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Diversity and Abundance of the Macroinvetebrate Community of River Ngadda, North-Eastern Nigeria

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Abstract

The diversity and abundance of macro invertebrates of River Ngadda, in northeastern Nigeria was studied between May, 2013 and January 2014. One station each at both the upstream and the downstream portion of the river were selected and sampled monthly and investigated for their macro-invertebrates community using basic statistical measurement of abundance and diversity indices. The species diversity in the river was high and quite evenly distributed between the two stations sampled. A total of 5912 individuals in 40 species, from 7 classes and 21 taxonomic families were encountered. The dominant class was the Insecta (38.9%) with the Nematomorpha (0.7%) being the least occurring class. The macro invertebrate community of River Ngadda demonstrated species distribution that is in synchrony with the perturbation level of the station, with pollution tolerating species being more abundant in station 2 which had more anthropogenic perturbations. The study recommends that the State environmental protection agency in synergy with other regulatory bodies should control unacceptable land-use and development plans on riparian land.

Keywords: Macro-invertebrates, diversity, River Ngadda, Maiduguri, Nigeria

Introduction

Macro benthic invertebrates are useful bio-indicators providing a more accurate understanding of changing aquatic conditions than chemical and microbiological data, which at least give short-term fluctuations (Ravera, 1998, 2000; Ikomi *et al.*, 2005). Odiete (1999) stated that the most popular biological method in assessment of freshwater bodies receiving domestic and industrial wastewaters is the use of benthic macro-invertebrates.

Macro invertebrates principally comprise of crustaceans like crayfish, leeches, annelids, water insects (mayfly and stonefly), and molluscs (snails and clams, etc.). They are of three types, some are sensitive to pollution like mayflies, some are pollution tolerant like

Dragonflies, Dames flies and aquatic worms (Benetti and Garrido, 2010; Davis *et al*., 2003).

Information on the biology and diversity of macro invertebrates in various water bodies are scattered (Ibemenuga, 2006) with Egborgbe (1993) reporting about 1630 species of invertebrates found in Nigerian waters out of 67% are macro invertebrates. Literature abound on the aquatic macro invertebrates in Nigerian waters including but not limited to those of Victor and Ogbeibu (1991); Ogbeibu and Egborge (1995); Ogbeibu and Oribhabor, 2001; Odo, 2004; Ansa (2005); and Idowu *et al*., 2004;) with marked differences in species composition of the water bodies reported across the various water bodies. This specificity makes the study of individual water bodies more relevant to the understanding of the aquatic resources therein which will in turn assist with improved management options to be practiced. There had been limited published studies done on the macro invertebrates of River Ngadda in recent times especially since the beginning of the insurgency some 10 years ago, hence this study is aimed at bridging that gap in research.

Materials and Methods

Study Area:

River Ngadda, located at latitude 11° 50'N and longitude 13° 09'E is found in Maiduguri, the capital city of Borno state in the north eastern geo-political zone of Nigeria which shares international boundaries with republic of Niger and Chad in the north and Cameroon in the east. It has a population of 4,171,104 (NPC, 2006) and a total area of 70,898 km^2 (27,374 m). The area is semi-arid, with a long summer and short winter and a mean temperature of 25 °C to 37 °C. The mean total rainfall is 150 to 300 mm per year with 80 to 85% of the river annual discharge in the wet season.

The river is used for various human activities including fishing, vegetables irrigation, brick making and by residences along the river banks for bathing, washing and as drinking water by animals. The river originates from Rivers Yedzram and Gombole which meet at a confluent at Sambisa both in Nigeria and flows as River Ngadda into Alau Dam and stretches down across Maiduguri Metropolis then empties into Lake Chad. The river receives copious amounts of wastes from residential houses and abattoirs sited along its course (Akan *et. al*., 2011).

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Two stations on River Ngadda were selected as sampling points i.e. behind State water board and behind the State quarry company as station 1 and 2 respectively. Station 1 which is up stream is characterized by sparse vegetation due largely to the massive soil excavation going on there with minimal human activity overall and absence of settlements. On the other hand, station 2 which is downstream is replete with human habitation on both sides of the river with its attendant human activities like waste disposal into the river, fishing and washing occurring there. Sampling frequency was monthly for nine months (May 2013 to January, 2014).

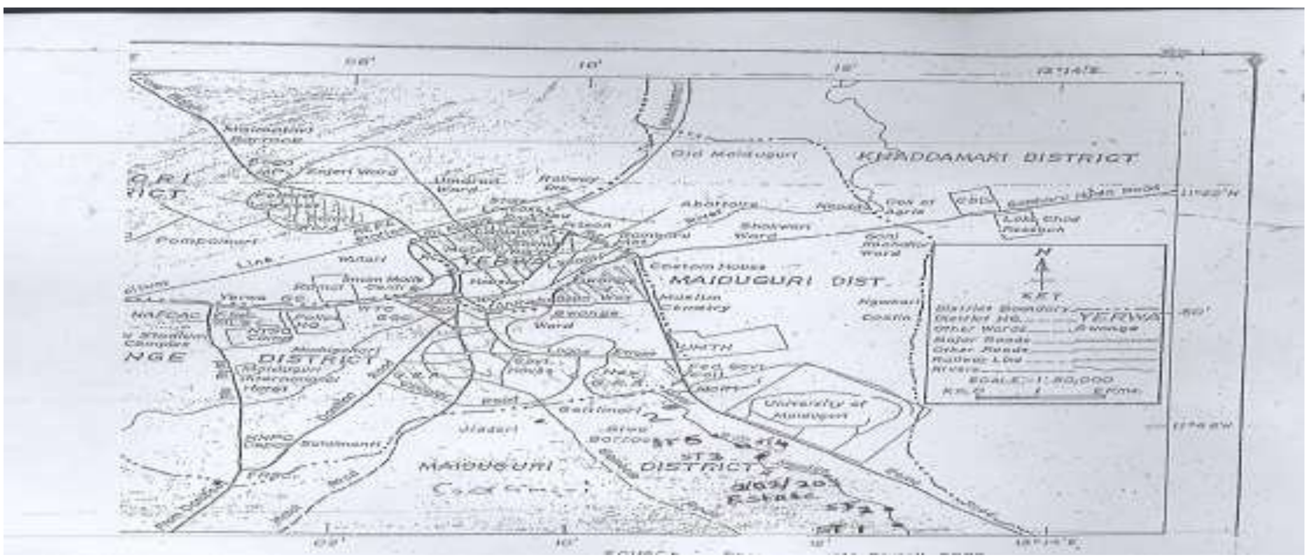

Fig. 1: Map of the sampling stations in River Ngadda showing location in Nigeria

Macro invertebrates sample collection

The benthic samples for the analysis of benthic organism were collected using a Surb sampler ($0.4m^2$, 20nm mesh netting) and a core borer of diameter 15 cm and 20 cm (for sampling the benthos on the water beds and substratum). This involves scraping the substratum and the sediments into the net where the net sampler can't be used while resorting to the core borer. The use of both sampling technique is to take habitat difference into account (Ogbeibu, 2001).

The washed sediment with macro-invertebrates were poured into a wide mouth labeled plastic container and preserved with 10% formalin solution to which Rose Bengal (dye) had been added. The Rose Bengal dye strength was 0.1% selectivity colored all the living organisms in the sample (Claudiu *et al*., 1979; Zabbey, 2002; Idowu and Ugwumba, 2005). The preserved samples were taken to the laboratory for further analysis. The washed and preserved sediment with the benthic macro-invertebrates were poured into a white enamel tray and sorted in the laboratory. For effective sorting, moderate volume of water was added into the container to improve visibility. Forceps were used to pick large benthos while smaller ones were pipetted out. The benthos were sorted into their different groups and preserved in 5% formalin. The preserved benthos were later identified to their lowest taxonomic group under light and stereo dissecting microscope and counted. The identification was done using the keys by Clifford (1991) and Pennak (1978). The monthly percentage occurrence and relative numerical abundance of macro invertebrates were estimated.

Faunal Diversity:

Faunal diversity index for taxa richness was analyzed using a combination of three diversity indices. The Margalef's Index (D) for species richness, D = (S-1)/Ln N (Margalef, 1968) where S = number of species and N = number of individuals; the Shannon-Wiener's Index (H') of species diversity H' = -∑Pi Ln Pi (Shannon & Wiener, 1963) where Pi is the proportion of the total number of individuals occurring in species i and the Pielou's Index (J) for species evenness J = H'/Ln S (Pielou, 1969) where H' is the species diversity index and S is the number of species.

Results

Macro invertebrates Composition and Abundance:

Table 1: Benthos abundance across stations

Phylum	Class	Family	Species	Station 1	Station 2
Mollusca	Gastropoda	Hydrobiidae	*P. jenkinsi*	√	x
		Bithynidae	*H. immatures*	√	x
		Lymnaeiidae	*B. tentaculata*	√	x

		Valvatidae	*L. truncatula*	√	√
		Viviparidae	*L. palustris*	√	√
		Physidae	*V. lewis*	√	√
			V. sincera	√	√
			Viviparous sp.	√	√
			P. gyrina	√	√
	Bivalvia	Dreissenidae	*D. polymorpha*	√	x
		Sphaeriidae	*S. simile*	√	√
		Unionidae	*P. casertanum*	√	√
		Nuculoida	*P. nitidum*	√	√
			E. campalamata	√	√
			L. radiate	√	√
			N. proxima	√	x
			N. tenius	√	x
Annelida	Oligochaeta	Lumbriciidae	*L. variegates*	√	√
		Tubificidae	*L. terrestris*	√	√
		Naididae	*Tubifex sp.*	x	√
			B. sowerbi	x	√
			N. barbata	√	x
			N. simplex	√	x
			N. pseaudobtusa	√	x
			N. elinguis	√	x
	Hirudinea	Glossiphoniidae	*H. stagnalis*	√	√
Arthropoda	Insecta	Chironomidae	*C. riparius*	√	√
		Simullidae	*Chriptochironomus sp.*	√	√
		Gamphidae	*L. ballentus*	√	√
		Culicidae	*H. piipes*	√	√
		Aeshnidae	*Paratendiphus sp.*	√	√
			P. serenus	x	√
			Anopheles sp.	√	√
			Culex sp.	√	√
			A. anas	x	√
			Brachtron sp.	x	√

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	Arachnida	Pisauridae	*Dolomedes sp.*	√	x
			Hydrocarina sp.	√	x
Nematoda	Nematomorpha	Mermithae	*Monhystera sp.*	x	√
			Nematomorphs sp.	x	√
04	**07**	**21**	**40**	**33**	**28**

***√ = Found in the station   x = Not found in the station**

Table 1 show the complete benthic faunal composition of the two stations. A total of four (4) phyla spread across seven (7) classes, twenty one (21) families and forty (40) species. The table also indicated that the nematomorpha class was absent at station 1 while station 2 recorded the class Arachnida as been absent. In terms of species, station 1 had a higher species composition with 33 species than station 2 which had 28.

Table 2: Benthos class composition and abundance

Benthos Class	Station 1	Station 2	All Stations	% Composition
Gastropoda	482	360	842	14.2
Bivalvia	1379	343	1722	29.1
Oligochaeta	261	506	767	13.0
Hiruidinea	28	134	162	2.7
Insecta	592	1705	2297	38.9
Arachnida	83	0	83	1.4
Nematomorpha	0	39	39	0.7
Total	**2825**	**3087**	**5912**	**100.0**
% by station	**47.8**	**52.2**	**100**	

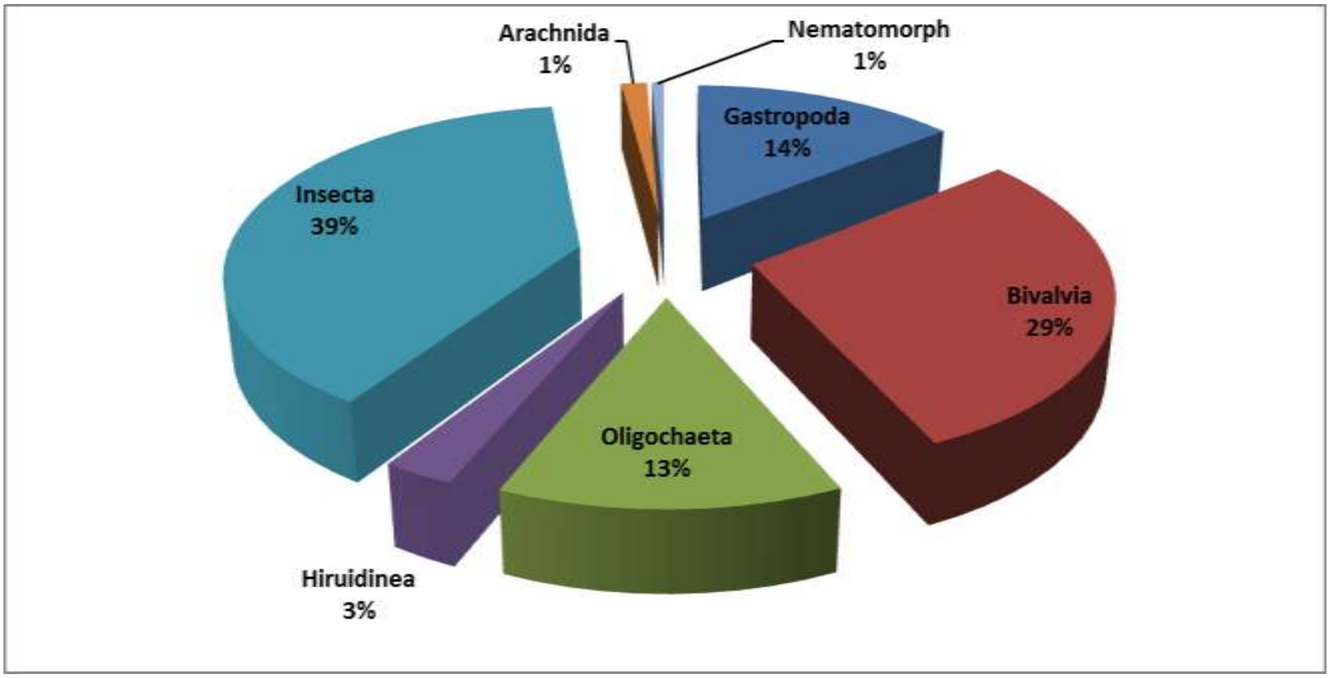

Fig. 2: Macro invertebrate class percentage composition

Table 2 show the distribution and percentage composition of the macro invertebrates by class. A total of 5912 invertebrates were encountered and identified into seven (7) classes. The fauna, by class was dominated numerically by Insecta (38.9%) followed by Bivalvia (29.1 %), Gastropoda (14.2%), Oligochaeta (13.0 %) while Nematomorpha (0.7 %) recorded the least abundance (fig. 2). Station 2 recorded much higher abundance than station 1 overall, however, Bivalvia, Gastropoda and Arachnida class demonstrated higher abundance in station 1 than in station 2 (table 2).

Table 3: Number of families and species in each class of macro invertebrates

Class	Total number of families	Total number of species	Percentage species composition (%)
Gastropoda	6	9	22.5
Bivalvia	4	8	20
Oligochaeta	3	8	20
Hirudinea	1	1	2.5
Insecta	5	10	25
Arachnida	1	2	5
Nematomorpha	1	2	5

	21	40	100

Table 3 show the number of families and species and the percentage species composition of each class of macro invertebrates. The gastropoda class had the highest number of families (6) followed by the insecta class (5) while the arachnida, nematomorpha and hirudinea recorded the least number of families with one each. In terms of species number, the insecta class recorded the highest number of species (10), followed by gastropoda (9) while hirudinea (1) recorded the least number of species. Correspondingly, the insect class had the highest species composition (25%), followed by gastropoda (22.5%) with arachnida and nematomorpha recording the least both with 5% species composition each.

Faunal Diversity and Dominance:

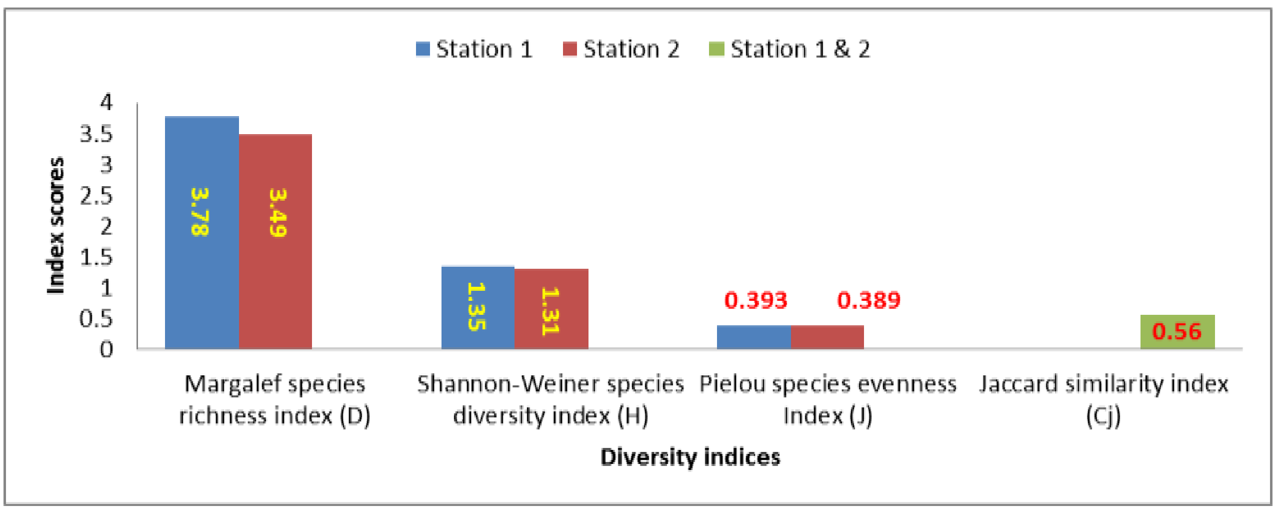

Fig. 3: Diversity of macro invertebrates across sampling stations

Fig. 3 shows the faunal diversity using various indices for the two sampling stations. Species richness (Margalef's index) was highest at station 1 (3.78) followed by station 2 (3.49). Station I had the least species evenness (J) with 0.389 while station 2 recorded 0.392. Shannon-Wiener diversity index (H) was highest at station 1

(3.78) 2 recorded the least (3.49). The Jaccard similarity index for the two stations was 0.56 indicative of 56% faunal similarity between the stations.

Discussion

The community structure of the benthic macro invertebrates recorded show 40 species in 21 families and 7 classes. There was marked dominance by the insecta and gastropoda group with the arachnida and nematomorpha being the least dominant. This finding varies from other reports on macro invertebrates in Nigeria waters. The macro invertebrate abundance in the study is quite higher than that of George et al., (2009) who found macro invertebrates in 19 species, 12 families and 6 classes in Okpoba creek in the Niger delta. The finding of this study is also higher than those reported by Sikoki and Zabbey (2006) in River Imo where 14 species and 11 families were reported, so also for the 20 species and 5 classes reported for Bonny River by Ansa (2005). However a higher abundance of 43 species was recorded for Lagos Lagoon and 46 species for Okazuwa in Benin City as reported by Ajao and Fagade (1990) and Olomukoro and Ovoijie (2015) respectively. The dominance of the insecta group in this study is similar to that of Okazuwa in Benin city (Olomukoro and Ovoijie (2015) but at variance with George et al., (2009) and Hart (1994) who both found polychaeta as the most dominant at Calabar River and Mangrove swamp of Port-Harcourt respectively. These differences between the studies could be as a result of the pollution status, difference in location, prevailing physical and chemical characteristics and nutrient availability of the respective water bodies (Ibemenuga and Inyang, 2006). The dominant Insecta class in the present study are pollution tolerant (Iyagbaye et al., 2017) which is indicative of the polluted status of the study area, same with Polychaeta reported for Calabar River by George et al., (2009) which are also known pollution tolerating groups (Ajao and Fagade, 1990).

Station 2 in the study which is human habited with significant anthropogenic perturbations had reduced species composition compared to station 1 which was with no human habitation around it which is in agreement with the position of Olomukoro and Oviojie (2015). The pollution tolerance characterization in this study show the pollution tolerating classes like insecta and oligochaeta were found more in the more perturbed station 2 while the pollution sensitive class like the gastropoda were found more abundant in the less perturbed station 1 (table 2). However the diversity of species and evenness were higher at station 1 compared to station 2 probably due to the enrichment of that part of the river with waste materials from residential areas resulting in more species number and spread. This could in turn be detrimental with time when eutrophication sets in. This is observation is supported by Victor and Ogbeibu (1989) who posited that higher the evenness the higher the diversity. The similarity index for the study indicate a 56% faunal similarity between the two stations suggesting an even spread of species type between them.

Conclusion

This study established the baseline data on the abundance and diversity of macro invertebrates in River Ngadda which can be a useful guide in formulating management approaches. The study identified point and non-point sources of pollution at both the up and downstream portion of the River with the latter portion being more perturbed. The insecta class was found to be the most dominant with the nematomorpha class being the least. Variability of macro invertebrate abundance by classes across stations show a distinct distribution of macro invertebrates along pollution sensitivity lines with the tolerant ones found more within perturbed stations. The faunal diversity at the River Ngadda was rich and well distributed across the river stretch.

However, improper land-use practices, such as overuse of extensive areas of fragile lands on both sides of the downstream area of the river for subsistence agriculture, soil excavation for building construction and raw sewage effluent from residential settlements negatively influence the environmental conditions in River Ngadda. It is recommended that the State Environmental Protection Board and with other relevant regulatory authourities should control unacceptable land-use and development plans on riparian land.

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