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IMPACTS OF PETROLEUM HYDROCARBON POLLUTION ON MACROBENTIC FAUNA OF OLUASIRI RIVER OF NIGER DELTA

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ABSTRACT: *The impacts of petroleum hydrocarbon pollution on macrobenthic of Oluasiri River in the Niger Delta of Nigeria was undertaken between January 2013 and June 2013, to assess the composition and distribution of benthic organisms. The diversity of benthic fauna was poor, only eleven (11) benthic macrofauna species in four classes polychaeta, mollusca, crustacean and oligochaeta were identified. The highest number of 218 benthic fauna were recorded in the month of February, followed by June (190), January (134), April (128), March (117) and May (112) respectively. The polychaetes population were the dominant class, comprising Neathes fucata, Neresis sp. and Nepthys hombergi. There was variation in the density of macro invertebrates from station 5 to station 1, the highest density was in station 5 (279), followed in decreasing order in the subsequent stations. Stations 4 (200), 3(188), 2(131) while the least species abundance of the identified benthic fauna was recorded in station 1 (98). Macrobenthic infauna distributed per station were significant ($p > 0.05$) in Oluasiri River except Neresis sp. and Tubicifid sp. Paehymelania aurita, Pachymelania bryonensis and Neritina oweniana were completely absence in stations 1 and 2 and negligible in station 3 (0.0 ± 0^C, 0.0 ± 0^C and 0.67 ± 0.21^C) respectively. It was recommended that there should be private and government partnership sensitization program for the public, on the health and safety hazards of oil when it spills and oil producing communities should be more conscious of their safety and environment.*

KEYWORD: Pollution, Macrofauna, Species, River and Niger Delta.

INTRODUCTION

Water quality plays a vital role in the distribution, abundance and diversity of aquatic organisms. A short-term exposure of benthic organisms to water of poor quality causes on alteration in the community structure due to the elimination of the species that are intolerant to stress and proliferation of stress tolerate species (Naiman and Turner, 2000).

The change in community structure requires time to return to stable condition and a balanced ecosystem especially if pollution sources are identified and controlled. The intertidal macrofauna serve primarily as a source of food for fish and other vertebrates of aquatic and terrestrial lives. The distribution of the macro invertebrate benthos will adversely affect the existence of a productive fishery as a major link in energy transfer in the food web (Lunberg *et al*, 2000).

The adverse effects by the release of heavy diesel oil into coastal water caused the death of many sub-lithoral and lithoral animals and finally settles on the substrate of low tides where its impacts on benthic community is usually serve. Dublin-Green (1990), noted that the main effect of petroleum hydrocarbon on macrobenthic organisms is sharp reduction in species diversity, reduction in population density, elimination of sensitive species, changes in the location of significant biotope boundaries and increase in the relative abundance of pollution

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tolerant species such as *Miliammina fusca*, *Trechammina inflate*, *Elpidium excavation* and *Ammonia becarii* variants.

These species and other pollution sensitive species such as *Ammonia cassis* are considered suitable for monitoring the state of the benthic environment in the creek and estuary (Gublin-Green, 1990).

The study was therefore undertaken to provide some baseline information on the composition of macrobenthic fauna of Oluasiri river. The study also provides information on the seasonal abundance and distribution of organisms in the study area.

Study Area

The study area is at Oluasiri river, Nembe Local Government Area of Bayelsa State. Oluasiri river is located within latitude N4^{0}.41' 25.26" and longitude E6^{0}.33' 36.29" in the Niger Delta of Nigeria. The river flows from the Okilo river in Abua Odua, LGA of Rivers State into the Bonny estuary through San Barbara and San Bartholomew river and is fresh water till Benikiri, after which it is Brackish (Fig. 1). Leading to Ijawkiri where the disputed Oluasiri – Soku oil wells and gas plant is located.

The river is about 10km in length from Okilo creek to Benikiri or Otumakiri and has an average width of 80m with a large flood plain circumference. The river is tidal except during the month of July, August, September and October, because it is subjected to flooding. The tidal range is a maximum of about 3.0m with rainfall typical of a tropical rainforest.

During low tide the river is confined to the lowest tide zone with a water depth of about 5 – 10m, its main channel has substrate mixture of soft clay, mud and mostly sand. For the purpose of this study, the river was divided into five (5) stations (Fig. 1).

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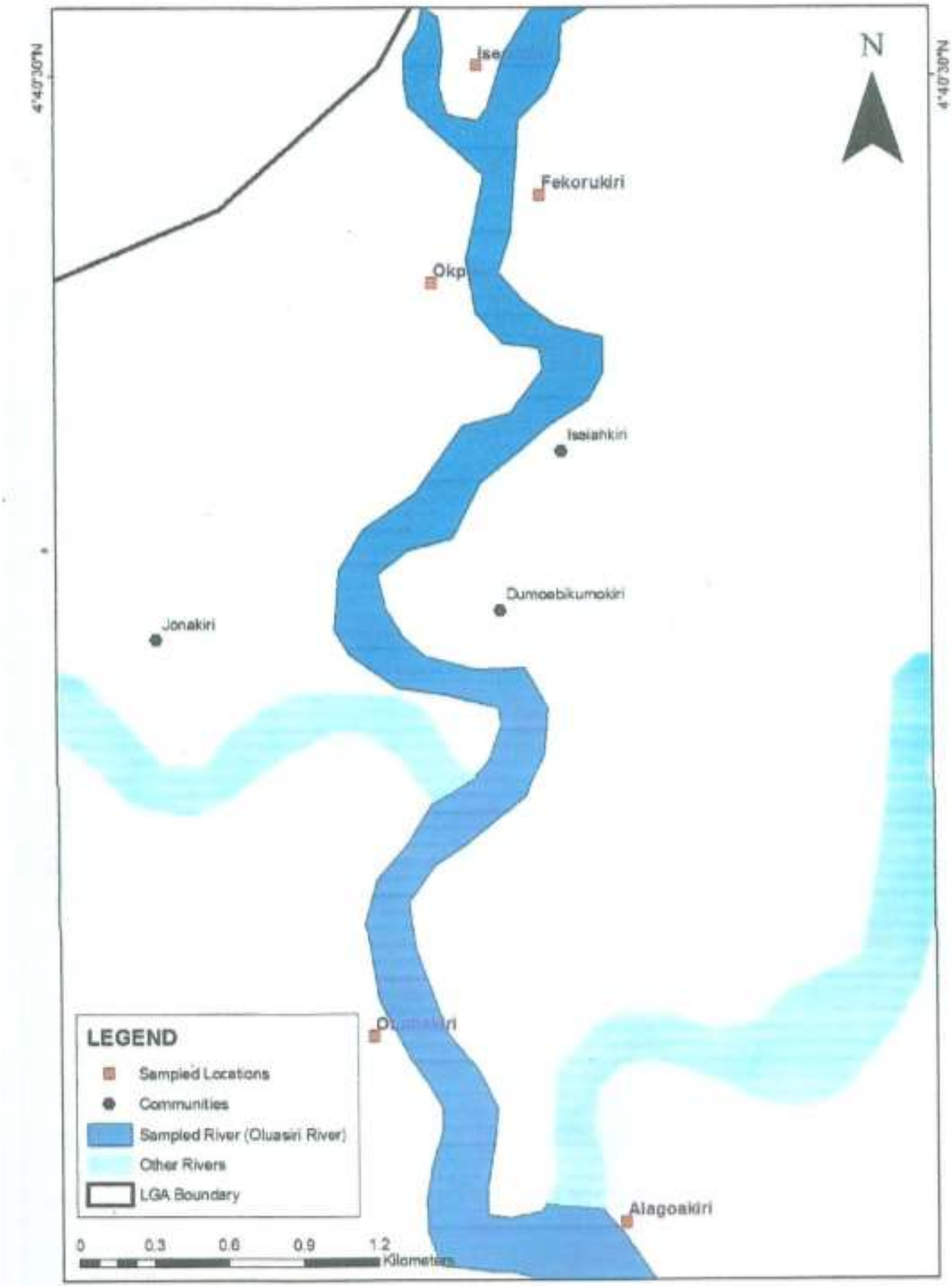

Fig. 1: Map of Oluasiri River Showing the Sampling Stations

Station 1: (Okpikirikiri) possesses the features of a typical freshwater environment with high vegetation mainly *Clapaca* sp. And oil palm. It includes water fern, water hyacinth and *Vossia cuspidate* at its bank. The substrate is composed of layers of mud and sand and the height of the water at full tide was 5.2m.

Station 2: (Iserekiri) vegetation is dominated by *Vossia cuspidate*, *Clapaca* sp. Few oil palm, water fern and water hyacinth. The height of the water at full tide was 6.5m.

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Station 3: (located at Fekorukiri) with many oil bunkering stations. Vegetation is also dominated by *Pandonus* sp, *Clacapa* sp, water hyacinth, Lettuce and fern. The height of the water at full tide was 7.5m.

Station 4: (Is at Alagoakiri) also inundated with petroleum hydrocarbon pollution owing to its bunkering activities. There is a shell gas pipe line at this station. Vegetation is dominated by *Razophora racemosa* (red mangrove), *Clapaca* sp, bamboo and water hyacinth. The height of the water at full tide was 9.2m.

Station 5: (situated at Otumakiri Community). This station is special because it is at a T-junction where the river empty into San Batholomew river (brackish water) leading to the Bonny estuary. This is the river mouth closer to the brackish water. A cyclic current occurs here and a lot of sediments settled at the Delta. Vegetation is dominated by *Razophora racemosa* (red mangrove) and few *Avicennia africana* (white mangrove), few *Pandonus* sp. The height of the water at full tide was 10m.

MATERIALS AND METHODS

Subtidal benthic samples were collected from a canoe randomly from three spots per station per sampling day, with an Eckman's grab measuring 225cm^2 (Southwood, 1980). The samples were dug out from a depth of about 20cm and the bulk of the sediments from each samples was first emptied into a 15 litre plastic bowl. The samples from each station were washed using 0.5mm mesh screen. The residue in the sieve was then emptied into a wide mouth labeled plastic container and preferred with 10% formalin to which the vital stain rose Bengal has been added. The dye at a strength of 0.1% selectively coloured all living materials in the sample (Claudius *et al*, 1979). The preserved samples were transported to the laboratory for subsequent treatment.

Benthos were sorted out by transferring successive quantities of preserved residue into a white plastic tray. Moderate volume of water was added to improve visibility. Large benthic organisms were packed with forceps while smaller ones were pipette out. Sorted macrobenthos were then preserved in 10% formalin for further identification and counting. Macrobenthos present were identified to their lowest possible taxonomic level under light and stereo dissecting microscopes using the keys provided by Hart (1994) and Merit and Cummins (1984). The number of each identified species or taxon was counted and recorded.

RESULTS

A total of 11 benthic fauna belonging to four classes were identified. Checklist of the fauna is presented in Table 1. The results value obtained showed that polychaetes population were the dominant class, comprising (*Neathes fucata*, *Neresis* sp. and *Nepthys hombergi*), followed by Mollusca (*Pachemelania aurita*, *Pachemelania bryonensis* and *Neritiria oweniana*), Crustaceans (*Macrobrachium macrobrachium*, *Macrobraehium vollenhveni*, *Sersama angulense* and *Sersama alberte*) and Oligochaetes (*Tubicifid* sp).

Result further showed that more organisms were identified at stations 5 (279), followed by 4 (200), 3 (188), 2 (131) while the least species abundance of the identified benthic infauna was recorded in station 1 (98) (Table 1). Monthly distributions of the identified classes of macrobenthic infauna are presented in (Table 2) and it shows that the month of June had the highest number of species (190), followed by February (218), January (134), April (128), March (117) and the month of May had 112 species only. Also macrobenthic infauna distributed per station are presented in (Table 3). Macrobenthic infauna distributed per station were significant ($p > 0.05$) in Oluasiri River except *Neresis* sp. and *Tubificid* sp. It also showed that *Pachymelania aurita*, *P. bryonensis* and *Neritina oweniana* were completely absence in stations 1 and 2 and limited number in station 3 (0.0 ± 0^C, 0.0 ± 0^C and 0.67 ± 0.21^C) respectively.

Table 1: Species Abundance of the Identified Benthic infauna of Oluasiri River per Station from January 2013 – June 2013.

S/No	Species Identified	Abundance per stations					
		1	2	3	4	5	Total
A.	MOLLUSCA						
1.	*Pachemelania aurita*	-	-	1	18	42	61
2.	*Pachemelania bryonensis*	-	-	1	10	15	26
3.	*Neritina oweniana*	-	-	3	7	7	16
B.	CRUSTACEA						
4.	*Macrobrachium macrobrachium*	8	1	2	-	1	12
5.	*Macrobrachium vollenhvenii*	8	2	-	1	1	12
6.	*Sersama angulense*	21	1	6	5	5	38
7.	*Sersama alberti*	9	2	1	3	5	20
C.	POLYCHAETA						
8.	*Neathes facata*	28	81	115	97	130	451
9.	*Neresis* sp.	-	5	9	9	19	42
10.	*Nepthys hombergi*	-	-	5	18	24	47
D.	OLIGOCHAETA						
11.	*Tubificid* sp.	24	39	46	32	30	171
	Grand Total	**98**	**131**	**188**	**200**	**279**	**896**

Table 2: Monthly Species Abundance of the Identified Benthic infauna of Oluasiri River from January 2013 – June 2013.

S/No	Species Identified	Abundance per months					
		Jan.	Feb.	March	April	May	June
A.	MOLLUSCA						
1.	*Pachemelania aurita*	10	15	9	12	7	8
2.	*Pachemelania bryonensis*	5	8	4	3	2	4
3.	*Neritina oweniana*	4	6	2	2	-	2
B.	CRUSTACEA						
4.	*Macrobrachium macrobrachium*	3	4	3	2	-	-

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5.	*Macrobrachium vollenhvenii*	1	3	2	1	2	3
6.	*Sersama angulense*	8	7	4	5	8	6
7.	*Sersama alberti*	4	8	2	2	2	2
C.	POLYCHAETA						
8.	*Neathes facata*	75	142	73	66	40	57
9.	*Neresis* sp.	16	15	2	6	2	2
10.	*Nepthys hombergi*	8	7	16	3	6	7
D.	OLIGOCHAETA						
11.	*Tubificid* sp.	-	3	-	26	43	99
	Grand Total	**134**	**218**	**117**	**128**	**112**	**190**

Table 3: Mean Population Densities of Macrobenthos per Station

MONTHS Macrobenthic infauna	STATIONS 1	2	3	4	5	MONTHLY (x ± sd)
MOLLUSCA						
Pachemelania aurita	0.0±0[c]	0.0±0[c]	0.17±0.17[c]	3.00±0.89[b]	7.0±0.63[a]	2.03±0.55
P. bryonensis	0.0±0[b]	0.0±0[b]	0.17±0.17[b]	1.67±0.49[a]	2.50±0.43[a]	0.87±0.23
Neritina oweniana	0.0±0[a]	0.0±0[a]	0.33±0.21[ab]	1.17±0.65[a]	1.17±0.31[a]	0.53±0.17
Total	0.0±0[c]	0.0±0[c]	0.67±0.21[c]	5.83±1.76[b]	10.67±0.96[c]	3.43±0.86
SHRIMPS						
Macrobrachium macrobrachion	1.50±0.34[a]	0.17±0.17[c]	0.33±0.21[b]	0.17±0.17[b]	0.17±0.17[b]	0.47±13
M. vollenhvenii	1.50±0.34[a]	0.33±0.21[b]	0.0+0[b]	0.0±0[b]	0.17±0.17[b]	0.33±0.11
Total	2.67±0.42[a]	0.50±0.34[b]	0.33±0.21[b]	0.17±0.17[b]	0.83±0.31[b]	0.80±0.21
GRAPSIDAE						
Sersama angulense	3.50±0.22[a]	0.17±0.17[b]	1.0±0.26[b]	0.83±0.40[b]	0.83±0.31[ab]	1.27±0.24
S. alberti	1.50±0.34[a]	0.33±0.21[b]	0.17±0.17[b]	0.50±0.34[b]	0.83±0.31[ab]	0.67±0.15
Total	5.0±0.52[a]	0.50±0.22[b]	1.17±0.17[b]	1.33±0.62[b]	1.67±0.33[b]	1.93±0.34
POLYCHAETA						
Neathes fucata	4.67±1.23[b]	13.50±3.87[ab]	19.17±3.78[a]	16.50±4.58[a]	21.67±2.79	15.10±1.80
Neresis sp	0.33±0.33[b]	2.0±1.29[ab]	3.67±2.89[ab]	3.0±1.67[ab]	21.67±2.70[a]	3.27±0.98
Nepthys hombergi	0.0±0[b]	0.0±0[b]	0.83±0.40[b]	2.67±0.71[a]	3.50±1.06[a]	1.40±0.36
Total	5.0±1.13[c]	15.50±4.45b[c]	23.67±3.70	22.17±4.60[ab]	32.50±5.25[a]	19.77±2.40
OLIGOCHAETA						
Tubificid sp	4.0±1.65	6.50±3.67	7.67±4.57	5.33±3.18	5.0±2.92	5.70±1.41

N.B: *Superscripts of the same alphabet are not significantly different ($p < 0.05$)

**Superscripts of different alphabet are significantly different ($p < 0.05$)

DISCUSSION

The low diversity of macrobenthic fauna recorded in this study may be causing some degree of environmental stress. The controlling factors were probably waste metabolites, such as total organic carbon, silt waste remains and heavy metals. The combine effect of these elements

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have been known to be responsible for environmental stress (Kreb, 1978; Bucklor *et al*, 1987 and Kullberg *et al*, 1993).

This study indicated that organic waste seemed to boost marine production by supplying the required nutrients, for primary production (e.g. carbon, nitrates, sulphate, phosophate, etc), through the release of organic metabolites into water column and sediment of the studied environment (Blonguist *et al*, 1993).

The benthos of Oluasiri River was found to be dominated by polychaetes, molluscs, crustaceans and oligochaetes in the descending order. Among the three major different species of polychaetes identified were the *Neathes fucata*, *Neresis* sp. and *Nepthys hombergi*. The distribution of *Neathes fucata* across stations showed that stations 5, 3 and 4 recorded the highest mean densities (130 ind/m^2, 115ind/m^2 and 97ind/m^2 while station 1 and 2 recorded 28 ind/m^2 and 81 ind/m^2) respectively.

Among the three species of molluscs that was identified were the most predominant species in the months sampled but other molluscs such as *Pachymelania bryonensis* and *Neritina oweniana* were also identified in the samples. These three identified species of molluscs were absent in station 1 and 2 and negligible in station 3 which contributed to the low mean monthly population density and was found to be very sensitive to environmental stress and were negatively affected by organic waste induced pollution (Ikomi and Sikoki, 2001).

The monthly distribution of *Tubificid* sp. fluctuated over the months and stations and recorded the highest mean densities of 99 ind/m^2 in June 2013. This spatial distribution showed that station 3 and 5 recorded the highest mean densities while the lowest was recorded in station 1 (24.00 ind/m^2).

Southerland (1980) reported that both the qualitative and the quantitative results on this species indicate that organic enrichment, depth and thermal conditions (most likely associated with upwelling) are the most important factors that structure benthic communities along the river. Human (2001) stated that availability of larvae for recruitment does not guarantee their settlement but that certain factors such as the phenomenon of larvae choosing, where to settle and settlement being controlled in hydrodynamics processes all come to play.

Information gained from this study indicates that the benthic fauna of Oluasiri River is reduced by the concentrations of organic carbon and waste remains which could be attributed to large volumes of waste influx and their spread were found to be the functions of tides and waves. The tidal movement of water along the studied river, contributed to the spread of waste metabolites within the entire ecosystem leading to increase impacted areas and which also influence their composition and distribution along the river (Clark, 1986).

The effect of organic waste influx into the ecosystem was found to be seasonal. The sites (study locations or stations) which received larger volumes of organic waste (such as stations 1 and 2) showed foamy dark (grey) appearance with fermented chocking smell. These physical properties were noted to be the visual characteristics of organic waste pollution. However, the study has enhanced our knowledge of benthic organisms in the tropics especially in the lower part of Niger Delta where published information on the subject is scanty.

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