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P. Tawari-Fufeyin
Federal University of Petroleum Resources. Effurun Nigeria

Akpoyovware Ejoh
Covenant University Ota Ogun State, Nigeria

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Community structure of crustacean zooplankton in Ekpan Creek, a perturbed tributary of Warri River, Niger Delta, Nigeria

T. O. T. Imoobe*, P. Tawari-Fufeyin and A. S. Ejoh

*Department of Animal and Environmental Biology, Faculty of Life Sciences, University of Benin, P. M. B. 1154, Benin City, Nigeria

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ABSTRACT: Crustacean zooplankton community along a stretch of Ekpan Creek, a perturbed tributary of Warri River was investigated at selected sites from November, 2002 to July, 2003. Field sampling was carried out with a 55µm mesh Hydrobios plankton net, and concentrated samples were examined and sorted under a binocular dissecting microscope, while identification was done using an Olympus Vanox Research Microscope. Twenty-two species made up of nine species of Cladocera, eight species of cyclopoid Copepoda, three species of calanoid Copepoda, two species of harpacticoid Copepoda, and an unidentified Ostracoda and six different larvae stages of both copepods and decapods were encountered. There was no significant difference ($P>0.05$) in species diversity among the stations. The crustacean zooplankton community was dominated by the large sized cyclopoid and calanoid Copepoda, cladocerans and larval stages of decapod crustaceans. The dry season period recorded the highest abundance of zooplankton than the wet season period. By comparison, species richness was much lower than that of Warri River; this may be due to the low mean concentration of dissolved oxygen and elevated level of BOD, temperature and phosphate reported in this study. The pollution level is what has influenced zooplankton species composition and structure in Ekpan Creek. Therefore, restoration and monitoring surveys of both environment and biological parameters is necessary to keep track of ecosystem changes in the creek because of the negative impact it has had on the fisheries potential of the creek.

Key Words: Crustacean zooplankton, Perturbed, Ekpan Creek, Niger Delta, Nigeria.

Introduction

Rivers and creeks in the Niger Delta of Nigeria are heavily exploited for water supplies for both domestic and industrial uses, fisheries exploitation, transportation, irrigation, electricity generation, animal husbandry and recreation. In many instances waste water is discharged into the rivers resulting in pollution and its associated consequences.

Zooplankton constitute an important link in food chain as grazers (primary and secondary consumers) and serves as food for fishes directly or indirectly, therefore any adverse effect to them will reflect in the fish populations. Although zooplankton exists under a wide range of environmental conditions, yet many species are limited by temperature, dissolved oxygen, salinity and other physicochemical factors.

In Nigeria, investigation of the response of zooplankton to pollution is not common, rather emphasis has been on the description of the faunal composition, spatial and temporal distribution in lakes and large rivers (Green 1962, Clarke 1978, Egborge 1981, Imoobe and Egborge, 1997). Elsewhere around the world, the use of zooplankton for environmental characterization of lakes has been adopted, for example, zooplankton community size structure has been used as an indicator of lake trophic status (Bays and Crisman 1983, Pace 1986, Beaver and Crisman 1990, Canfield and Jones 1996). Abundance of selected major zooplankton groups (e.g. Rotifera, Copepoda) has also been used to show changes in trophic state (Fuller *et al.* 1977 , Sprules 1977, Gannon and Stemberger 1978 and Pace 1986).

Ekpan Creek is highly susceptible to pollution, indeed the pollution potentials of the Creek are very high and sources of pollution are as diverse as the pollutants themselves, yet there has been no documented information of the water quality and biodiversity of the ecosystem. The purpose of this paper is, firstly, to present a general account of the water quality and crustacean zooplankton species composition, diversity, spatial and temporal distribution in Ekpan Creek, and secondly, to compare the crustacean zooplankton of the study area with results from the less disturbed portions of Warri River that has earlier been reported (Gabriel 1986, Egborge 1987), with a view to ascertain the degree of alteration of the crustacean zooplankton community structure for the purpose of management and conservation of the biodiversity of this highly disturbed ecosystem of the oil rich Niger-Delta of Nigeria.

Study Area

This study was carried out on a stretch of Ekpan Creek, a tributary of Tori Creek which empties into Crawford Creek that finally discharge into the Warri River at Bennet Island. It lies within Latitudes 5^0 30' and 5^0 35'N and longitudes 5^0 43' and 50 46'E (Fig 1). Ekpan Creek a tidal River with a 12 hourly cycle, stretch over 12km distance within the Effurun-Warri metropolis of Delta State, Southern, Nigeria.

The Creek is a source of water for laundry and cooking, and in the past a lucrative fishing ground. It drains the Shell Petroleum Development Company SPDC) Residential Estate, Nigerian National Petroleum Corporation (NNPC) Residential Housing Complex, NNPC Refinery and Petrochemical complexes, Chevron-Texaco Nigeria Limited, Western division office complex all sited in the well watered swamps of Ekpan (Egborge 1991),and discharge effluents into the creek.

The region consists of freshwater swamp, mangrove swamps and tropical rainforest characterized with sparse vegetation in the south. The Creek is flanked by *Rhizophora racemosa, Rhizophora mangle,* Oil palm trees (*Elaeis guinensis*), Raffia palms and floating Water hyacinth (*Eichornia crassipes).*

The climatic regime is governed by the position of the inter-tropical convergence zone (ITCZ). The Wet season is characterized with heavy rains and last from March to October while the dry season is between November and February. Rainfall values obtained from the weather station at the Warri Port showed a range of between 5.6mm in December 2002 to the highest value of 244.5mm recorded in June 2003. The relative humidity values were between 77 – 86% recorded in December, 2002 and January, 2003 respectively.

Four sampling stations (designated 1 to 4) were selected. Station 1 was located just before the Sokoh Estate at Ugboroke near a vegetable farm, a hospital and refuse dump. The substratum is clay and muddy, human activities here include fishing, bathing and laundering.

Station 2 was located at the bridge site near the NNPC Housing Complex Road about 2km downstream of Station1. The substratum is a mixture of sand, silt and clay and marginal vegetation consisting of red mangrove (*Rhizophora racemosa*), water hyacinth (*Eichornia crassipes*) and grasses were found along the shore line. Human activities at this Station include fishing, laundering and bathing.

Station 3 was located along the Market Creek, a tributary of the Ekpan Creek between stations 2 and 4. It is about 2km from station 2. The water is dark and turbid with a muddy substratum. It is shaded by canopies of red mangrove (*Rhizophora racemosa*) and the major human activity here is fishing.

Station 4 was located near the Chevron – Texaco Company facility, close to the bridge on Warri Port Express Road, about 2km downstream of station 3 and 1km upstream of the confluence of Ekpan creek and Tori Creek; it is about 6km from Warri refinery and petrochemical jetty where crude oil is loaded into barges and vessels for export. There were always oil films on the surface of the water resulting from leakages during loading and from the numerous engine boats. The substratum was a mixture of sand and silt and the vegetation is sparse tropical rainforest. Human activities include fishing, bathing and laundering.

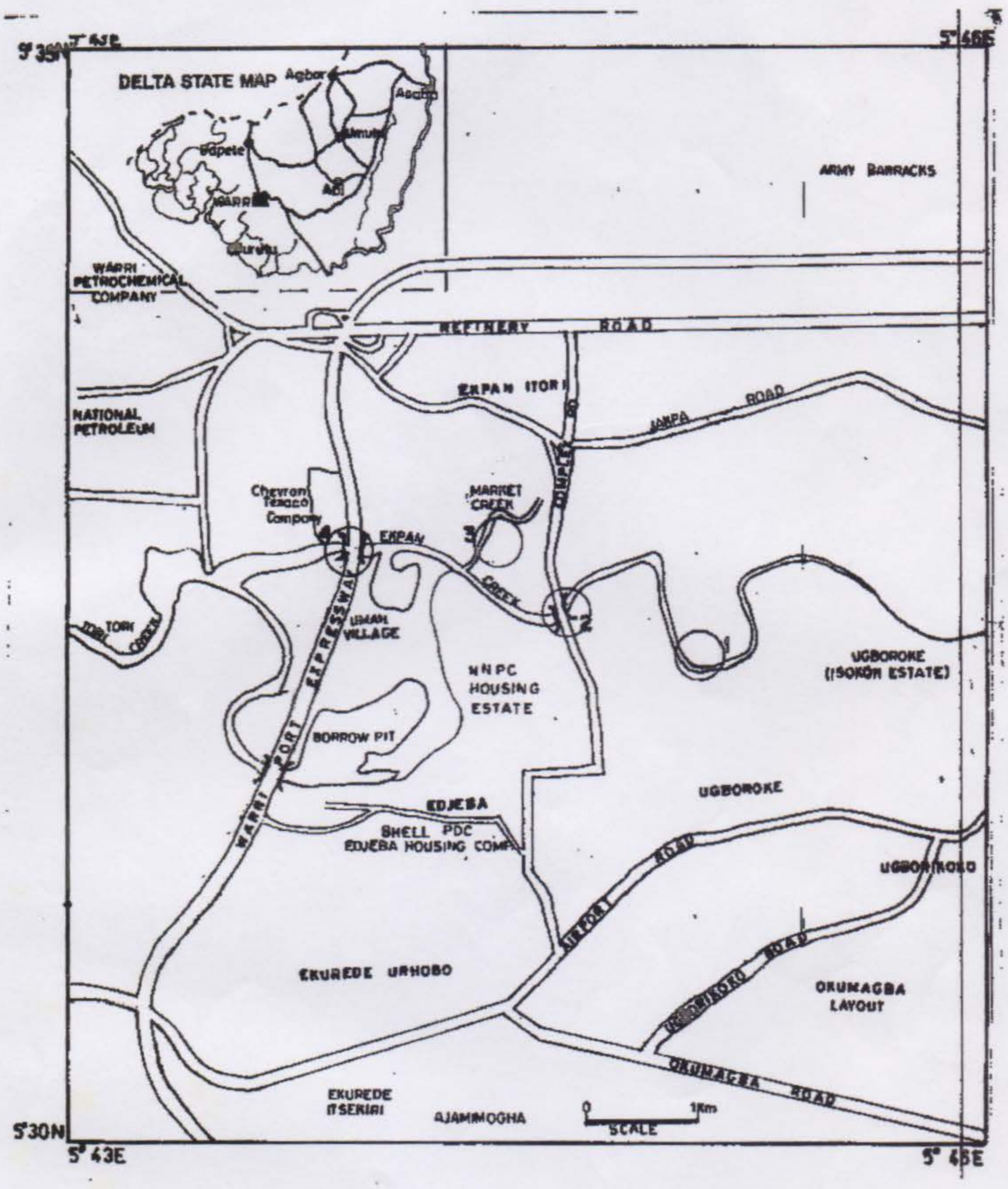


Fig 1: Map of the study area showing the sampling stations

Materials and Methods

Samples were collected during high and low tides between November, 2002 and July, 2003. Qualitative plankton samples were collected by towing a 55µm mesh Hydrobios plankton net tied to a 25HP engine-powered boat driven at low speed against current just below the water surface for 5 minutes at each sampling station. Quantitative samples on the other hand were collected by filtering 100L of water fetched with a bucket through a 55µm mesh Hydrobios net. Both samples were preserved separately in 4% buffered formalin solution.

In the laboratory, specimens were sorted and dissected where necessary under a binocular dissecting microscope (American Optical Corporation, Model 570), while counting and identifications were done with an Olympus Vanox Research Microscope Model 230485. Identification of specimens was carried out at the University of Benin, Zooplankton laboratory using relevant literatures (Smirnov 1974, Van de Velde 1984, Gabriel 1986, Jeje and Fernando 1986, Jeje 1988, Boxshall and Braide 1991, Imoobe 1997).

The percentage relative abundance of the specimens was estimated by direct count. Each quantitative sample was concentrated to 25ml and from this; 1ml of sample was taken and counted.
Three measures of diversity were used to describe the communities of species in the sampling stations in the river. These indices are Margalef's species richness index (D), Shannon-Weiner index of general diversity (H') and Evenness index (E). The BASIC programme SPDIVERS for diversity indices was used for diversity while Inter-station comparison was carried out to test for significant differences in the abundance of the crustacean zooplankton using one-way analysis of variance (ANOVA) (Zar 1984).

Results

Water was acidic to slightly alkaline (pH range 5.97 – 7.08) and fresh throughout the year with electrical conductivity values in the range of 10.60 – 1400 μScm^{-1}. It was generally characterized by very low to moderate levels of dissolved oxygen concentrations (0.40 – 6.8 mgl^{-1}). A summary of some of the physical and chemical conditions of the study stations is presented in Table 1. Mean values of water temperature, BOD, dissolved oxygen and phosphate across the stations indicate low water quality status of the waterbody.

Table 2 shows the checklist and percentage relative abundance of the individual species in the study area. A total of twenty-two species made up of nine species of Cladocera, eight species of cyclopoid Copepoda, three species of calanoid Copepoda, two species of harpacticoid Copepoda, and an unidentified Ostracoda and six different larvae stages of both copepods and decapods were encountered. All the species were encountered across the entire stretch of the creek; and diversity indices computed indicate that the four sampling stations were about equally diverse (Table 3). The equitability index (E) was generally high in the study stations ranging from 0.937 in station 4 to 0.963 in station 1.

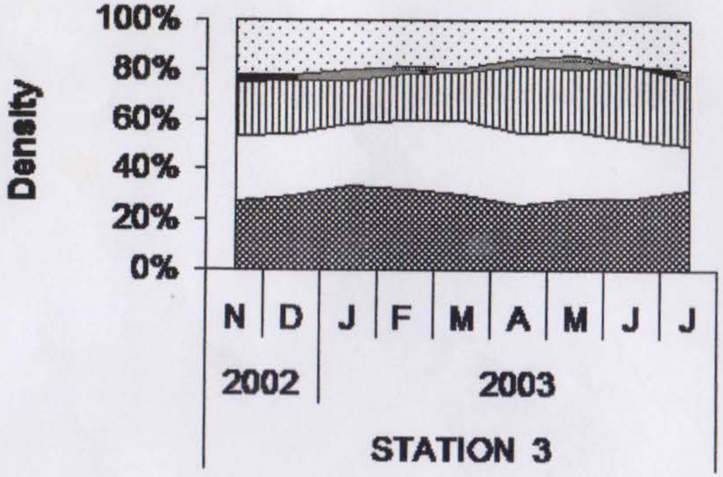
The crustacean zooplankton community was dominated by the Copepoda (calanoids, cyclopoids and harpacticoids) which constituted 53.4% of the number encountered, with the cyclopoids recording the highest species richness and a relative proportion of between 25.7 and 29.6% at the different sampling stations during both dry and wet seasons (Fig 2). The calanoid Copepoda namely, *Acartia tonsa, Thermodiaptomus yabensis and Tropodiaptomus laurentii* which together constituted between 22.5% and 24.0% of the number collected across the stations were the species with the highest number of individuals at every sampling station (Table 1). The Cladocera was equally well represented like the cyclopoid and calanoid Copepoda and occurred in relatively high proportions at all stations (Fig 2). Nauplii, copepodites and other larval stages also showed fairly high proportions at all stations. All the major taxa were recorded across the three sampling stations without restriction; however, harpacticoid copepods and the Ostracoda were rarely encountered (Fig 2). One-way analysis of variance (ANOVA) (Zar, 1984) performed to detect significant differences in the abundance showed that there was no significant difference ($P>0.05$) among the stations.

Table 1: Mean (± S.E) values of some physical and chemical conditions of the study stations in Ekpan Creek from November 2002 to June 2003 (Minimum and Maximum in Parenthesis). N = 9.

PARAMETERS	STATIONS 1	2	3	4
Air Temperature °C	28.48± 0.03 (28.2 – 28.8)	27.55± 0.05 (26.2 – 28.0)	27.25± 0.01 (27.0 – 27.8)	27.21± 0.01 (27.2 – 27.8)
Water Temperature °C	28.25 ± 0.01 (27.2 – 28.5)	28.53± 0.01 (28.0 – 28.7)	28.43 ± 0.01 (28.3 – 28.5)	28.60 ±0.01 (28.4 – 28.7)
pH	(6.57 – 7.08)	(5.97 – 7.00)	(6.33 – 6.87)	(6.4 – 6.8)
Turbidity NTU	10.4 ±5.14 (4.64 – 20.65)	13.92±7.3 (5.22 – 28.42)	10.52±5.99 (2.84 – 22.33)	10.1±5.7 (2.84 – 21.35)
Total Dissolved Solids (mg/l)	425.52±139.71 (13.15 – 753)	467.17±156.24 (15 – 847)	492.18±164.68 (17.1 – 875)	544.17±186.89 (19 – 994)
Total Suspended Solids (mg/l)	4.78±1.08 (3.7 – 5.85)	4.64±1.61 (3.03 – 6.25)	4.93±0.63 (4.3 – 5.55)	5.98±0.78 (5.2 – 6.75)
Dissolved Oxygen (mg/l)	3.54± 0.77 (1.2 – 6.8)	4.7± 0.43 (3.7 – 6.5)	3.45± 0.7 (0.8 – 5.6)	2.96± 0.69 (0.4 – 5.6)
BOD (mg/l)	1.86±0.34 (0.5 – 2.8)	2.44±0.57 (1 – 4.5)	1.98±0.51 (0.6 – 3.7)	1.68±0.37 (0.2 – 2.8)
Conductivity (μS/cm)	465.93±207.53 (10.6 – 1120)	484.17±216.84 (11 – 1110)	495.52±220.50 (11.1 – 1130)	540.88±249.64 (11.3 – 1400)
Total Alkalinity (mg/l)	58.39±5.56 (36.6 – 73.2)	62.66±4.62 (45 – 74.18)	68.17±7.19 (48.8 – 97.6)	67.65±7.12 (48 – 97.6)
Salinity (Chloride) (mg/l)	39.39 ±6.49 (17.55 – 55.24)	42.33±7.03 (17.55 – 61.06)	21.06±56.8 (48.8 – 97.6)	47.05±8.99 (19.31 – 66.74)
Nitrate (NO_2) (mg/l)	0.17 ±0.07 (0.02 – 0.42)	0.17±0.07 (0.02 – 0.38)	0.11±0.06 (0.01 – 0.34)	0.21±0.1 (0.01 – 0.6)
Sulphate (SO_4) (mg/l)	0.63 ±0.17 (0.03 – 1.06)	0.49±0.14 (0.0 – 0.84)	0.57±0.14 (0.00 – 0.92)	0.57±0.14 (0.00 – 0.96)
Phosphate (PO_4) (mg/l)	0.079 ±0.05 (0.01 – 0.28)	0.076±0.04 (0.005 – 0.19)	0.078±0.04 (0.01 – 0.24)	0.14±0.03 (0.01 – 0.24)
Total Hardness ($CaCO_3$) (mg/l)	95.9 ±25.4 (35 – 164)	108.2±31.2 (20 –184)	120.1±36.1 (23 –204)	95.4±38.8 (21.4 – 220)
Sodium (Na) (mg/l)	16.51 ±1.18 (13 – 20.18)	24.51±2.27 (15.6 –31.42)	25.72±1.73 (19.39 –29.43)	27.96±2.76 (18.91 – 34.5)
Potassium (K) (mg/l)	19.74 ±3.58 (7.44 – 28)	25.03±5.06 (8.78 –34)	18.61±3.28 (6.86 –26)	20.92±4.04 (6.75 – 29.1)
Calcium (Ca) (mg/l)	14.22 ±2.71 (4.82 – 21.63)	11.87±2.45 (5.64 –17.64)	12.04±2.55 (4.01 –17.7)	12.61±2.73 (4.01 – 18.84)
Magnesium (Mg) (mg/l)	15.99 ±5.93 (1.46 – 30.4)	20.16±6.91 (2.43 –36.88)	21.64±7.88 (1.46 –39.43)	22.61±8.60 (1.46 – 42.04)

Table 2: The crustacean zooplankton of Ekpan Creek.

Major groups	Relative abundance (%)	Family/Species
Cladocera		**Family Bosminidae**
	2.5	*Bosmina longirostris* Muller,1785
	2.7	*Bosminopsis deitersi* Richard 1892
		Family Sididae
	2.5	*Diaphanosoma excisum* Sars, 1885
		Family Macrothricidae
	3.1	*Ilyocryptus spinifer* Herrick, 1882
	3.0	*Macrothrix spinosa* King, 1853
		Family Moinidae
	3.3	*Moina micrura* Kurz, 1874
		Family Chydoridae
	3.9	*Chydorus spaericus* O.F.Muller, 1785
	2.8	*Leydigia ciliata* Gauthier, 1939
	3.3	Pleuroxus leavis Sars, 1862
Copepoda		**Order Cyclopoida**
		Family Cyclopidae
	3.0	*Ectocyclops phaleratus* Koch, 1838
	2.8	*Eucyclops agiloides* Sars, 1909
	2.7	*Halicyclops korodiensis* Onabamiro ,1952
	4.0	*Mesocyclops ogunnus Onabamiro, 1957*
	3.1	*Metacyclops minutus* Claus 1863
	4.6	*Microcyclops varicans* Sars, 1863
	3.5	*Oithona nana* Giesbrecht, 1892
	3.8	*Tropocyclops prasinus* Fischer, 1860
		Order Calanoida
		Family Acartiidae
	7.7	*Acartia tonsa* Dana, 1849
		Family Diaptomidae
	7.3	*Thermodiaptomus yabensis* Wright and Tressler, *1928*
		Family Eucalanidae
	8.6	*Tropodiaptomus laurentii* Gauthier,1951
		Order Harpacticoida
		Family Canthocamptidae
	1.3	*Bryocamptus minutus Claus, 1863*
		Family Ameiridae
	0.9	*Nitrocra dubia* Boeck, 1864
	3.7	*Copepodite larvae*
	4.3	Nauplius larvae
Ostracoda	0.6	Unidentified
Decapoda	2.6	Anomuran larvae
	2.1	Palaemonid larvae
	2.8	Penaeid larvae
	3.4	Zoea larva



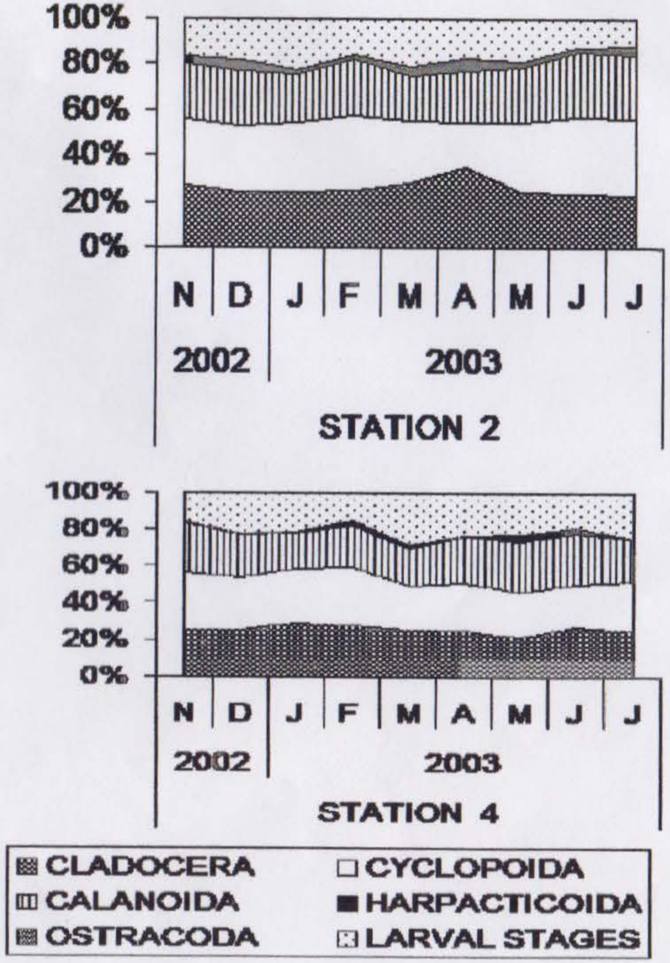


Fig 2: Spatial and temporal variations in the relative importance of the major taxonomic groups of crustacean zooplankton in Ekpan Creek

Table 3: Diversity of crustacean zooplankton in the study stations of Ekpan Creek

	Station 1	Station 2	Station 3	Station 4
Number of samples	8	8	8	8
Number of species (S)	22	22	22	22
Margalef's index (D)	3.251	3.272	3.262	3.249
Shannon-Weiner index (H`)	2.977	2.967	2.971	2.897
Evenness index (E)	0.963	0.96	0.961	0.937

The seasonal variation in the number of the crustacean zooplankton encountered during the study is shown in Fig 3. At all stations the number was significantly ($P<0.05$) higher between November, 2002 and February, 2003 a period that correspond to the dry season. Between March and July 2003 (wet season) the number remained low. The pattern of variation of Copepoda, Cladocera and the larval stages dictated the seasonal trend, as these major groups were most abundant during the dry season.

A comparison of result of this survey with those of Gabriel (1986) and Egborge (1987) (Table 4) carried out along the Warri River shows that the species diversity in Ekpan Creek is much lower. Out of a combined total of fifty one taxa of Copepoda and Cladocera earlier reported from Warri River only twenty two species occurred in its tributary, the Ekpan Creek. There was only little similarity (45.6%) in species composition as computed using Sorensen (1948) index of similarity, between crustacean zooplankton of both water bodies. Only eighteen species were common to both areas.

Discussion

In order to assess the pollution status of Ekpan Creek, several physical and chemical parameters of water quality that are likely to be influenced by the input of and / or recovery from pollution were measured over a nine month period. Water temperature, BOD, dissolved oxygen and phosphate which are some of the common indicators for assessing water quality in Nigeria (Oluwande et. al. 1983) were the parameters among those measured that indicate the low quality status of the water.

The low water quality of Ekpan Creek reported in this study is the consequence of the inflow of organic matter, nutrients, toxic substances and oil from the surrounding industrial and residential areas into the waterbody. The mean value of the water temperature was higher than the ambient air temperature, possibly because unlike the atmosphere, water has high specific heat capacity and therefore only slowly loss the heat gained from radiation received from the sun. But more importantly, it can be attributed to the release of heat during decomposition of organic matter in the water as decomposition produces heat from anaerobic respiration of microorganisms (Chapman 1992, Oben 2000).

Rapid breakdown of organic matter by microorganisms, which utilize oxygen to the detriment of the stream biota also result in the low mean concentration of dissolved oxygen and an elevated BOD observed across the stations. This low mean concentration of dissolved oxygen and elevated level of BOD, temperature and phosphate which result from domestic wastes across the stations all allude to the fact that the organic matter load in the water is high. Increasing wastewaters, introduction of phosphorous containing detergents, use of fertilisers, and erosion in the watershed are the major reasons for increased loading of nutrients.

Fig 3: Seasonal variation in the abundance of crustacean zooplankton in Epkan Creek.

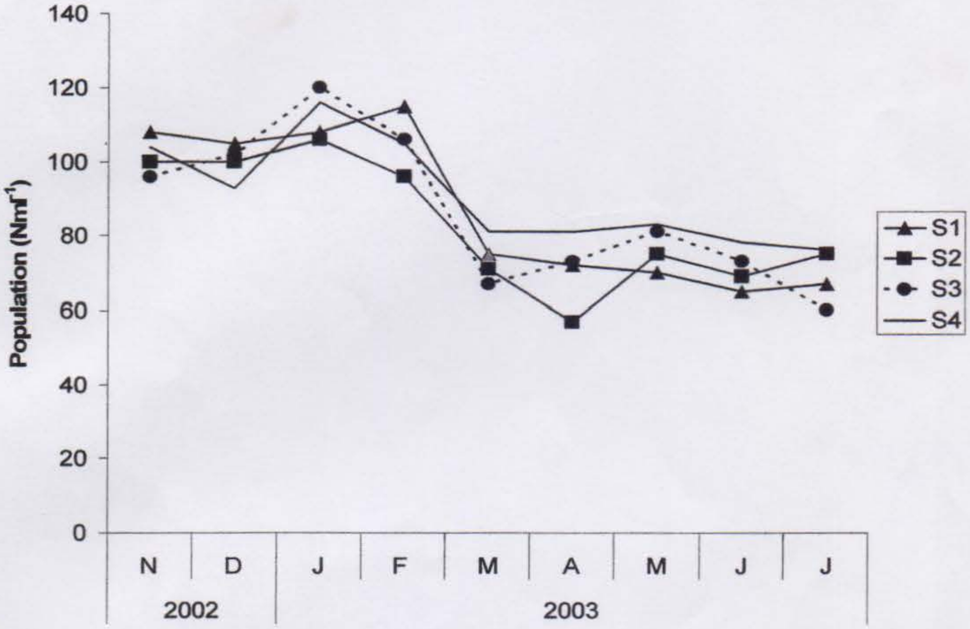


Table 4: Species composition at Ekpan Creek and Warri River (after Gabriel 1986 and Egborge 1987)

	Sampled Area	
	Ekpan Creek (Present study)	*Warri River (Gabriel 1986, Egborge 1987)*
Cladocera		
Alona alonopsoides Brehm, 1933	-	+
Alona diaphana King, 1853	-	+
Alona eximia Kiser, 1948	-	+
Alona holdeni Green, 1952	-	+
Alona karua King, 1853	-	+
Alona pulchella King, 1853	-	+
Alona quadrangularis O.F.Muller, 1785	-	+
Alona rectangular Sars, 1862	-	+
Bosmina longirostris O.F.Muller, 1785	+	+

	Sampled Area	
	Ekpan Creek (Present study)	***Warri River (Gabriel 1986, Egborge 1987)***
Bosminopsis deitersi Richard, 1897	+	+
Ceriodaphnia cornuta Sars, 1885	-	+
Ceriodaphnia rigaudi Richard, 1897	-	+
Chydorus sphaericus O.F.Muller, 1785	+	+
Diaphanosoma excisum Sars, 1885	+	+
Ephemeroporus sp	-	+
Ilyocryptus spinifer Herrick, 1882	+	+
Kurzia longirostris Daday, 1898	-	+
Leydigia ciliata Gauthier, 1939	+	+
Macrothrix laticornis Jurine, 1820	-	+
Macrothrix spinosa King, 1853	+	+
Moina micrura Kurz, 1874	+	+
Penilia sp	-	+
Pleuroxus laevis Sars, 1862	+	+
Scapholeberis kingi Sars, 1903	-	+
Copepoda		
Acartia tonsa Dana, 1848	+	+
Bryocamptus minutus Claus, 1863	+	+
Cletocamptus sp	-	+
Diathrodes cf. major	-	+
Ectocyclops phaleratus Koch, 1838	+	-
Eucyclops agiloides Sars, 1909	+	-
Eucyclops macrurus Sars, 1863	-	+
Euterpina acutifrons Dana, 1848	-	+
Halectiosoma sp	-	+
Halicyclops korodiensis Onabamiro, 1952	+	+
Halicyclops troglodytes Kiefer, 1954	-	+
Leptomesochra sp	-	+
Macrocyclops distinctus Richard, 1887	-	+
Mesocyclops ogunnus Onabamiro, 1957	+	+
Metacyclops minutus Claus 1863	+	-
Microcyclops varicans Sars, 1863	+	+
Nannopus palustris Brady, 1880	-	+
Nitrocra dubia Boeck, 1864	+	+
Oithona nana Giesbrecht, 1892	+	+
Pseudobradya sp	-	+
Thermocyclops crassus Fischer, 1853	-	+

	Sampled Area	
	Ekpan Creek (Present study)	***Warri River (Gabriel 1986, Egborge 1987)***
Thermocyclops neglectus Sars, 1901	-	+
Thermodiaptomus yabensis Wright and Tressler, *1928*	+	+
Tropocyclops prasinus Fischer, 1860	+	-
Tropodiaptomus laurentii Gauthier,1951	+	+

The crustacean zooplankton identified in this study are common occurrence in several other Nigerian waters like Jamieson River (Imoobe and Egborge 1997), Sokoto River (Green 1960), Lake Asejire (Egborge 1981), Kainji Lake (Bidwell and Clarke 1977) and coastal rivers of western Nigeria (Egborge et al. 1994), however, the species diversity is relatively low with only twenty two species of crustacean zooplankton reported. Changes in the availability of suitable algal food as a result of nutrient enrichment of the water as well as prey-predator interactions can be responsible for the reduction in the zooplankton species number and density.

The abundance and diversity of zooplankton vary according to limnological features and the trophic state of freshwater bodies (Jeppesen et al. 2002), so that crustacean zooplankton abundance may have decreased with increasing eutrophication, toxic substances and oil in the water. Pollution levels can alter species composition and community structure; it is known that zooplankton diversity in aquatic ecosystems is lowered by increase of eutrophication (Lazzaro 1987).

The dominant species at every station were the large sized *Acartia tonsa, Thermodiaptomus yabensis and Tropodiaptomus laurentii* as against the small sized cladoceran and cyclopoid copepod species, the dominance of these large sized plankton may indicate the absence of planktivorous fish and shellfish that are very sensitive to reduced oxygen level in the water. In these situations, larger species or larger individuals within a given species have improved chances of survival than the smaller individuals when predators are other invertebrates, such as midge larvae, *Chaoborus sp.*, or backswimmers, *Notonecta sp.* Prey-predator interactions play an important role in determining population densities. Several studies have documented the size-selectivity of fish for their invertebrate prey (Brooks and Dodson 1965, Dodson 1974, Zaret 1980, O'Brien 1987). Thus the changes in the physicochemical nature of water, interspecific and intraspecific competition, pollution level and absence of planktivorous fish are some of the factors that have influenced zooplankton species composition and structure in favour of the large sized individuals in Ekpan Creek.

Conclusion

With only twenty two species of crustacean zooplankton recorded in Ekpan Creek, a tributary of Warri River from where fifty one species had earlier been reported (Gabriel 1986, Egborge 1987); it is obvious that the low water quality of the Creek has negatively impacted on the community structure of zooplankton in the water.

References

Bays, J. S. & T.L. Crisman. 1983, Zooplankton and trophic state relationships in Florida lakes. Can. J. Fish. Aquat. Sci. 40: 1813–1819.

Beaver, J. R. & T.L. Crisman. 1990, Use of microzooplankton as an early indicator of advancing cultural eutrophication. Verh. Internat. Verein. Limnol. 24: 532–537.

Bidwell, A. & N.V. Clarke. 1977. The invertebrate fauna of lake kainji, Nigeria. Nig. field. 42: 104-110

Box shall, G. A & E.I. Braide. 1991. The freshwater cyclopoid copepods of Nigeria with an illustrated key to all species. Bull. Br. Mus. Nat.Hist. (ZOOL). (2) : 185-212.

Brooks, J. L. & S. I. Dodson. 1965. Predation, body size, and composition of the plankton. Science150: 28-35.

Canfield, T. J. & J.R. Jones. 1996. Zooplankton abundance, biomass, and size-distribution in selected midwestern waterbodies and relation with trophic state.
J. Freshwat. Ecol. 11: 171–181.
Chapman, E. 1992. Water quality Assessment ; a guide to the use of Biota, Sediments and water in Environmental Monitoring. Chapman (ed) publisher ; Chapman and Hall for UNESCO, WHO and UNEP, 237pp.
Clark, N.V.1978. A comparison of the zooplankton of lake kainji and of the river niger and swashi. Hydrobiologia 58:17-23.
Dodson, S. I. 1974. Adaptive change in plankton morphology in response to size-selective predation: a new hypothesis of cyclomorphosis.
Limnology and Oceanography 19:721-729.
Egborge, A.B.M. 1981. The Composition, Seasonal Variation and Distribution of Zooplankton in Lake Asejire, Nigeria. Rev. Zool. Afr. 95(1): 136 – 180.
Egborge, A.B.M. 1987. Salinity and the Distribution of Cladocera in Warri River, Nigeria. Hydrobiologia. 145: 159 – 167.
Egborge, A.B.M., C.C. Onwudinjo, & P.C. Chigbu. 1994. Cladocera of Coastal Rivers of Western Nigeria. Hydrobiologia. 272: 39 – 46.
Fuller, D. R., R.S. Stemberger & J.E. Gannon. 1977. Limnetic rotifers as indicators of trophic change. J. Elisha Mitchell. Sci. Soc. 93 : 104–113.
Gabriel, C. 1986. Copepoda of Warri River. Nigeria. Ph.D thesis. University of Benin .Benin City. Nigeria. 200pp
Gannon, J.E. & R.S. Stemberger. 1978. Zooplankton (especially crustaceans and rotifers) as indicators of water quality. Trans. Am. Micros. Soc. 97: 16–35.
Green, J.E. 1962. Zooplankton of the River Sokoto. The Crustacea. Proc. Zool. Soc. London 138: 415 – 453.
Imoobe, T. O. T 1997. Crustacean of Jamieson River Nigeria. Phd thesis, University of Benin , Benin city, Nigeria. 155pp.
Imoobe, T.O.T & A.B.M. Egborge. 1997. The Composition, Distribution and Seasonal Variation of Crustacea in Jamieson River, Southwest Nigeria. Tropical Freshwater Biology, 6: 49-63.
Jeje, C.Y. & C.H. Fernando. 1986. A practical guide to the identification of Nigerian zooplankton. Kainji Lake Research Institute Nigeria. ISBN 978 – 177-025 2.
Jeje, C.Y. 1988. A revision of the Nigeria species of the genera Mesocyclops, Sars 1914 and Thermocyclops Kiefer, 1927 (Copepoda, Cyclopoida). Hydrobiologia 164 : 171-184.
Jeppesen, E., J.P. Jensen, & M. Sondergaard. 2002. Response of phytoplankton, zooplankton and fish to re-oligotrophication: an 11-year study of 23 Danish lakes. Aquatic Ecosystems Health and Management. 5: 31-43.
Lazzaro, X. 1987. A review of planktivorous fishes: Their evolution, feeding behaviours, selectivities, and impacts. Hydrobiologia.146: 97-167.
Oben, B.O. 2000. Limnological Assessment of the impact of Agricultural and domestic effluents of three man-made Lakes in Ibadan, Nigeria. Ph.D Thesis, University of Ibadan.
O'Brien, W. J. 1987. Planktivory by freshwater fish: thrust and parry in the pelagic. In Predation: Direct and Indirect Impacts on Aquatic Communities. W. C. Kerfoot and A. Sih (Editors).University Press of New England, Hanover.
Oluwande, P.A., M.C.Sridhar, A.O. Bammeke, & A.O. Olubadejo. 1983. Pollution levels in some Nigerian Rivers. Water Research. 17: 947 – 963.
Pace, M. J. 1986. An empirical analysis of zooplankton community size structure across lake trophic gradients, Limnol. Oceanogr. 31: 45–55.
Smirnov, N.N. 1974. Fauna of the USSR.Crustacea vol 1No 2 Chydoridae. Academy of science of the USSR p 644 English Transl., Israel program scientific translation, Jerusalem.
Sorensen, T. 1948. A method of establishing groups of equal amplitude in plant sociology based on similarity of species content and its application to analyses of the vegetation on Danish Commons. Biol. skr. 5(4): 1 – 34.
Sprules, W. G. 1977. Crustacean zooplankton communities as indicators of limnological conditions: an approach using principal component analysis, J. Fish. Res. Board Can. 34 : 962–975.
Van de Velde, I. 1984. Revision of the African species of the genus Mesocyclops, Sars 1914 (Copepoda, Cyclopoida). Hydrobiologia 109 : 3-66.
Zar, J.H. 1984. Biostastistical analysis. 2nd end. Prentice hall Inc. New Jersey, 718pp.
Zaret, T. M. 1980. Predation and freshwater communities. Yale University Press. 187 pp.