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TYPES AND ABUNDANCE OF ARTHROPOD FAUNA IN RELATION TO PHYSICO-CHEMICAL PROPERTIES OF THE BOTTOM SEDIMENT OF WARRI RIVER, NIGERIA

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ABSTRACT

The occurrence of arthropods associated with the bottom sediment of Warri River was investigated, and samples were collected from January 2002 to May 2003. The values of pH, alkalinity, magnesium and total hardness were significantly different ($P < 0.01$) between the study stations, while organic matter recorded for the bottom sediment shows no significant difference ($P>0.05$). The dominant fauna were Dipteran larvae, which constitute 90.47%. Two rare groups of fauna (Arachnida and Ephemeropterans) were restricted to the upstream (Agbarho) station. *Megapus* sp. had a single record and is being recorded for the first time in Nigerian water bodies. All the organisms did not show any correlation with pH, conductivity and percentage (%) organic matter. Fauna densities were maxima only in the dry season period.

KEYWORDS: Arthropods, bottom sediment, insects, abundance, river, Nigeria, perturbation.

INTRODUCTION

Aquatic insects are adapted to inhabiting and breeding in different microhabitats or biotopes including the bottom substrates rich in particulate organic matter (Olomukoro and Osewengie, 2004). Studies on the Insect fauna in Nigerian lotic waters (Ogbeibu and Victor, 1989; Olomukoro and Ezemonye, 2007; Olomukoro and Victor, 2001) and lentic aquatic ecosystems (Bidwell and Clarke, 1977) Mbagwu, 1991; 1992; Ogbeibu and Egborge, 1995 are limited. Over the past two decades, part of Warri River has been subjected to dredging activities to enable bigger vessels to sail up to the steel company. Newell *et al* (2004) revealed that the physical disturbance or impacts of dredging included a suppression of species varieties, population density and biomass as well as differences in species composition within the dredged area compared with the surrounding deposits. The limited available evidence does suggest that, where hydrodynamic conditions or physical disturbance differs between sites or aquatic ecosystems, distribution patterns of assemblages of microbenthos differs. Infact benthic organisms have different responses to disturbance and are not able to re-establish as rapidly as possible in disturbed sediment (Austen and Widdicombe, 2006; Olomukoro and Ezemonye, 2007)

The erosional biotope is subject to frequent perturbation due to environmental stresses and very few organisms are well adapted to it. The present paper describes the abundance and distribution of insect fauna associated with erosional biotope of Warri River. The data collated from such study are useful since insect populations have been found to reflect the underlying biotic and abiotic conditions of stream ecosystems (Culp and Davies, 1992).

STUDY AREA AND SAMPLING STATIONS.

Warri River is one of the most important coastal rivers in the Niger- Delta area of Nigeria and a major tributary of the Forcados River. It is 150 km long covering a surface area of about 255.8 sq.km and empties into the Atlantic Ocean. NEDECO (1961) and Egborge (1987) described the geography of the rivers catchment area identifying a rainy season of 7- 10 months and a dry season of 2- 5 months.

Two sites on Warri River were selected for the study. The first, Agbarho, is purely fresh water throughout the year. The watershed drains primarily through a thick swamp forest, the substratum is muddy with clay and is rarely disturbed except for the occasional movement of canoes at certain times of the day. The second, Aladja, has forest water most of the year and slightly brackish from January to April or May (Oronsaye, 1996). The water shed drains through mangrove swamp forest, the substratum which is sandy soils underlined by clay commonly form the river basement. The water is turbulent as a result of human activities and wave action.

MATERIALS AND METHODS

In determining the physicochemical properties of the bottom sediments, the methods of Adam *et al* (1980), APHA (1980) and Ezemonye (1992) were used for pH, organic matter content, conductivity, alkalinity, total hardness, calcium and magnesium The digestion of the sediment sample using Nitric acid-per-chloric acid was carried out as described by Adam *et al* (1980). The digested solution was filtered with a No. 40 Whatman filter paper and diluted to 2ml mark for analyses. While the organic matter determination of the bottom sediments was according to the method of Ezemonye (1992).

At the two sites the bottom substrate were sampled from Jan 2002 to May 2003 to a depth of 15 – 20cm, using an Ekman grab (measuring 0.31 x 0.21m) as recommended for sand and silt (Elliot,1977; Hynes,

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1961). Content trapped by the grab were processed following the method of Olomukoro and Victor (1999) and Olomukoro and Ezemonye (2000). The organisms were identified by reference to appropriate keys in publications by Brinkhurst (1966); Mellanby (1963), Needham and Needham (1982) and Pennak (1953)).

Data Analysis

Physico- chemical parameters values at the two stations were analysed using analysis of variance (ANOVA) and other statistical procedures (a two way t – test and measurements of central tendency and correlation coefficients between physico- chemical parameters and chironomids), which were adopted from Zar (1984).

RESULTS

Physical and chemical conditions

Table 1 shows results of the physico-chemical parameters of the bottom sediments. Differences between the two stations were significant ($P< 0.01$) with pH, alkalinity, magnesium and total hardness. Between the 2 stations, pH, alkalinity, phosphate, magnesium and total hardness were significantly different ($P < 0.01$). Conductivity level showed no significant differences ($P> 0.01$) at the bottom sediment of the sampling stations.

Fig. 1 shows the monthly variations in percentage organic matter (POM) at the erosional biotope of the stations. Fluctuations in percentage organic matter were significant and ranged between 3.04-7.16% and 1.33-7.02% at stations 1 and 2 respectively. At station 1, the minimum POM recorded in the erosional biotope was in June and the maximum was in July 2002; corresponding periods at station 2 were April and December 2002. POM values were high at the beginning of sampling, but increased sharply at station 1 in April 2002 with subsequent fluctuations in values in the other months. Non-seasonal pattern of fluctuations was observed in the two stations. There was no significant difference ($P > 0.05$) in organic matter content between the study stations.

INSECT FAUNA

Table 2 shows the composition, distribution and abundance of the arthropods at the study area. Six (6) taxa were identified, which include Ephemeroptera (1 Sp.), Diptera (4 Spp.) and Arachnida (1 Sp.). Pentaneura sp. had the highest density of occurrence, representing 36.84% of all collection. Diptera constituted the dominant group with 89.47% density, while Ephemeroptera (*Ephemerella ignita*) *Clinotanypus maculates* and *Meglapus Sp.* had the least density of 5.26% each respectively. The variation in the abundance of organisms in the study stations shows that Agbarho had the highest number of individuals, organisms with 95% density occurrence; and Aladja had the least record representing 5% density.

Chironomids (Diptera larvae), which constituted the dominant group in the study area, were negatively insignificantly correlated ($P > 0.01$) with all the physico–chemical parameters including percentage (%) organic matter ($P > 0.01$, $r = -0.1$) at the erosional biotope of station 1.

Fig. 2 shows the relative abundance of these invertebrates in the bottom sediment. The most abundant insects were dipterans, which constituted 85.71 and 4.76% of the collections in stations 1 and 2 respectively. The larvae of family chironomidae were most represented in the erosional biotope of both stations.

Ephemeroptera (*Caenis* sp.) and Arachnida (*Megapus* sp.) were rare and were collected at the upstream station 1 in May and October respectively, with low density of 5.26% each.

At the stations, all the insect groups indicated no correlation with pH, conductivity and percentage (%) organic matter. Species diversity was generally low at the erosional biotope of the study area.

Table 1: Physical and Chemical Parameters of bottom sediment samples taken at the study stations, Warri River, Nigeria (N, is the Number of samples and C.V, the Coefficient of Variation).

		Station 1			Station 2		
Parameter	**N**	**Mean ± SE**	**Min – Max**	**% C.V**	**Mean ± SE**	**Min – Max**	**% C.V**
pH	18	5.53 ± 0.26	3.35 – 7.20	18.8	3.98 ± 0.45	0.69 – 6.25	45.6
Alkalinity	18	0.54 ± 0.04	0.26 – 0.80	32.5	0.27 ± 0.07	0.00 – 0.65	99.8
Conductivity	16	37.68 ± 1.73	27.0 – 48.0	18.3	37.16 ± 2.60	15.0 – 50.0	27.6
Calcium 1^{-1}	16	0.33 ± 0.01	0.26 – 0.42	14.2	0.15 ± 0.04	0.00 – 0.37	106.1
Magnesium mgl^{-1}	16	0.36 ± 0.02	0.28 – 0.50	22.8	0.16 ± 0.04	0.00 – 0.40	104.7
Total hardness	16	0.68 ± 0.03	0.54 – 0.90	19.5	0.30 ± 0.70	0.00 – 0.76	94.7
Organic matter (%)	16	5.23 ± 0.33	3.04 – 7.16	25.4	4.94 ± 0.46	1.33 – 7.02	37.6

Table 2: Composition, distribution and abundance of insecta in the study stations.

				STATIONS	
Group	**Order**	**Family/Sub Family**	**Species**	**AGBARHO (No. of individuals)**	**ALADJA (No. of individuals)**
INSECTA	Ephemeroptera	Caenidae	*Caenis Sp.*	1	-
	Diptera	Chironomidae	*Polypedilum Sp*. Kieffer 1913	3	-
		Chironominae	*Tanytarsus Sp*. Wulp 1874	5	-
		Tanypodinae	*Clinotanypus maculates* Kieffer 1913	-	1
			Pentaneura (Ablabesmyia) Sp. Johannnsen	7	-
			1905	2	-
ARACHNIDA	Hydrachnella	Hygrobatidae	Tanypus Sp. Miegen 1803	1	-
			Megapus Sp.		
				19	1

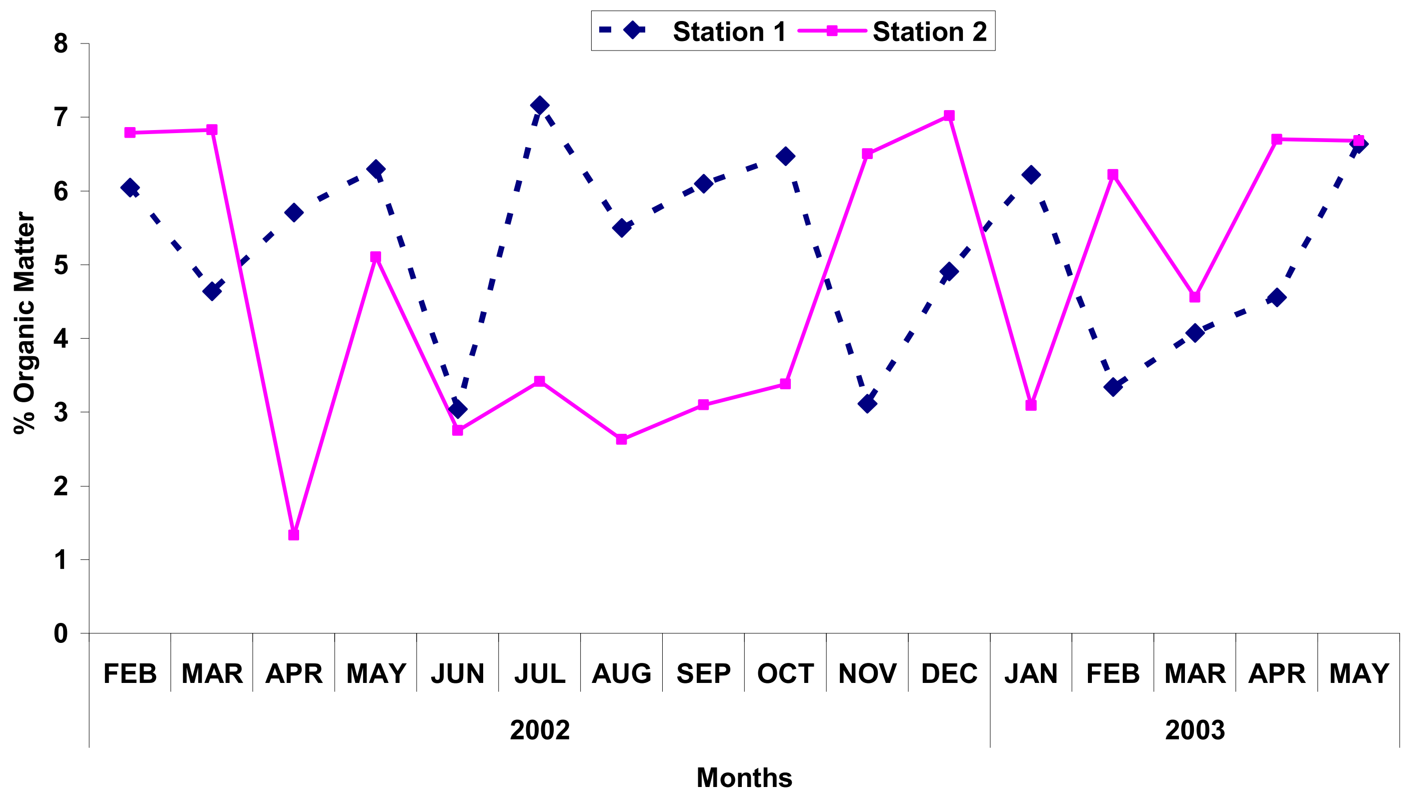

Figure 1: Seasonal variation of percentage organic matter of the bottom sediments of Warri River.

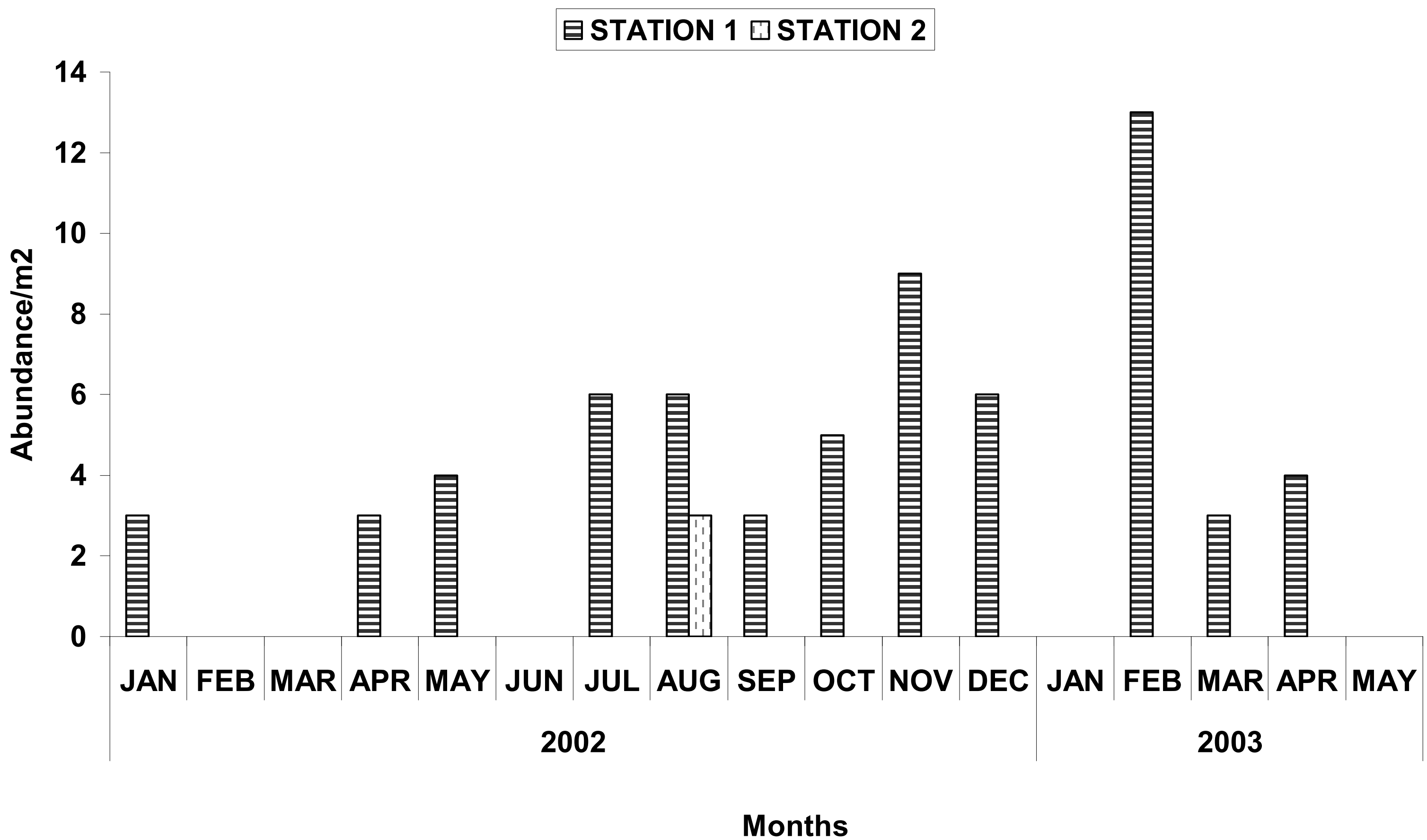

Figure 2: Spatial and temporal variations in the relative abundance of insect fauna in the study Stations.

DISCUSSION

The community structure consisted of few arthropods that were adapted to the upstable erosional biotope of the river catchment area. Ephemeroptera (*Caenis* sp) and Arachnida (*Megapus* sp) were found within the substratum layer under consideration. Ephemeropteran larvae were known to associate with aquatic macrophytes in fresh water ecosystem. *Caenis* sp was one of the few species under the group that was capable of living on or in a substratum rich in organic matter of rivers and streambeds. It was known to be facultatively herbivorous, feeding on periphyton and detritus as noted by Costa and Fernando (1967). Intandem with Mellanby (1963) *Megapus* sp was found to occur among floating aquatic macrophytes, but in this study, the species was collected from the river bed. This was the first record of *Megapus* sp in Nigerian water body. What limited its distribution is not known with certainty.

The chironomid larvae were restricted to the upstream Station 1, with the exception of *C. maculatus*. The chironomids were filter feeders depending on particulate organic matter as food. Fernando (1977) noted that increase in nutrients and particulate organic matters arising from land preparation enhance the population of macrofauna in both fresh and brackish water types in South East Asia. This might be the reason why the chironomids had high density in the above station. Ogbeibu (2001) and Ogbeibu and Oribhator (2002) noted that the family Chironomidae dominated aquatic invertebrate communities and show no habitat restriction. The present investigation also revealed the negative insignificant correlation of chironomid with all the physico-chemical parameters including percentage (%) organic matters. The chironomid larvae, which are filter feeders, appeared not to have been influenced by the amount of POM at the upstream station 1. The absence of correlation between these organisms and POM showed that other prevailing synergistic factors other than the later and physico-chemical properties might have affected chironomid larval populations in the study area. Species of Oligochaeta and Diptera might be favoured by rapid sedimentation of organic matter and not by water quality.

POM in the bottom sediment was generally low (1.33 – 7.16%) at two stations. This could be attributed to the regular dredging of the Warri River from Udu Bridge to Forcados terminal to allow smooth sailing of ship to Warri port and Aladja Steel Complex. At the upper reaches of the river, allochtonous materials released into the water transported downstream rather than settling on the river bed because of the high gradient in this part of the Warri river catchment area. Although POM (mean statistical) was higher at station 1 (5.23+ 0.33) than at station 2 (4.94 ± 0.46), yet the difference was not significant ($P > 0.05$). The pattern of fluctuations was non-seasonal as observed throughout the study period. The substratum type may have limited the occurrence of the most ubiquitous dipteran larvae and odonata naiads in the study area.

On a general note, paucity in species abundance at the biotopes or stations could be more attributed to strong preference for ecological niche or substrate type and feeding habit than the predominant set of physico-chemical conditions in the ecosystem.

REFERENCES

Adam, T; Atchinson, G. AND Vetter, R. T., 1980. The impact of an industrially contaminated lake on Heavy metals levels in the effluents stream. Hydrol. Vol. 69: 1-2, 187-193.

American Public Health Association, 1980. American Water Works and Water Pollution Control. Standard methods for the examination water and waste waters. 14th Ed.

Austen, M. C. and Wilddicombe. 2006. Comparison of the response of micro and macrobenthos to disturbance and organic enrichment. Journal of Experimental Marine Biology and Ecology. **330**: 96 – 104.

Bidwell, A. and Clarke, N. V., 1977. The invertebrate in fauna of Lake Kanji, Nigeria. The Nig. Fld. 42(3):104-110.

Brinkhust, R. O. 1966. A contribution towards a revision of aquatic Oligochaeta of Africa. Zoological Africana **2(2)**: 131 – 166.

Costa, H. H. AND Fernando, E. C. M., 1967. The food and feeding relationships of common meso and macrofauna in the Maha Oya, a small mountainous stream at Peradeniya, Ceylon. Ceylon J. Sci. (Bio. Sci) 7:74-90.

Egborge, A. B. M., 1987. Salinity and distribution of cladocera in Warri River. Nigeria. *Hidrobiología*. 145: 159 – 167.

Elliot, J. M., 1977. Some methods for the statistical analysis of Benthic Invertebrates, scientific publication No. 25, Freshwater Biological Association, Windermere.

Ezemonye, L. I. N., 1992. Heavy metals concentrations in Water, sediments and Selected Fish fauna in the Warri River and its tributaries. Ph.D. Thesis, University of Benin, Nigeria. 175pp.

Fernando, G. H., 1977. The ecology of the aquatic fauna of rice fields with special reference to South East Asia. Geo – Eco – Trop. 1:169-188.

Hynes, H. B. N., 1961. The Ecology of Running Waters. Toronto Univ. Toronto Press. 555pp.

Hynes, H. B. N., 1972. The ecology of stream insects. Ann. Rev. Entomol. 15:25-42.

Mbagwu, I. G., 1991. The influence of environmental factors on the Horizontal Distribution of Macrobenthic Invertebrates. NIFFR Ann. Rep. Pp 160-171.

Mbagwu, I. G., 1992. The influence of environmental factors on the Seasonal distribution of Macrobenthic Invertebrates in Jakara Reservoir, Kano State. NIFFR. Ann. Rep. P.125-134.

Mellanby, H., 1963. Animal life in Freshwater Chapman and Hall Ltd. 308pp.

Nedeco (Netherlands Engineering Consultants). 1961. The Waters of the Niger Delta. 2nd revised ed. The Hague Netherlands.

Needham, J. G and Needham, P. R., 1982. A guide to the study of Freshwater Biology. Holden – Day revised ed. The Hague Netherlands.

Newell, R. C., Seiderer, E. J., Simpson, N. M. and Robinson, J. E., 2004. Impacts of Marine Aggregate Dredging on Benthic Macrofauna off the south Coast of the United Kingdom. Journal of Coastal Research. **20(1)**: 115 – 125.

Ogbeibu, A. E. and Victor, R., 1989. The effects of road and bridge construction on the bankroot macrobenthic invertebrates of a Southern Nigerian stream. Environmental Pollution 56:85-100.

Ogbeibu, A. E. and EGBORGE, A. B. M., 1995. Hydrobiological studies of water bodies in the Okomu Forest Reserve (sanctuary) in Southern Nigeria. 1. Distribution and diversity of the Invertebrate fauna Tropical Freshwater Biology 4:1-27.

Ogbeibu A. E., 2001. Composition and diversity of Diptera in temporary pond in Southern Nigeria Tropical Ecology 42(2):259-268.

Ogbeibu, A. E. and Oribhator, B. J., 2002. Ecological impact of river impoundment using benthic macro-invertebrates as indicators. Water Research 36: 2427-2436.

Olomukoro, J. O. and Ezemonye, L. I. N., 2000. Studies of the macrobenthic fauna of Eruvbi stream, Benin City, Nigeria. Trop Environ. Res. Vtl. 2, Nos. 1 & 2: 125-136

Olomukoro J. O. and Victor R., 1999. The distributional relationship between the macrobenthic invertebrates fauna and particulate organic matter in a small tropical stream. Trop. Journal of Environ. Science and Health 2(1): 58 – 64.

Olomukoro, J. O. and Ezemoye L. I. N., 2007. Assessment of the macrobenthic fauna of rivers in Southern Nigeria. African Zoology. **41(2)**: 1 – 11.

Olomukoro, J. O. and Osenwengie, 2004. Studies on macrobenthic fauna associated with microhabits of Ikpoba River, Nigeria. Tropical Journal of Environmental Research, 5, (1 & 2): 384 – 394.

Oronsaye, C., 1996. Occurrence and seasonal variation of freshwater copepods (crustacean) in Warri River. Nigeria. Tropical Freshwater Biology, 5 (1996): 85-91.

Pennak, R. W., 1953. Freshwater invertebrate of the United States. Ronald Press Company. New York.

Sorensen, T., 1948. A method of establishing groups of equal amplitude in plant sociology based on similarity of species content and its application to analysis of the vegetation on Danish commons. Biol. Skr: 5(4):1-34.

Urk, G. Van, 1978. The macrobenthos of the River Ijssel. Hydrobiologia. Bull. 12:21-29.

Victor, R. and Dickson, D. T., 1985. Macrobenthic invertebrates of a perturbed stream in Southern Nigeria. Env. Poll. (Series A). 38:99-107.

Victor, R. and Ogbeibu, A. E., 1985. Macrobenthic invertebrates of a stream flowing through farmland in Southern Nigeria. Env. Poll. (Series A). 39. 337-349.

Wharfe, J. R., 1977. An ecological survey of the benthic invertebrate macrofauna of the lower Medway Estuary, Kent. J. Animal. Ecol. 46:93-113.

Zar, J. H., 1984. Biostatistical Analysis. 2nd ed. New Jersey. Prentice-Hall. 717pp.