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The Distribution, Abundance and Seasonality of Benthic Macro Invertebrate in Okpoka Creek Sediments, Niger Delta, Nigeria.

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Abstract: The distribution, abundance and seasonality of benthic macro invertebrates in Okpoka creek sediments were studied for a period of one year (January-December 2006). Polychaeta was highest and constituted 82.8%. The others were Bivalvia (4.6%), Crustacea (4.5%) and Oligochaeta (3.9%), Gastropoda (2.1%) and Insecta (2.0%). From nineteen (19) species encountered in the area, all the species of the class (Polychaeta) with the exception of *Nereis virens* occurred in all the stations. The species found were relatively more abundant in stations 5 and 6. However, *Ophidonais serpentina* occurred only in stations 1 and 2 but more abundant (91.4%) in station 1. *Clibernarius cooci* and *Iphinoe tripanosa* were absent in station 2. *Iphinoe tripanosa* was more abundant (35.9%) in station 1 than the rest of the stations. Stations 1, 2 and 4 had seventeen (17) species each. Eighteen (18) species each were recorded in stations 3, 5 and 6. There was seasonal variation in the abundance of only *Ophidonais serpentine* (20.0 ± 14.6 dry, 115.24±25.49 wet); *Eunice harassi* (26.88 ± 3.53 dry, 47.78 ± 5.45 wet); and *Nereis pelegica*, (21.92 ± 4.14 dry, 40.96 ±8.32 wet). There were no significant seasonal differences in the other species encountered. The Shannon-Weaver and Margalef diversity values calculated generally show a high species diversity. The calculated values of Shannon-Weaver and Margalef diversity was maximum in November with H= 1.44, M=5.64 and J=0.911 and H= 1.136, M= 5.082 and J = 0.923 respectively. The lowest values (H = 0.87, M = 3.852, J= 0.806) were observed in August. Pielou's index of relative density or evenness (J=0.911; 0.923) revealed that the species were evenly distributed in the study area in February, October and November. The lowest evenness occurred in July.

Key words: Abundance and seasonality, benthic invertebrate, distribution, Okpoka Creek Sediments, Niger Delta and Nigeria

INTRODUCTION

Benthic macro fauna are those organisms that live on or inside the deposit at the bottom of a water body (Barnes and Hughes, 1988; Idowu and Ugwumba, 2005). In the brackish water ecosystem, they include several species of organisms, which cut across different phyla including annelids, coelenterates, molluscs, arthropods and chordates. These organisms play a vital role in the circulation and recirculation of nutrients in aquatic ecosystems. They constitute the link between the unavailable nutrients in detritus and useful protein materials in fish and shellfish. Most benthic organisms feed on debris that settle on the bottom of the water and in turn serve as food for a wide range of fishes (Imevbore and Bakare, 1970; Adebisi, 1989; Ajao 1990; Oke, 1990; Idowu and Ugwumba, 2005). They also accelerate the breakdown of decaying organic matter into simpler inorganic forms such as phosphates and nitrates (Gallep *et al*., 1978). All forms of aquatic plants, which are the first link of several food chains existing in aquatic environment, can utilize the nutrients. These organisms therefore form a major link in the food chain as most estuarine and marine fishes, birds and mammals depend directly or indirectly on the benthos for their food supply (Barnes and Hughes, 1988)

Macrobenthic 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.

Their composition, abundance and distribution can be influenced by water quality (Imevbore, 1967; Haslam, 1990; APHA, WWA, WEF, 1992; Odiete, 1999). They all stated that variations in the distribution of macro-benthic organisms could be as a result of differences in the local environmental conditions. Studies on macro invertebrates

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in the Niger area delta of Nigeria are few (Okpuruka, 1985; Onwuteaka, 1992; Umeozor, 1995; Nweke, 2002; Ansa, 2005). However, only few published works are available on the macro invertebrate fauna of bonny river of the Niger Delta. Despite the importance of benthic macro invertebrate in the aquatic environment, particularly in the Okpoka Creek, information on the distribution, abundance and seasonality of benthic macro invertebrate in Okpoka creek sediments, is still lacking. This study is aimed at bridging that gap.

MATERIALS AND METHODS

Study Area: The study was carried out in Okpoka creek, which is one of the several adjoining creeks off the Upper Bonny River estuary in the Niger Delta (Fig. 1). The Bonny River Estuary lies on the Southeastern edge of the Niger Delta, between longitudes 6°58¢ and 7°14¢¢ East, and latitudes 4°19¢¢ and 4°34¢ North. It has an estimated area of 206Km^2 and extends 7Km offshore to a depth of about 7.5 metres (Irving, 1962, Scott, 1966; Alalibo, 1988). The Bonny River is a major shipping route for crude oil and other cargoes, and leads to the Port Harcourt quays, Federal Ocean Terminal, Onne, and Port Harcourt Refinery company terminal jetty, Okirika. Specifically, the Okpoka creek lies between Longitudes 7°03¢ and 7°05¢ East and Latitudes 4°06¢ and 4°24¢ and it is about 6 kilometers long.

Characteristically, the area is a typical estuarine tidal water zone with little fresh water input but with extensive mangrove swamps, inter-tidal mud flats, and influenced by semi-diurnal tidal regime. In the Bonny River estuary, the salinity fluctuates with the season and tide regime is influenced by the Atlantic ocean (Dangana, 1985). Tidal range in the area is about 0.8 m at neap tides and 2.20 m during spring tides (NEDECO, 1961).

It is strategically located southwestern flanks of Port Harcourt and Okirika of Rivers State. The creek is bounded by thick mangrove forest dominated by Rhizophora species interspersed by White mangrove (*Avecinia* sp.) and Nypa palm. Along the shores of the creek are located the Port Harcourt Trans-Amadi Industrial layout, several establishments, markets, the main Port Harcourt Zoological garden and several communities. The communities are Oginigba, Woji New layout, Azuabie, Okujagu- Ama, Ojimba- Ama, Abuloma, Okuru- Ama, Oba-Ama and Kalio- Ama.

Artisanal fishers mainly exploit the fisheries. The fishers use wooden/dug-out canoes ranging in size from 3 to 8m long. The canoes are either paddled or powered by small outboard engines, and manned by an average of two men. From these boats, the fishers operate their cast nets, hook and lines, gillnets, crab pots, etc.

Sampling stations: Six sampling stations were established along a spatial grid of the Okpoka creek covering a distance of about six kilometers. The sampling stations were established based on ecological settings, vegetation and human activities in the area. The sampling station is about one kilometer apart from each other.

Station 1: Located upstream of the Port Harcourt main abattoir at Oginigba waterfront with living houses on the left flank of the shoreline. Vegetation is sparse with mainly red mangrove (*Rhizophora* sp.,) white mangrove, *Avicenia* sp. and Nypa palm (*Nypa fructicans*).

Station 2: Situated at Azuabie/Port Harcourt main abattoir waterfront. It is located downstream of Station 1. The bank fringing the Azuabie/abattoir is bare with no visible plants except toilet houses, residential houses, animal pens, boats and badges, while at the opposite side there are few mangrove and Nypa palm. Human activities here include slaughtering of animals, marketing, fishing and boat building. It is located downstream of station 1 and it is main collection point of abattoir wastes and other human and market wastes.

Station 3: It is downstream from the Port Harcourt abattoir at the Woji sand-Crete. It is about one kilometer away from Station 2. The major activities here included sand mining and loading.

Station 4: This station is located at Okujagu-Ama area. There are no industrial activities here. Mainly fishers occupy the area. Nypa palm dominates the marginal vegetation while the opposite side is thickly populated with red mangrove forest. *Rhizophora racemosa* and *Rhizophora mangle*. The main activity is fishing, boat ferrying and occasional sand moving.

Station 5: Is situated at Ojimba cum Abuloma waterfronts. There are no commercial activities apart from ferryboats operations. The shoreline fringes have mainly Nypa palm. The area is shallow and at low tide, the greater part of the bottom mud flat is exposed.

Station 6: Is located in front of Kalio-ama directly between Okpoka and Amadi creeks. The human activities here include jetty operations, oil and non-oil industrial activities, boat traffic and fishing. Vegetation is few dominated by red mangrove interspersed with white mangrove *Avicenia africana*.

Sample collection: Benthic samples for the analysis of benthos and sediment particle size were collected using an Eckman grab of 10cm diameter and 12 cm long. At each sampling station, sending the grab down into the bottom and using the messenger to close and grab some quantity of sediment made 3 hauls. The grab was then removed under suction pressure. The sub tidal benthic samples were collected monthly from each station. Composite samples was composed from each station and put into labeled polythene bags for subsequent determination of the sediment particle sizes. The remaining benthic samples were washed through a sieve of 1mm x 1mm mesh size to collect the benthos.

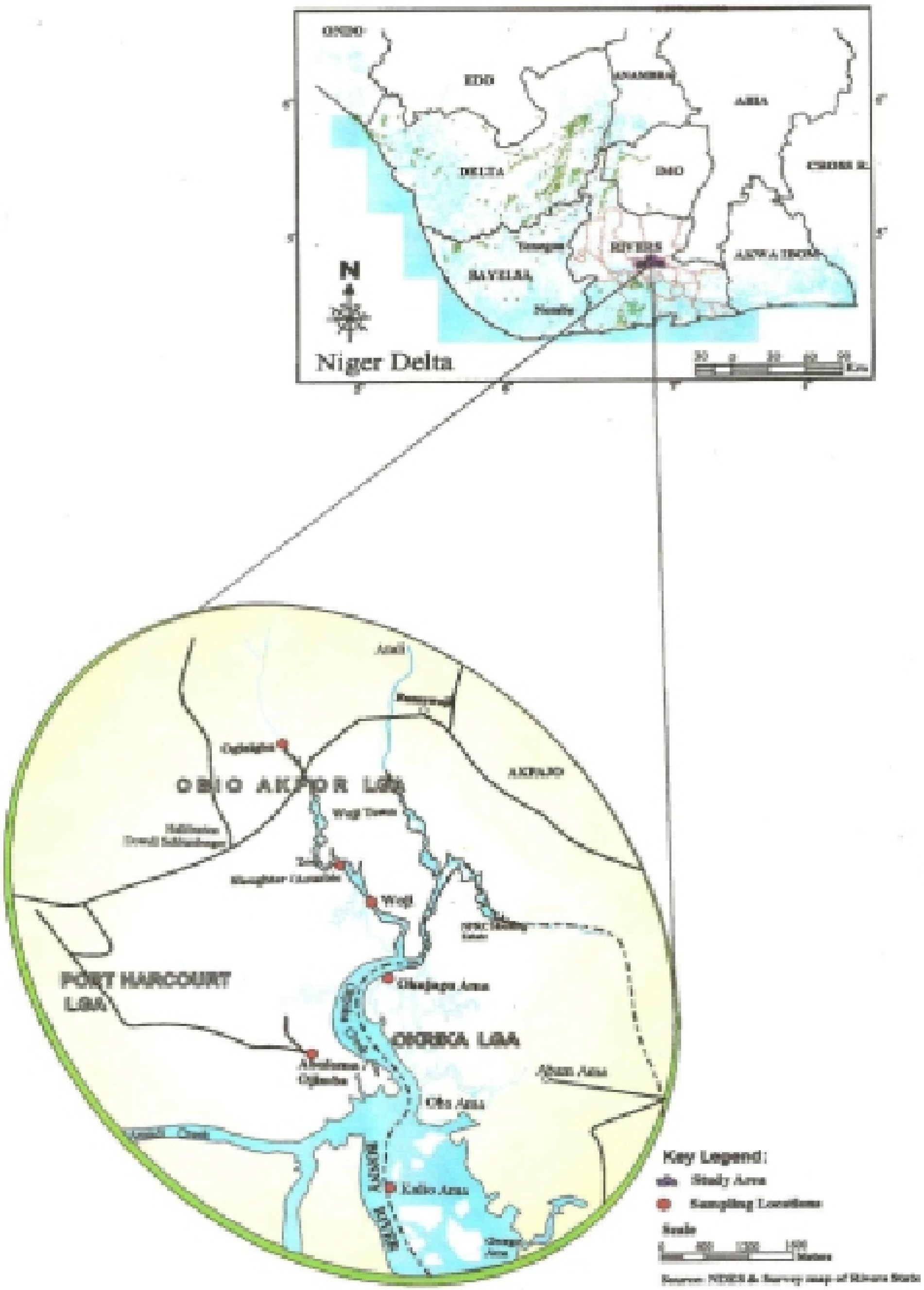

Fig:1 Map of Niger delta showing Rivers State and the Study Area

The washed sediment with macro benthos 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 at strength of 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 later taken to the laboratory for further analysis.

In the laboratory, the washed and preserved sediment with benthic invertebrates were poured into a white enamel tray and sorted. The sorting was made effective by adding moderate volume of water into the container to improve visibility. Large benthos was picked using forceps while the smaller ones were pipette out. The organisms were sorted into their different groups and preserved in 5% formalin. The preserved animals were later identified to their lowest taxonomic group under light and stereo dissecting microscope and counted. The identification was carried out using the keys, by Days (1967), Pennak (1978) and Hart (1994).

The monthly percentage occurrence and relative numerical abundance of macro benthos were estimated.

The densities of abundant species were analyzed for each of the sampling stations using the formula:

$$\text{Density} = \frac{\text{Total number of animals}}{\text{Area of Sampling Unit}} \qquad (1)$$

Diversity of the benthic fauna was determined using Shannon Weaver index and Margalef index. Pielou's index (J) of evenness was also applied to calculate the relative diversity.
Shannon – Weaver index was expressed as:

$$Hs = \sum \frac{Ni}{N} Log_2 \frac{Ni}{N} \text{ (Shannon-Weaver, 1963)} \qquad (2)$$

Where:
Hs = Shannon-Weaver index
N = total number of individual in the sample
Ni = the number of individuals of species in the sample.

Margalef – value is a measure of species richness. It was expressed as:

$$D = \frac{S-1}{Log_e N} \text{ (Margalef, 1967)} \qquad (3)$$

Where:

D = Margalef value
S = number of species collected
N = total number of individual in the sample

Pielou's index measures how evenly the species are distributed in a sample community. It was expressed as:

$$J = \frac{Hs}{H\max} \text{ (Pielou, 1969)} \qquad (4)$$

Where:

J = diversity evenness
H = diversity index (Shannon Weiner)
Hmax = $Log_2 S$

Data Analysis: Data collected for the environmental parameters were subjected to statistical analysis using Analysis of variance (ANOVA) to determine their variations at stations and seasons. Whereas the multiple linear correlation analysis was carried out on the water parameters and benthos to verify if there is any significant relationship. If any, the Duncan multiple range test was used to separate the means.

RESULTS

The relative class abundance trend of benthic macro invertebrate in Okpoka creek sediments is presented in Fig 2. *Polychaeta* was highest and constituted 82.8%. The

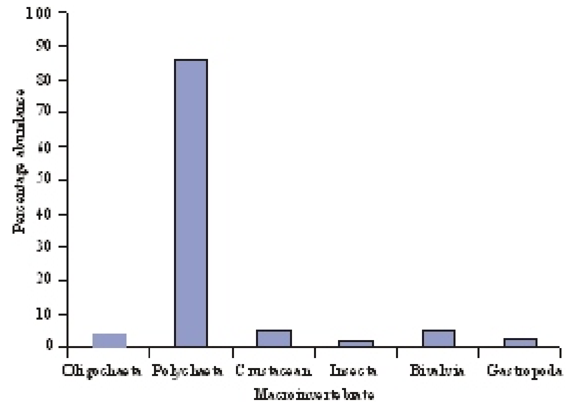

Fig 2: Class abundance of benthic macro Intertebrates

others were *Bivalvia* (4.6%), *Crustacea* (4.5%) and *Oligochaeta* (3.9%) while the least were *Gastropoda* (2.1%) and *Insecta* (2.0%).

Table 1 shows the distribution patterns of species and their relative abundance during the study area. Of the nineteen (19) species encountered in the area, all the species of the class (Polychaeta) with the exception of *Nereis virens* occurred in all the stations. The species found were relatively more abundant in stations 5 and 6. However, *Ophidonais serpentina* occurred only in stations 1 and 2 but more abundant (91.4%) in station 1. *Clibernarius cooci* and *Iphinoe tripanosa* were absent in station 2. Iphinoe tripanosa was more abundant (35.9%) in station 1 than the rest of the stations. Stations 1, 2 and 4 had seventeen (17) species each while in stations 3, 5 and 6, eighteen (18) species were recorded.

Table 2 shows that seasonal variation occurred in the abundance of *Ophidonais serpentine* (20.0 ± 14.6 dry, 115.24±25.49 wet); *Eunice harassi*_(26.88 ± 3.53 dry, 47.78 ± 5.45 wet); and *Nereis pelegica*, (21.92 ± 4.14 dry, 40.96 ±8.32 wet).

Table 3 shows the Shannon-Weaver and Margalef diversity values calculated for all the species per month during the study period. The results generally show a high species diversity. The calculated values of Shannon-Weaver and Margalef diversity was maximum in November with H = 1.44, M =5.64 and J=0.911 and H= 1.136, M= 5.082 and J = 0.923 respectively. The lowest values (H = 0.87, M = 3.852, J= 0.806) were observed in August. Pielou's index of relative density or evenness (J=0.911; 0.923) revealed that the species were evenly distributed in the study area in February, October and November. The lowest evenness occurred in July.

DISCUSSION

The nineteen species belonging to twelve families, six classes and four phyla of benthic macro invertebrates encountered in the study area varied from other reports. Hart (1994), reported forty-three species from mangrove swamp of Port Harcourt area of the Niger Delta. Umeozor (1995) recorded twenty three species in the New

Table 1: Distribution and relative abundance of Benthic macro invertebrate

	Family	Species	Stations					
			1	2	3	4	5	6
1	Naididae	*Ophidonais serpentina*	68.7(91.4)	65(8.6)	0	0	0	0
2	Arenicolidae	*Arenicola marina*	79 (7.8)	82(8.1)	140(16.8)	186(18.4)	15(11.4)	376(37.2)
3	Eunicidae	*Eunice harassi*	53 (5.3)	146(14.5)	31(3.1)	32(3.2)	124(12.3)	234(23.2)
4	"	*Marphysa sanguinea*	10 (3.6)	6(2.2)	13(4.7)	36(12.9)	88(31.7)	125(45.0)
5	Capitellidae	*Capitella capitata*	305 (18.1)	263(15.6)	216(15.0)	387(12.8)	514(30.5)	494(29.3)
6	"	*Notomastus latrella*	28 (5.7)	80(16.2)	37(7.5)	76(15.4)	138(27.9)	136(27.5)
7	"	*Notomastus tenuis*	5 (0.4)	47(3.6)	76(5.8)	109(8.3)	376(28.6)	702(53.3)
8	Glyceridae	*Glycera capitata*	26 (4.3)	138(22.7)	48(7.9)	59(9.7)	155(25.5)	183(30.0)
9	"	*Glycera convoluta*	17 (3.1)	66(12.1)	43(7.9)	22(4.0)	135(24.8)	261(48.0)
10	Nereidae	*Nereis diversicolor*	40 (3.2)	158(12.7)	165(13.3)	153(12.3)	343(27.6)	383(30.8)
11	"	*Nereis pelagica*	34 (4.9)	63(9.2)	157(22.9)	101(14.7)	126(18.3)	206(30.0)
12	"	*Nereis virens*	(-)	34(4.3)	202(25.8)	82(10.5)	202(25.8)	263(33.5)
13	Nephthyldae	*Nephthys hombergi*	92 (4.2)	127(5.9)	236(11.0)	368(17.1)	433(20.1)	895(41.6)
14	Gammaridae	Nototropis swamidami	17(7.5)	30(13.2)	20(8.8)	0(0)	60(26.4)	100(44.1)
15	Callianassidae	Clibernarius cooci	6(1.7)	(-)(0)	26(7.5)	21(6.0)	148(42.4)	148(42.4)
16	"	Iphinoe tripanosa	42(35.9)	(-)(0)	20(17.1)	17(14.5)	12(10.3)	26(22.2)
17	Chironomidae	Chironomus ablabiesmia	91(26.8)	33(9.7)	9(2.6)	28(8.2)	99(29.1)	80(23.5)
18	Tellidae	Tellina nymphalis	(-)	13(1.7)	58(7.7)	116(15.4)	211(28.0)	355(47.1)
19	Potamidae	Tympanotonus fuscatus	33(10.1)	5(1.5)	20(6.1)	26(8.0)	77(23.5)	166(50.8)
	Total number of species per station		17	17	18	17	18	18

Table 2: Seasonal variations of benthic macro invertebrates of Okpoka Creek sediments

Species	Season	
	Dry	Wet
Ophidonais serpentina	20.0 ± 14.6^{b}	115.24 ± 25.49^{a}
Arenicola marina	18.67 ± 3.59^{a}	36.06 ± 3.99^{a}
Eunice harassi	26.88 ± 3.52^{b}	47.78 ± 5.45^{a}
Marphysa sanguinea	20.33 ± 12.14^{a}	27.93 ± 3.11^{a}
Capitella capitata	38.00 ± 12.81^{a}	82.27 ± 18.25^{a}
Notomastus latrella	28.50 ± 6.73^{a}	43.76 ± 13.15^{a}
Notomastus tenuis	18.44 ± 4.51^{a}	25.9 ± 3.97^{a}
Glycera capitata	23.7 ± 6.93^{a}	26.17 ± 4.16^{a}
Glycera convoluta	37.18 ± 8.82^{a}	32.9 ± 6.92^{a}
Nereis diversicolor	21.6 ± 2.84^{b}	38.54 ± 4.56^{a}
Nereis pelagica	21.92 ± 4.141^{b}	40.96 ± 8.32^{a}
Nereis virens	12.78 ± 3.81^{a}	34.71 ± 3.89^{a}
Nephthys hombergi	40.56 ± 5.95^{a}	58.45 ± 8.94^{a}
Nototropis swamidami	19.56 ± 4.16^{a}	22.60 ± 5.88^{a}
Clibernarius cooci	30.64 ± 5.59^{a}	23.57 ± 9.33^{a}
Iphinoe tripanosa	22.00 ± 11.46^{a}	26.20 ± 14.85^{a}
Chironomus ablabiesmia	36.50 ± 4.31^{a}	26.78 ± 4.84^{a}
Tellina nymphalis	28.32 ± 4.69^{a}	26.50 ± 2.67^{a}
Tympanotonus fuscatus	25.17 ± 6.82^{a}	15.86 ± 3.33^{a}

Table 3: Monthly species diversity of benthic invertebrates

Month	Total No. of organism	No. of Species	H	M	J
January	754	16	-1.069	5.213	0.88
February	557	13	-1.016	4.37	0.912
march	575	15	-1.04	5.073	0.907
April	686	13	-1.003	4.231	0.9
May	1406	16	-0.969	4.765	0.805
June	1896	16	-1.082	4.576	0.989
July	1926	17	-0.958	4.87	0.779
August	717	12	-0.87	3.852	0.806
September	1382	15	-1.003	4.458	0.853
October	1210	17	-1.121	5.19	0.911
November	1067	18	-1.144	5.614	0.911
December	1058	19	-1.132	5.621	0.902

H = Shanon-Weaver index of diversity, M = Margalef index, J = Pielou's index of evennessphysico-chemical parameters.

Calabar river; Ansa (2005) in her study of Adoni flats reported twenty eight families, six classes and five phyla, Hart and Zabbey (2005) recorded thirty taxa belonging to twenty families and five classes of macro invertebrates in Woji Creek in the upper reaches of Bonny River in the Lower Niger Delta; while Sikoki and Zabbey (2006) identified fourteen species representing eleven families of macro invertebrates in Imo River. Similarly, Oyenekan

(1975), Williams (1999) Ajao and Fagade (1990) had reported varied results of species composition of benthic organisms in Lagos Lagoon. Diversity of benthic macro fauna in this study is not unusual in the Niger Delta.

The observed trend that *Polychaeta* was more dominant, with six families followed by Crustacea with two families in this study is in agreement with the studies of Ombu (1987) in the Bonny River. In his report *Polychaeta* was the highest in species richness with 68.78% followed by Oligochaetes and Crustacea with 6.5% each. Zabbey (2002) also had similar results for Woji creek in the upper reaches of Bonny River. In contrast, Hart (1994) reported the predominance of crustaceans, polychaetes, and gastropods, while Nwadiaro (1987) recorded a dominance of crustaceans and insects followed by molluscs and annelids in a lower Niger Delta river (River Sombriero). The dominance of polychaetes in the area can be attributed to their high level of pollution-tolerance.

This assertion is in agreement with the observation of Ajao and Fagade (1990 and 2002). They reported that the Polychaetes, *Capitella capitata*, *Nereis* sp., and *Polydora* sp. were found associated with sites grossly polluted with organic matter, heavy metals and petroleum hydrocarbons (Ajao and Fagade, 1990). They also observed that the important polychaete species were pollution-tolerant and proliferated in the Western industrialized portions of the Lagos lagoon receiving effluents from industrial establishments on the shore.

The distribution pattern of the macro invertebrates in all the stations of the creek did not show major differences. This indicates that all the fauna are able to inhabit both sandy and sand-loamy substrates with or without vegetation cover. Ansa (2005) reported that the presence of bivalve and polychaete in her benthic collection in the Andoni mud flats was due to their ability to inhabit sandy and loamy substrates with or without vegetation.

A total of forty-two species of benthic macro fauna were collected from the Lagos lagoon during the wet and dry seasons by Ajao and Fagade (1990) while Williams (1999) recorded fifteen benthic species at Oworoshoki portion of the lagoon and nine at the Lighthouse creek. The differences in species composition recorded could be attributed to the ecological differences of the different geographical locations and depth of investigation.

The distribution pattern of the macro invertebrates in all the stations of the creek did not show major differences. This indicates that all the fauna are able to inhabit both sandy and sand-loamy substrates with or without vegetation cover. Ansa (2005) reported that the presence of bivalve and polychaete in her benthic collection in the Andoni mud flats was due to their ability to inhabit sandy and loamy substrates with or without vegetation. The sediment characteristics correlated positively with her findings. Of the nineteen species recorded in the study area, seventeen species were encountered in stations 1, 2 and 3 while eighteen species were recorded in stations 5 and 6 respectively.

This pattern of distribution could be explained by similarity in the environmental conditions across the stations. The overall differences observed in the abundance and species richness may be due to the slight variations in the physico-chemical and sediment quality of the aquatic habitat. Wood (1987) explained that species have to contend with environmental changes and biological interaction, which may produce significant alterations in overall community structure.

In fact, Wildish (1977) identified three major biotic factors namely: (1) food supply, (2) supply of colonizing larvae, and (3) inter specific competition as factors which exercise some control over the number of animals inhabiting estuaries. The absence of *Nereis virens* in station 1 may be due to the low salinity level in that station as explained by Mclusky (1989) in his study, he asserted that *N. virens* is large and more voracious than the others, but intolerant to low salinities. However, *Nereis diversicolor* can live in a wide range of salinities but is apparently excluded from higher salinities. The gastropods and bivalves are relatively tolerant to physical and chemical variations in the environment and are usually found in broad range of habitats (Ajao and Fagade, 2002). The low abundance of *Tympanotonus fuscatus* and *Tellina nymphalis* in the upstream stations could be ascribed to the amphibious mode of life of these species and their preference for mudflats of mangrove swamps at low tide (Oyenekan, 1979; Egonmwan, 1980).

However, the mud flats of the Creek were not sampled in this study to ascertain this view

Ophidonais serpentina occurred only in stations one and two but more abundantly (91.45%) in station one, while *Clibernarus cooci* and *Iphinoe tripanosa* were absent in station two. This observation may be as a result of the effects of physical, chemical and biological differences of the stations as well as the reproductive cycles and recruitment patterns of the benthic organisms. In fact, Davis (1988) observed such trend and explained that individual species may respond in different ways to combination of environmental factors. They also observed that timing of life history with major environmental features could contribute to the spatial and temporal heterogeneity observed in benthic assemblages. The absence of *Ophidonais serpentina* in stations three to six could also be attributed to elimination by heavy petroleum pollution as was observed by Williams (1999) in similar situation.

There was no seasonal variation of the benthic organisms' abundance except for *Ophidonais serpentina, Capitalla capitata, Nereis pelegica, Nereis diversicolor* and *Nereis virens*. The non-seasonality of benthos composition and abundance of some species observed in this study disagrees with earlier report by Umeozor (1995) that density of organisms during rainy season is significantly low. He explained further that during the rainy season, substrate is unstable causing dislodgement of fauna while in the dry months, the substrates stabilize and population builds up. Ajao and Fagade (2002) also confirmed this assertion. They reported that, of the forty-two benthic fauna observed in Lagos Lagoon, the highest number of species (41) was recorded during the dry season. This decreased to an average of 23 during the wet season. However, in this study result showed that fauna were available all year round, while differences observed in some species may be due mainly to recruitment and reproductive cycle, which occur all the year.

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