*, 2015; Edegbene *et al.,*, 2015; Arimoro and Keke, 2016) and elsewhere (Nelson and Roline 2003; Azrina *et al.,*, 2006; Edia *et al.,*, 2013; Elias *et al.,*, 2014; Peter *et al.,*, 2015; Kun Li *et al.,*, 2015; Ndana, 2016).

The order Odonata is separated into two suborders: Anisoptera - the dragonflies and Zygoptera - damselflies. This group were recorded in good number in abundance and diversity in the Landzun River and are group to be class 2 (moderately intolerant of pollution) organisms, following the Pollution Tolerance Index (PTI) of Hoosier Riverwatch classification system of aquatic insects for the biomonitoring potentials. Most family of this group were virtually present in the water body probably due to vegetation cover of the stream favouring their colonisation. The recorded families are: Libellulidae comprising of *Libellula* sp.; *Brachythemis* sp.; *Celethemis* sp.; *Erethemis* sp. and *Tremea lacerata*, Corduilidae comprises *Cordulia* sp. and *Epitheca* sp., Gomphidae: *Ophiogomphus* sp. and Aeshnidae comprises *Anax junius* and *Coryphaeschna ingens,* and for the zygopterans which include family Coenagrionidae with *Coenagrion* sp. and Lestidae with *Lestes* sp. All the reported anisopterans (except *Celethemis* sp., *Erethemis* sp., *Tramea lacerata, Anax junius*, and *Coryphaeschna ingens*) and zygopterans above, have been reported in similar fresh water studies in Nigeria (Arimoro and Ikomi, 2008; Emere and Nasiru 2009; Arimoro *et al.*, 2015; Edegbene *et al.*, 2015; Arimoro and Keke, 2016) and elsewhere (Walsh *et al.*, 2002; Reuda *et al.*, 2002; Nelson and Roline 2003; Azrina *et al.*, 2006; Odume *et al.*, 2012; Edia *et al.*, 2013; Elias *et al.*, 2014). However, the findings of this study is at variance from the study of Dadi-Mamud *et al.*, (2014) work, where the authors reported absence of the odonates in River Ndakotsu Lapai, Niger State, Nigeria. Moreover, judging based on the abundance and diversity of the odonata which was earlier propose to be moderately pollution intolerant groups, at all the sampling stations, simply indicated that, the Landzun stream was fairly polluted.

Hemiptera, also called true bugs, are recorded in abundance and diversity of families such as Belostomatidae: *Lethocerus* sp., Nepidae: *Nepa cenerea* and *Ranatra linearis* and Naucoridae: *Naucoris* sp. in the Landzun river. Still, similar studies in Nigeria, reported the above hemipterans from their studies (Arimoro and Ikomi, 2008; Emere and Nasiru 2009; Arimoro *et al.*, 2015; Edegbene *et al.*, 2015; Arimoro and Keke, 2016) and elsewhere (Walsh *et al.*, 2002;

Reuda *et al.*, 2002; Nelson and Roline 2003; Azrina *et al.*, 2006; Odume *et al.*, 2012; Edia *et al.*, 2013; Elias *et al.*, 2014).

From this current study, several different groups of coleopterans were recovered in large abundance and diversity. The groups include: Hydrophilidae – the most abundant group, Amphizoidae, Scirtidae, and Hydraenidae and are observed to be associated to a high nutrients environments and are pollution tolerant due to their hard exoskeleton. These findings was in agreement with Dickens and Graham (2002), who stated that, among water beetles, and generalised at the family level, adult and larval Gyrinidae, Dytiscidae and Hydrophilidae score as highly tolerant to water pollution, though at the low end of the category; Hydraenidae are moderately tolerant to pollution; whereas larval Scirtidae have very low tolerance to pollution. Similarly, Emere and Nasiru (2009), also reported that coleopterans are associated to organically polluted water body because of their ability to renew oxygen supply directly from the atmosphere and thus unaffected by oxygen depleting wastes and others have special adaptation for obtaining oxygen. In contrast, Arimoro and Keke (2016), reported that this group of coleopterans of the family Gyrinidae and Dytiscidae to be associated with fairly clean water environments (gross pollution free). Similar studies of this kind elsewhere that share same view (Merrit and Cummins 1996; Arimoro and Ikomi 2008; Andem *et al.*, 2014).

The order Diptera are known as the true or two-winged flies. The group of dipterans recorded include family chironomidae (midges) and syrphidae (*Eristalis* sp. rat-tail maggot) which were in abundance, and grouped to class 4 (very tolerant of pollution). Thus, the abundance and diversity of the family chironomidae in Landzun stream indicated gross pollution of the water body, as documented by (Arimoro and Ikomi, 2008; Arimoro *et al.*, 2015; Edegbene *et al.*, 2015; Arimoro and Keke, 2016) and elsewhere (Walsh *et al.*, 2002; Reuda *et al.*, 2002; Nelson and Roline 2003; Azrina *et al.*, 2006; Odume *et al.*, 2012). The favourable chemical properties of water conditions for the coleopterans and dipterans at station 2 and 3 may be likely the main factors accounting for the increased species richness and diversity at these two stations (Arimoro *et al.*, 2015 and Arimoro and Keke, 2016).

Generally, in terms of temporal assemblage variation, on the average, higher abundances of macroinvertebrates were recorded during the dry season than in the wet season. Increased flow characteristics of the rainy season usually lead to a reduction in macroinvertebrate diversity in tropical streams because of effects of wash offs from surrounding catchment activities and dislodgement of taxa with no adhesive features (Arimoro and Ikomi 2008, Arimoro *et al.*, 2015; Edegbene, 2015 Adamu *et al.,* 2022). Arimoro and Ikomi (2008) recorded higher densities of macroinvertebrates in the dry season in a municipal stream in Nigeria, and these authors suggested that dry season usually favours diverse macroinvertebrate taxa because of less wash-off effects.

CONCLUSION

A significant abundance of benthos invertebrates was observed in comparison to similar studies, possibly due to the diverse habitat and nutrient availability that provide favorable conditions for high numbers of coleopterans and dipterans. As a result, this research offers foundational insights into the present water quality status of the Landzun River and the composition as well as distribution of bioindicators. Moreover, this study can serve as a valuable resource for forthcoming ecological investigations in the area, given its relevance to the evaluation and preservation of river ecosystems.

REFERENCES

Adama, B.S., Mohammed, Y.M., Musa, I.N., Samuel, P.O. & Saba, J.J. (2023). The Effect of Flood Regime on Water Quality and Plankton Distribution in Bosso Area, Minna, Niger State. *Kampala international University Journal of Science, Engineering and Technology,* 02(2), 150-156. https://doi.org/10.59568/KJSET-2023-2-1-19

Adamu, K. M. Mohammed, Y. M., Ibrahim, U. F., Abdullahi, I. L. & Jimoh, Y. O. (2022). Assessment of some physical, chemical and biological parameters of Lake Dangana, Niger State, Nigeria. *The Zoologist,* 20,133-140. http://dx.doi.org/10.4314/tzool.v20i1.17.

Adekola, F. A., & Saidu, M. M., (2005). Determination of pollution level of water and sediments samples of Landzu River, Bida, Nigeria. *Journal of Chemical society of Nigeria.* 30(2), 181 – 186

Akaahan, T. J. A., Araoye, P. A., & Azua, E. T., (2014). Physicochemical characteristics and macroinvertebrate of River Benue at Makurdi, Benue State, Nigeria. *The International Journal of Science and Technology,* 2(6), 32 – 39

Aliyu, D.A., Rusea, G., Hishamuddin, O., Syazrin, S., Azroie, M.S., Fazli, B. (2019). Water Quality Characteristics of the National Hydraulic Research Institute of Malaysia (NAHRIM) Lake undergoing Remediation by the Constructed Wetlands: A Base line study. *Pertanika Journal of Science and Technology*, 27(2): 565 – 587

Arimoro, F. O. & Keke, U. N. (2016). The intensity of human-induced impacts on the distribution and diversity of macroinvertebrates and water quality of Gbako River, North Central, Nigeria. *Energy, Ecology and Environment, DOI 10.1007/s40974-016-0025-8*

Arimoro, F. O. & Keke, U. N., (2021). Stream biodiversity and monitoring in North Central Nigeria: the use of macroinvertebrate indicator species as surrogates. *Environmental science and pollution research*, https://doi.org/10.1007/s11356-021-12922-w

Arimoro, F. O., & James, H. M. (2008). Preliminary pictorial guide to the macroinvertebrates of Delta State Rivers, Southern Nigeria. Grahamstown: Albany Museum.

Arimoro, F. O., Ikomi, R. B., & Efernuna, E., (2007). Macroinvertebrate community patterns & diversity in relation to water quality status of River Ase, Niger Delta, Nigeria. *Journal of Fisheries and Aquatic Science,* 2(5), 337 – 344

Arimoro, F. O., Obi-Iyeke, G., & Obukeni, P. J. O. (2012). Spatiotemporal variation of macroinvertebrates in relation to canopy cover and other environmental factors in Eriora River, Niger Delta, Nigeria. *Environmental Monitoring and Assessment,* 184, 6449 –6461.

Arimoro, F. O., Odume, O. N., Uhunoma, S. I., & Edegbene, A. O., (2015). Anthropogenic Impact on water chemistry and benthic macroinvertebrate associated changes in a Southern Nigeria stream. *Environmental Monitoring and Assessment,* 187(2), 1 – 14

Azrina, M. Z., Yap, C. K., Ismail, A. R., Ismail A. & Tan, S. G. (2006). Anthropogenic impacts on the distribution and biodiversity of benthic macroinvertebrates and water quality of Langat River, Peninsular Malaysia. *Ecotoxicological Environment Safety*, 64, 337–347

Dadi-Mamud, N. J., Oniye, S. J., Auta, J., & Ajibola, V. O., (2014). Community Pattern and Diversity Index of Macroinvertebrates in relation to surface water interface of River Ndakotsu, Lapai, Nigeria. *Asian Journal of Science and Technology*, 5(9), 546 – 552.

David, D. (2008). *Tropical Stream Ecology.* Academic Press of ELSEVIER UK & USA, In: Oganic Matter Processing in Tropical Streams: Karl, MW, Catherine M. Y., Jude, MM, & Catherine M.P. 28pp

de Moor and Day, I. J., (2002). Freshwater Invertebrates of Southern Africa. Vol. 6: Arachnida and Mollusca. WRC Report No. TT 182/02. 141pp.

de Moor and Day, I. J., (2002). Freshwater Invertebrates of Southern Africa. Vol. 6: Arachnida and Mollusca. WRC Report No. TT 182/02. 141pp.

deMoor, I. J.,Day, J. A., & de Moor, F. C.(2003). Guides to the freshwater invertebrates of Southern Africa, vol. 7. Insecta I (Ephemeroptera, Odonata and Plecoptera) TT Pretoria: Water Research Commission.

Dobson, M., Magana, A., Mathooko, J. M. & Ndegwa, F. K. (2002). Detritivores in Kenya Municipal Streams: more evidence for the paucity of shredders in the tropics? *Freshwater Biology,* 47, 909–919

Edegbene, A. O., Arimoro, F. O., Odoh, O., & Ogidiaka, E. (2015). Effect of anthropogenicity on the composition and diversity of aquatic insects of a municipal River North Central Nigeria. *Bioscience Research in Today's World* (BRTW), 1(1), 55 – 66

Edia, E. O., Yves, B. K., Felix, K. K., Allassane, O., & Germain, G., (2013), Distribution of Aquatic Insects among four costal River Habitats (Cote d'Ivoire, West Africa). *Bulletin of Environmental Pharmacology and Life Sciences,* 2(8), 68 – 77

Elias, J. D., Ijumba, J. N., Mgaya, Y. D., & Mamboya, F. A., (2014). Study on Fresh water macroinvertebrates of some Tanzanian Rivers as a Basis for developing biomonitoring index for assessing pollution in tropical African regions. *Journal of Ecosystems,* 3(1), 65 – 74

Emere, M. C., & Nasiru, C. E., (2009). macroinvertebrates as indicators of the water quality of an Urbanised stream, Kaduna, Nigeria. *Nature and Science,* 7(1), 1 – 5

Hammer, O. & Harper D. A. T., & Ryan, P. D., (2001), Paleontological Statistics Software Package (PAST) for education and data analysis.

Kun Li, Chunguang, H., Jie, Z., Zhenxing, Z., Hongyong, X., Zhongqiang, W., Haijun, Y. and Lianxi, S. (2015). Long-Term changes in the water quality and macroinvertebrate communities of a subtropical river in South China, *Water 2015*, 7, 63 – 80

Merritt, R. W., & Cummins, K. W. (1996). An introduction to the aquatic insects of North America (3rd ed.). IOWA, Dubuque: Kendall-Hunt.

Mohammed, Y.M., Adamu, K.M., Ibrahim, B.U., Danjuma, S. & Amuzat, A.O. (2023). Exploring the Impact of Human Activities on Water Quality Characteristics of a Rural River in North-Central Nigeria using Macroinvertebrates Structural Assemblage. *West African Journal of Life Sciences,* 1, 023-034.

Mohammed, Y.M., Arimoro, F. O., Ayanwale, A.V., Adama, B. S., Keke, U.N., Auta, Y. I. & Umar, B.L. (2020). Seasonal changes in the abundance of benthic macroinvertebrates & Physico-chemical condition of Moussa stream Bida, Nigeria. *Tropical Freshwater Biology,* 29(1), 57-70. DOI: https://dx.doi.org/10.4314/tfb.v29i1.4.

Mohammed, Y.M., Arimoro, F.O., Ayanwale, A.V. Adamu, K.M., Keke, U.N., Abubakar, M.D. & Achebe, A.C. (2021). The current state of water quality and benthic invertebrate fauna in Chikke Stream (North-Central Nigeria). *Ukranian Journal of Ecology*, 11(3), 26-34. DOI: 10.15421/2021_136

Ndana, T. K. (2016). Anthropogenic impacts on physicochemistry and macroinvertebrates diversity of a municipal stream, Landzun, Bida, Niger State, Nigeria. *Unpublished M.TECH. Project submitted to Federal University of Technology, Minna, Niger State.*

Nelson, S. M. & Roline, R. A. (2003), Effects of multiple stressors on the hyporheic invertebrates in a lotic system. Ecology & Ind 3, 65–79

Odume, O. N., Muller, W. J., Arimoro, F. O., & Palmer, C. G. (2012). The impact of water quality deterioration on macroinvretebrate communities in Swartkops River, South Africa: a multimetric approach. *African Journal of Aquatic Science,* 37(2), 191–200.

Olagoke, O., & Olatunji, J.., (2014), Evaluation of water resources of Bida town in central Nigeria, *Journal of Environmrntal Sciences and Resources management*. 6(1), 44 – 55.

Olomukoro, J. O., & Dirisu, A. (2014). Macroinvertebrate community and pollution tolerance index in Edion and Omodo Rivers in derived savannah wetlands in Southern Nigeria. *Jordan Journal of Biological Sciences,* 7, 19 –24.

Orendt, C., Wolfram, G., Adamek, Z., Jurajda, P., & Schmitt-Jansen, M., (2012), The response of macroinvertebrate community taxa and functional groups to pollution along a heavily impacted river in central Europe (Bilina River, Czech Republic). *Biologia,* 67(1), 1 – 20

Peter, K. Emmanuel, H. L., & Alex, W. K. (2015). Amphibian and benthic macroinvertebrate response to physical and chemical properties of Themi River, Arusha, Tanzania. *Research and Review: Journal of Ecology and Environmental Sciences*, 3(2), 38 – 50

Reuda, J., Camacho, A., Mezquita, F., Hernanadez, R. & Roca, J. R. (2002), Effect of episodic and regular sewage discharge on water chemistry and macroinvertebrate fauna of a Mediterranean stream. *Water Air Soil Pollution*, 140, 425–444

Stals, R. & de Moor, I. J. (2008). *Guides to the Fresh water Invertebrates of Southern Africa. Volume 10: Coleoptera.* Water Research Commission, Gezina, Pretoria, South Africa

ter Braak, C. J. K., & Smilauer, P. (2002). CANOCO reference manual and Canoco draw for Windows user's guide: software for canonical community ordination (Version4.5). New York: Microcomputer Power, Ithaca.

Umar, D. M., Harding, J. S., & Winterbourn, M. J., (2013). *Photographic Guide: Freshwater Invertebrates of the Mambilla Plateau, Nigeria.* Published By School of Biological Sciences, University of Canterbury, New Zealand.

Walsh, C. J., Gooderham, M. R., Grace, S., Sdraulig, M. I., Rosyidi, A. & Lelono, A. (2002), The relative influence of diffuse and point-source disturbances on a small upland stream in East Java Indonesia: a preliminary investigation. *Hydrobiologia* 487, 183– 192