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Environmental Impacts of Oil Exploration and Production on the Macrobenthic Invertebrate Fauna of Osse River, Southern Nigeria

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Abstract: The impact of Dubri Oil Company operations on the macrobenthic invertebrate fauna of Osse River, Edo State (Nigeria) was investigated between July 2000 and June 2002. Fifty-seven taxa which were well represented in the five stations were encountered. Ephemeroptera accounted for 26.30%, Decapoda (21.53%), Diptera (17.04%), Annelida (11.31%), Odonata (6.56%), Nematoda (1.45%), Coleoptera (0.75%) and Hemiptera (0.28%) of the total number of organisms collected from the study stations. The family Naididae (Annelida), Alpheidae (Decapoda), Chironomidae (Diptera), Baetidae (Ephemeroptera) and Libellulidae (Odonata) were the most widespread. The overall abundance of the macrobenthic invertebrate fauna was significantly different ($p<0.05$) among the study stations. A posteriori Duncan Multiple Range (DMR) test showed that the abundance was significantly higher ($p<0.05$) in stations 1, 2 and 5 than the other stations (3 and 4) which were not significantly different ($p>0.05$) from each other. The diversity indices revealed that taxa richness was highest in station 2 and lowest in station 5, while Shanon Wiener and Evenness indices were higher in stations 1, 2 and 4 than those of other stations. The temporal dynamics showed higher macrobenthic invertebrate fauna abundance during the dry season months than the rainy season. The impact of crude oil exploration on macrobenthic invertebrate fauna is reported.

Key words: Macrobenthic invertebrate, crude oil, tempora dynamics, diversity

INTRODUCTION

Macrobenthic invertebrates are biological quality elements required for the classification of the biological status of waterbodies (Timm and Mois, 2008). Benthic infaunal community studies provide the 'gold standard' in terms of determining whether or not alterations in benthic communities are occurring and, together with sediment toxicity and chemistry, whether or not such changes are due to toxic contaminants in the sediments (Chapman and Anderson, 2005). Over the last decades there has been considerable efforts to document the ecology, composition, spatial distribution and biodiversity of macrobenthic invertebrate communities of Nigerian rivers (Ogbeibu and Victor, 1989; Ogbeibu and Egborge, 1995; Ogbeibu and Oribhabor, 2002; Olomukoro and Victor, 1999; Olomukoro and Egborge, 2003; Ezemonye *et al*., 2004; Osemwegie and Olomukoro, 2004). Researchers established a pattern of relationship between benthic macro-invertebrate fauna, depth, substrate type and organic contents of sediment. They reported that areas with high accumulation of sediment and high organic flux rates from terrestrial (riverine) sources supported high macro-infauna abundance and biomass. Other studies using macrobenthic invertebrate as bio-indicator of

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anthropogenic impact on the aquatic ecosystem have shown general decrease in macrobenthic invertebrate population and reduction in species diversity and richness (Ogbeibu and Victor, 1989) and they possess higher ability to tolerate pollution-induced environmental stress than plankton (Rosenberg and Resh, 1993).

The Osse River has been subjected to domestic and industrial pollution by the oil exploration activities of Dubri Oil Company and the numerous communities on the bank of the river. The river is the major source of drinking water to the inhabitants of these communities. This study is the fourth in a series documenting the impact of the exploration activities of Dubri Oil Company on the water quality of the Osse River providing baseline data on the composition, distribution and temporal dynamics in macrobenthic invertebrate of river.

A detailed description of the hydrological and drainage features of the Ovia River and the climatic and edaphic features of its environs had earlier been documented (Omoigberale and Ogbeibu, 2005; Ogbeibu and Omoigberale, 2005).

MATERIALS AND METHODS

The sampling period spanned from July 2000 to June 2002. Stations 1 and 2 were upstream of station 3 (the nucleus of activities at Gelegele), while stations 4 and 5 were downstream (Fig. 1). The characteristic features of these stations had earlier been described (Ogbeibu and Omoigberale, 2005; Omoigberale and Ogbeibu, 2007).

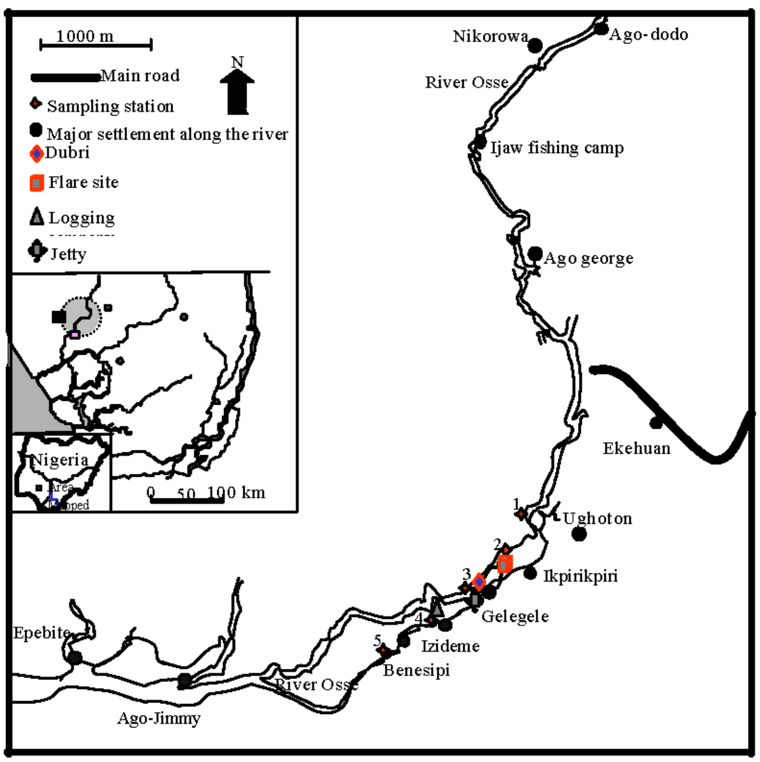

Fig. 1: Study area and sampling stations

Macrobenthic invertebrate fauna were sampled from the bottom using an Eckman grab recommended for sand and silt (Hynes, 1961; Elliot, 1977) and a kick method used to sample the aquatic macrophyte (Hynes, 1961; Egglishaw, 1964; Paterson and Fernando, 1970). Samples collected were sieved with a set of Tyler sieves of mesh sizes of 2 mm, 1 mm, 150 μm and 100 μm, respectively. The contents retained in the sieves were washed into polyproylene bottle and preserved in 5% formalin. Macrobenthic invertebrate were sorted under a binocular microscope (American Optical Corporation model 570), while drawings, counting and identification were done using an Olympus Vanox Research Microscope Model 230485 (Mag. 50-500x) with an attached drawing tube model MKH240-790. Identification of specimens of macrobenthic invertebrate was carried out using relevant literature (Ward and Whipple, 1959; Pennak, 1953; Powell, 1980; Mellanby, 1963; Needham and Needham, 1962; Brinkhurst, 1966).

Data Analysis

Characterising the community structure and fauna similarities were according to Ogbeibu and Egborge (1995). The single factor Analysis of Variance (ANOVA) and Duncan Multiple Range test were used to test for significant difference in the density of fauna among stations and to locate site(s) of significant difference, respectively. All statistical procedures for test of significance, diversity and similarity indices were adopted from Magurran (1988), Zar (1984) as well as SPSS 11.0 computer package.

RESULTS

The mean, minimum and maximum values of some physical and chemical parameters of the study station are shown in Table 1. All the factors with the exception of air temperature, Biochemical Oxygen Demand (BOD) and Nitrate were not significantly different among all the stations. The values of air temperature of station 3 were significantly higher ($p<0.05$) than those of other stations, which were not different ($p>0.05$) from each other.

Checklist of Macrobenthic Invertebrate Fauna

Phylum	Nematoda
Class	Secernenta
Order	Enoplida
Family	Dorylaimidae
	Dorylaimus sp.
Family	Plectidae
	Rhabdolaimus sp.
Phylum	Annelida
Class	Oligochaeta
Order	Plesiopora
Family	lumbricidae
	Eiseniella sp.
Family	Naididae
	Aulophorus furcatus Muller (1973)
	Aulophorus vagus Leidy (1852)
	Chaetogaster diastrphus Gruith,
	Nais communis Piquet (1906)

Table 1: Summary of mean values for physical and chemical characteristics

	Station 1		Station 2		Station 3	
Parameters (n = 13)	Min-Max	Mean±SE	Min-Max	Mean±SE	Min-Max	Mean±SE
Air temperature	26.10-31.20	29.13±0.34A	26.00-31.2	29.18±0.34A	27.00-33.70	31.35±0.38B
Water temperature	25.20-29.10	27.30±0.26	25.30-29.0	26.29±1.09	25.50-29.30	27.42±0.25
pH	5.76-7.91	6.96±0.11	6.02-7.84	7.03±0.11	5.80-7.83	7.01±0.10
Dissolved oxygen	4.40-7.80	6.43±0.18	4.80-8.20	6.44±0.17	5.40-8.80	6.39±0.15
Biochemical oxygen demand	1.60-4.20	3.23±0.15	1.60-4.10	2.83±0.14	1.20-4.80	2.93±0.13
Conductivity	11.00-123	33.48±6.98	13.00-180.0	40.03±7.33	16.00-208.0	50.92±8.81
Alkalinity	20.00-75.0	50.65±3.01	17.50-100.0	48.71±3.79	21.00-90.00	49.96±3.35
Nitrate	0.04-0.61	0.25±0.03	0.09-0.73	0.31±0.04	0.06-0.73	0.33±0.04
Phosphate	0.28-2.88	1.61±0.13	0.72-3.06	1.73±0.12	0.15-2.60	1.66±0.12
Sodium	0.47-10.56	3.40±0.54	1.19-19.10	3.71±0.74	0.89-15.40	3.50±0.62
Potassium	0.11-3.20	1.50±0.16	0.16-5.84	1.46±0.22	0.20-8.35	1.74±0.32
Calcium	1.23-9.62	3.14±0.35	1.11-7.21	3.08±0.28	1.53-6.41	3.04±0.26
Magnesium	0.49-7.78	1.59±0.29	0.20-3.89	1.47±0.18	0.62-3.89	1.47±0.15

	Station 4		Station 5		
Parameters (n = 13)	Min-Max	Mean±SE	Min-Max	Mean±SE	Statistical significance
Air temperature	26.80-31.30	29.28±0.32A	26.20-31.20	29.20±0.30A	p<0.05*
Water temperature	25.70-29.10	27.27±0.26	25.50-29.30	27.26±0.26	p>0.05
pH	6.09-7.70	6.92±0.08	5.55-7.73	6.83±0.11	P>0.05
Dissolved oxygen	5.20-11.60	6.76±0.28	5.40-7.80	6.50±0.15	p>0.05
Biochemical oxygen demand	0.80-4.80	2.65±0.17	1.60-5.60	3.17±0.18	p>0.05
Conductivity	10.00-130.00	43.73±7.03	14.00-110.0	48.86±6.50	p>0.05
Alkalinity	17.50-80.00	47.94±3.85	19.20-95.00	45.92±3.80	p>0.05
Nitrate	0.06-0.69	0.34±0.04	0.10-1.14	0.39±0.05	p>0.05
Phosphate	0.43-3.10	1.79±0.13	0.40-3.52	1.73±0.13	p>0.05
Sodium	0.99-17.50	3.49±0.70	0.18-14.16	3.29±0.59	p>0.05
Potassium	0.15-5.96	1.52±0.24	0.15-6.24	1.42±0.25	p>0.05
Calcium	1.65-8.71	3.34±0.34	1.18-5.82	2.89±0.18	p>0.05
Magnesium	0.60-4.86	1.70±0.21	0.41-5.84	1.60±0.23	p>0.05

*Significantly different means (p<0.05); similar letters indicate means that are not significantly different using Duncan Multiple Range test

	Nais sp.
	Pristina sp.
	Stylaria fossularis Leidy (1852)
Class	Hirudinea
Order	Arynchobdellida
Family	Hirudidae
	Haemospsis sp.
Phylum	Arthropoda
Class	Crustacea
Order	Conchostraca
Family	Cyclestheriidae
	Cyclestheria hislopi Baird (1895)
Subclass	Malacostraca
Order	Decapoda
Family	Alpheidae
	Potamalpheops monodi Powell (1980)
Family	Atyidae
	Caridina africana Kingsley (1882)
Family	Desmocaridae
	Desmocaris trispinosa Aurivillius (1898)
Class	Insecta

Subclass	Pterygota
Order	Coleoptera
Family	Chrysomelidae
	Donacia sp.
Family	Dytiscidae
	Dytiscus marginalis
	Hydroporus sp. Clairville
Family	Helmidae
	Promeresia sp. Sanders
Family	Hydrophilidae
	Hydrophilus sp. Geoffrey
Order	Diptera
Family	Ceratopogonidae
	Alluaudomyia sp.
	Stilobezia sp.
Family	Chironomidae
	Chironomus fractilobus Kieffer
	Chironomus transvaalensis Kieffer
	Polypedilum sp. Kieffer (1913)
	Pseudochironomus sp.
	Stictochironomus sp.
	Tanytarsus sp.
Subfamily	Orthocladiinae
	Cricotopus sp. 1
	Cricotopus sp. 2
	Corynoneura sp.
Subfamily	Tanypodinae
	Pentaneura (*Ablabesmyia*) sp.
Family	Culicidae
Subfamily	Culicinae
	Anopheles sp.
	Culex sp.
Order	Ephemeroptera
Family	Baetidae
	Baetis bicaudatus
	Baetis tricaudatus Leach
	Centroptilum sp. Eaton
	Cloeon bellum Navas
	Cloeon cylindriculum Kimmins
	Pseudocloeon sp. Klapalek
Family	Leptophlebiidae
	Adenophlebiodes sp. Ulmer
Family	Siphlonuridae
	Siphlonisca sp. Needham
Family	Trichorythidae
	Dicercomyzon sp. Demoulin
Order	Hemiptera
Family	Naucoridae

	Pelocoris femoratus P.B
	Micronecta sp.
Order	Odonata
Suborder	Anisoptera
Family	Corduliidae
	Cordulid sp.
Family	Gomphidae
	Gomphid sp.
Family	Libellulidae
	Libellula sp. 1
	Libellula sp. 2
	Orthemis sp.
	Plathemis sp.
Family	Zygopptera
	Coenagrion scitulum Rambur
	Enallagma sp. Charpentier
Order	Plecoptera
Family	Perlidae
	Neoperia sp. Needham
Phylum	Mollusca
Class	Gastropoda
Order	Mesogastropoda
Family	Ancyliidae
	Ferrisia sp.
Family	Hydrobiidae
	Potamopyrgus ciliatus Gould (1850)
Family	Neritidae
	Neritina tiassalensis
Phylum	Chordata
Subphylum	Vertebrata
Class	Pisces
	Fishfry

Fifty-seven taxa from a total of 6,262 individuals were encountered (Table 2). All the taxa were well represented in the five stations. Nematoda accounted for 1.45% of the total number of individuals recorded from all stations. The families Dorylaimidae and Plectidae were the only groups encountered. They were represented by one taxon each. Abundance was highest (46.15%) at station 1 and lowest (3.30) at station 5.

Annelida contributed 11.31 to the total density. The family Naididae was the most dominant and widely distributed. Of the seven taxa recorded in this family *Aulophorus vagus*, *Nais communis*, *Pristina* sp. and *Stylaria fossularis* were the most dominant species. Station 2 recorded the highest density, while station 3 recorded the least density. A test of significance using a *posteriori* Duncan Multiple Range (DMR) revealed that the means of station 2 was significantly higher ($p>0.5$) than those of 1 and 4 which were not different from each other, but significantly higher than stations 3 and 5 which were not different from each other.

Decapoda well represented in all the stations by 3 taxa accounted for 21.53% of the total number of individuals encountered. *Potamalpheops monodi* which was well represented in

Table 2: Taxa composition, abundance and distribution of macrobenthic invertebrate in Osse River

	Station				
Distribution	1	2	3	4	5
Phylum: Nematoda					
Class: Secernenta					
Order: Enoplida					
Family: Dorylaimidae					
Dorylaimus sp.	29	10	5	6	1
Family: Plectidae					
Rhabdolaimus sp.	13	15	2	8	2
Phylum: Annelida					
Class: Oligochaeta					
Order: Plesiopora					
Family: lumbricidae					
Eiseniella sp.	4			3	6
Family: Naididae					
Aulophorus furcatus	43	17	8	-	5
Aulophorus vagus	37	66	11	22	20
Chaetogaster diastrphus	4	9	5	26	10
Nais communis	21	83	16	33	-
Nais sp.	14	27	-	16	-
Pristina sp.	24	17	9	15	7
Stylaria fossularis	17	21	14	46	21
Class: Hirudinea					
Order: Arynchobdellida					
Family: Hirudidae					
Haemospsis sp.	-	1	2	6	2
Phylum: Arthropoda					
Class: Crustacea					
Order: Conchostraca					
Family: Cyclestheriidae					
Cyclestheria hislopi	107	179	97	105	118
Subclass: Malacostraca					
Order: Decapoda					
Family: Alpheidae					
Potamalpheops monodi	349	208	101	123	187
Family: Atyidae					
Caridina africana	48	38	33	18	28
Family: Desmocaridae					
Desmocaris trispinosa	65	51	23	33	43
Class: Insecta					
Subclass: Pterygota					
Order: Diptera					
Family: Ceratopogonidae					
Alluaudomyia sp.	17	8	10	5	4
Stilobezia sp.	21	2	23	16	15
Family: Chironomidae					
Chironomus fractilobus	37	18	22	41	22
Chironomus transvaalensis	43	25	50	84	37
Polypedilum sp.	74	19	10	23	27
Stictochironomus sp.	13	5	8	7	2
Tanytarsus sp.	10	5	1	19	9
Cricotopus sp. 1	15	20	12	28	-
Cricotopus sp. 2	7	14	4	9	2
Corynoneura sp.	19	20	24	24	17
Clinotanypus maculates					
Pentaneura (*Ablabesmyia*) sp.	18	13	11	15	10
Family: Culicidae					
Anopheles sp.	-	8	4	9	2
Culex sp.	6	14	2	5	3
Order: Ephemeroptera					
Family: Baetidae					
Baetis bicaudatus	202	113	69	7	165
Baetis tricaudatus	151	89	24	18	111

Table 2: Continued

	Station				
Distribution	1	2	3	4	5
Centroptilum sp.	53	42	12	13	21
Cloeon bellum	79	58	46	12	67
Cloeon cylindriculum	34	46	-	15	5
Pseudocloeon sp.	25	25	6	1	21
Family: Leptophlebiidae					
Adenophlebiodes sp.	15	10	3	2	7
Family: Siphlonuridae					
Siphlonisca sp.	32	12	8	-	6
Family: Trichorythidae					
Dicercomyzon sp.	11	6	-	-	5
Order: Odonata					
Family: Corduliidae					
Cordulid sp.	13	7			8
Family: Gomphidae					
Gomphid sp.	2	3	1		
Family: Libellulidae					
Libellula sp. 1	60	39	14	7	36
Libellula sp. 2	23	11	4	-	24
Orthemis sp.	5	14	2	4	11
Plathemis sp.	10	12		2	14
Family: Zygopptera					
Coenagrion scitulum	20	8	-	4	12
Enallagma sp.	22	9	2	1	15
Order: Plecoptera					
Family: Perlidae					
Neoperia sp.	8	3	3	-	9
Order: Hemiptera					
Family: Naucoridae					
Pelocoris femoratus	6	4	3	-	1
Micronecta sp.	12	2	-	2	-
Order: Coleoptera					
Family: Chrysomelidae					
Donacia sp.	8	1	-	1	-
Family: Dytiscidae					
Dytiscus marginalis	11	1	2	5	4
Hydroporus sp.	11	6	4	3	2
Family: Helmidae					
Promeresia sp.	2	-	1	2	-
Family: Hydrophilidae					
Hydrophilus sp.	14	12	7	4	6
Phylum: Mollusca					
Class: Gastropoda					
Order: Mesogastropoda					
Family: Ancyliidae					
Ferrisia sp.	-	-	-	1	-
Family: Hydrobiidae					
Potamopyrgus ciliatus	1	-	105	33	-
Family: Neritidae					
Neritina tiassalensis	-	1	-	2	-
Phylum: Chordata					
Class: Pisces					
Fishfry	26	8	7	12	20

all station recorded the highest density. The dipterans contributed 17.04% to the total number of individuals, with the family Chironomidae alone acounting for 83.37% of the dipteran density. Of the 13 taxa recorded, *Chironomus transvaalensis*, *C. fractilobus*, *Polypedilum* sp. and *Corynoneura* sp. were the most dominant species. Test of significance using DMR revealed that the means of stations 1 and 4 which were not significantly different from each other ($p>0.05$), but were significantly higher than stations 2, 3 and 5.

Ephemeroptera accounted for the highest (26.30%) number of individuals collected from all stations. The family Baetidae alone contributed 92.90% to the total ephemeroptera density. it was represented by 9 taxa from 4 families, Baetidae (6), Leptophlebiidae (1), Siphlonisca (1) and Trichrythidae (1). Abundance was highest at station 1 (36.55%) and lowest (4.13%) at station 4. The most important taxa were *Baetis bicaudatus*, *B. tricaudatus*, *Cloeon bellum* and *Centroptilum.* The overall abundance of ephemeroptera was significantly different ($p>0.05$) among the stations. An a *posteriori* Duncan Multiple Range (DMR) test showed that the abundance was significantly higher ($p<0.05$) in station 1 than that of other stations which were not significantly different ($p>0.05$) from each other.

The odonata accounted for 6.56% of the total number of individuals recorded in the study. The highest density was recorded at station 1 with 155 individuals and the lowest (18 individuals) was recorded at station 4. The most important taxa were *Libellula* sp., *Coenagrion scitulum* and *Enallagma* sp. These 3 species all recorded their highest density at station 1, while *C. scitulum* was absent at station 3. The overall abundance of odonata was significantly different ($p>0.05$) among the stations. Duncan Multiple Range (DMR) test revealed that density of odonata at stations 1, 2 and 5 were not significantly different ($p>0.05$) from each other but significantly higher ($p<0.05$) than that of stations 3 and 4 which were not significantly different ($p>0.05$) from each other. Coleoptera and Hemiptera contributed 0.73 and 0.28%, respectively to the total number of individuals encountered. The highest density was recorded at station 1 for both groups. The taxa *Dytiscus marginalis* and *Hydroporus* sp. were the dominant coleopteran, while *Micronecta* sp. was the most important hemiptera recorded. Duncan Multiple Range (DMR) test showed that the abundance was significantly higher ($p<0.05$) in station 1 than that of other stations which were not significantly different ($p>0.05$) from each other for both coleoptera and hemiptera.

Temporal Dynamics

The macrobenthic invertebrate fauna display great varieties in their relative abundance temporally (Fig. 2-6). In all stations, higher densities were recorded during the dry season months (October to March) than during the rainy season. The density of annelida at station 1 was highest between September 2000 and March 2001 and September 2001 and March 2002 while the minimum densities were obtained in May and June 2001. Peaks were observed in August 2000 at station 1, July 2000 at stations 3 and 4. The same trend was observed in stations 2, 3, 4 and 5 with a peak between September and October 2001 and minimum in June 2001.

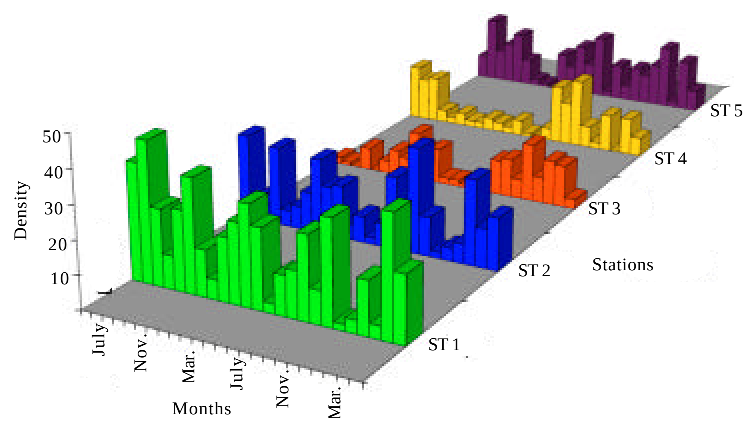

Fig. 2: Temporal variation of Decapoda in the study station

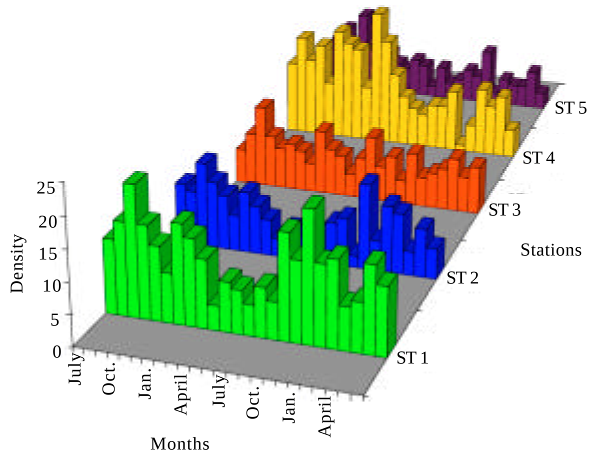

Fig. 3: Temporal variation of Diptera in the study station

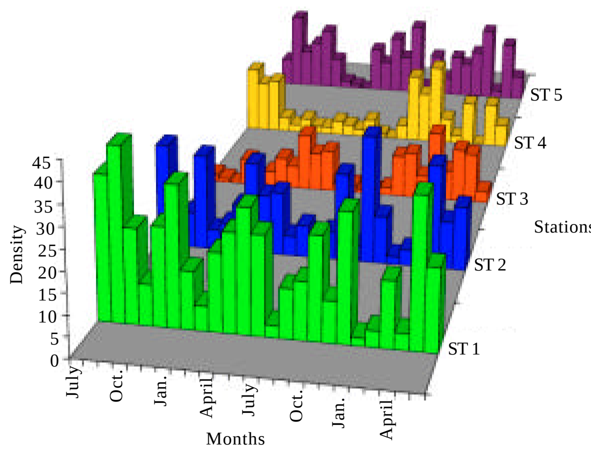

Fig. 4: Temporal variation of Ephemeroptera in the study station

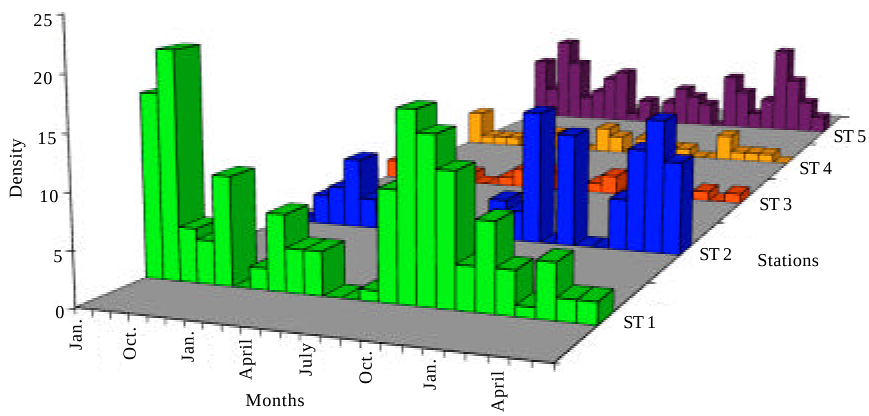

Fig. 5: Temporal variation of Odonata in the study station

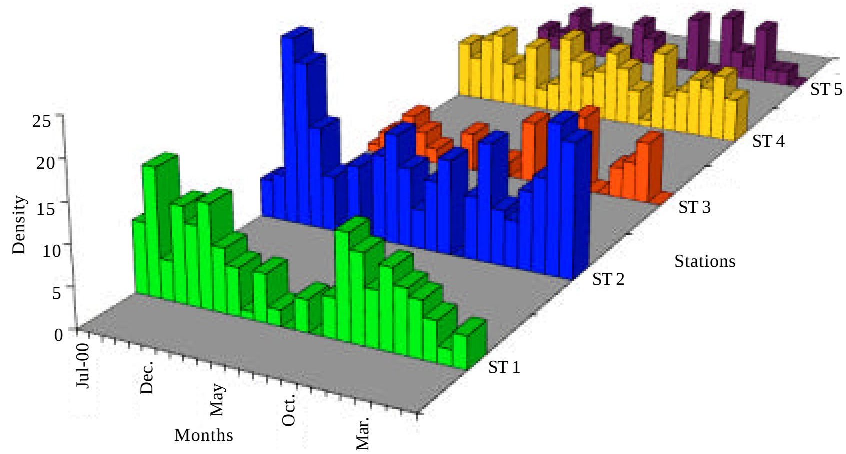

Fig. 6: Temporal variation of Annelida in the study station

Table 3: Diversity of macrobenthic invertebrate in the study stations of Osse River

	Station				
Parameters	1	2	3	4	5
No of taxa	53	53	46	49	47
No of individual	1890	1455	830	896	1170
Taxa richness (d)	6.8825	7.1401	6.6950	7.0610	6.5112
General diversity (H)	3.2940	3.2808	3.1269	3.2733	3.0632
Evenness (E)	0.8297	0.8263	0.8167	0.8411	0.7956

The overall density of Ephemeroptera fluctuated from months to months in the study station. Station 1 had three peaks August-September 2000 and December 2001 and May 2002. While the lowest density was recorded in July 2001 and April 2002. Similar trend was encountered in stations 2 and 5 were 2 and 3 peaks were recorded October 2000 and April 2002 station 2 and November 2000, April 2001 and March 2002. The dipterans showed no pattern of fluctuation in overall density. In all stations, the highest densities of diptera were recorded between October and December in all the stations. Among the Odonata, certain degree of irregularity in density was encountered, though highest density was in dry season, peak density were also encountered in rainy season months in some stations (August 2000 in station 1, July 2000 in station 3 and 4). Zero densities were recorded in all station in May-July 2001 (station 1, 2 and 5 and November 2001 (station 3) and February to April 2001 station 4. The same trend was also observed among the coleopterans and hemipterans, with higher density recorded during the dry season months. Density of macrobenthic invertebrate fauna was generally low in stations 3 and 4 throughout the study period.

Biological Indices

The diversity indices calculated for the five stations are shown in Table 3. Taxa richness (d) was highest in station 2 followed by stations 4, 1 and 3 while the lowest value was recorded at station 5. General diversity (H') showed that station 1 had the highest value followed by station 2, 4 and 3, while the least was station 5. Evenness index (E) was higher in station 1 than other stations.

DISCUSSION

A total of 57 macrobenthic invertebrates were recorded in this study. The community structure was dominated by various macrobenthic invertebrate groups recorded in this river are widely distributed in tropical African freshwater ecosystems. The invertebrate communities of lotic ecosystem are a conservative assemblage of types that recur in similar biotopes regardless of geographical location, similar environmental niches harbor analogous taxa, often of the same family or generic group wherever such habitats are found (Bishop, 1973).

Fifty-seven macrobenthic invertebrates reported in this study is similar to an earlier study on the macro-invertebrate fauna of Edo ecozone (Olomukoro and Ezemonye, 2007) which recorded 55 taxa. Other studies on lotic ecosystems with relative high diversity of tropical macro-invertebrates include Olomukoro and Egborge (2003), recorded 138 macro-invertebrate taxa from the Warri River; Ezemonye *et al.* (2004) recorded 51 macro-invertebrate taxa from 2 river-catchment areas (Warri and Forcados Rivers) in Delta State, reported 134 from a temporary pond in southern Nigeria.

The dominant benthos in this study was the Ephemeroptera, Diptera, Decapoda, Oligochaeta and Odonata. The prominence of ephemeroptera larvae (Baetidae), dipteral larvae (particularly Chironomidae) and oligochaetes in many tropical assemblage has been acknowledged (Ogbeibu and Oribhabor, 2002; Osemwegie and Olomukoro, 2004). Their significance as biological indicators of water quality which determines their distribution has been stressed (Williams and Feltmate, 1992).

Spatial and temporal dynamics revealed that Nematode were recorded in all the study stations, though the abundance was low constituting 1.45% of total abundance, the highest values were recorded at station 1 and 2 where the substrate was silty and muddy a preferred substrate for nematodes.

The oligochaetes dominated the annelids group in this study. They were dominated by the family Naididae were *Nais* sp. and *Anlophorus* sp. were prevalent. The abundance of oligochaetes has been associated with muddy substratum rich in organic matter. This explains why they were more in abundant in station 1 and 2, also at station 4, were much decomposition of wood, a by-product of the logging activities of the lumbering factory near the bank of this river at the station. The shrimp *Potamalpheops monodi* was encountered in high abundance in all the stations. Powell (1980) reported that *P. monodi* is abundant among vegetation and submerged roots in natural waterbodies such a swamps, streams and river bankwaters.

Among the Odonata nymph, the anisoptera were dominant, here the family Liberllulidae were prevalent. Like the Libellulidae, the Corduhidae were also present but in low abundance. The presence of vertebrate predators like fish could be attributed to the decrease in abundance. While the presence of aquatic plants affects their distribution since they are known to be macrophyte associated. This could be the reason why they were more abundant at stations 1, 2 and 5 which possess these conditions (Bidwell and Clarke, 1977).

The clear pattern in spatial distribution of macrobenthic invertebrate was observed in this study. The macrophyte-rich stations 1, 2 and 5 harboured more species and had the highest abundance, compared with the impacted stations 3 and 4.

In this study, distinct seasonality was observed in macrobenthic invertebrates. Ephemeroptera, Odonata and diptera maxima occurred in the dry season months. However, maxima Annelida was observed in station 1, 3 and 4 in the rainy season. This is similar to the findings of Olomukoro and Egborge (2003), Ogbeibu and Oribhabor (2002). Species diversity is known to be highly variable in streams and rivers in response to disturbance resource availability and the presence of suitable habitat. Higher diversity also results when many species have equal or near equal opportunity of co-existence. It is clear that the species composition of the Osse River is highly cosmopolitan and all the species were those commonly found in tropical African freshwater ecosystems. Low abundance of species in station 3 and 4 when compared to stations 1, 2 and 5 further supports the facts available of the negative impact of the activities of crude oil exploitation activities on the fauna of aquatic ecosystems.

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