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Zooplankton Fauna of a Creek Receiving Petroleum Refinery Effluent in South-South Nigeria

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A B S T R A C T

The zooplankton community structure of Ekerekana/Okari Creek in Okrika, South-South Nigeria had been studied for two months, February and August 2014 representing wet and dry months. Surface water for physico-chemical and zooplankton samples, were collected in 4 stations for analysis, identification and enumeration. Seasonal mean parameter values varied within February and August temperature, 28.5ºC ± 1.5 and 30.7ºC ± 3.42; flow rate was 8cm/s ± 4.1 and 8.7cm/s ± 4.3; depth 120cm ±30.7 and 200cm ± 20.9; pH 7.9 ± 0.14, 7.0 ± 0.04; salinity was 23.6% ± 1.6, 21.4 $^{0}/_{00}$ ± 0.2; DO was 9.3mg/l ± 2.8, 2.3mg/l ± 1.04, BOD was 6.9mg/l ± 4.2, 0.8mg/l ± 0.1 respectively. Four zooplankton taxa (Protozoa, Rotifera, Cladocera, and Copepoda) found during the study showed seasonal variations between dry and wet months respectively, with a total of 72 organisms in February and 121 organisms in August respectively. Dominant taxon in the dry month was Protozoa with 32 organisms representing 44.4% of total organisms. However, Copepoda with 41 organisms, representing 33.9% of wet month organisms dominated August samples.

Key words: *Refinery, Petroleum, South-South Nigeria, effluent, Zooplankton and environmental Changes.*

Introduction

The South-South region of Nigeria is the economic base of the country with rich petroleum and non-petroleum natural resources. As a result, several indigenous and foreign oil prospecting and servicing companies abound in the region. Oil prospecting activities started in the region since the days of the British colonial masters in 1956 when oil was first discovered in Oleibiri. The establishment of refinery that will meet the country's refined petroleum need was necessary. Hence, the Port Harcourt refinery, the first in the country, was established within Eleme and Okrika in 1978. The refinery effluent, like others globally, are channeled into the nearby creek. Since environment influences survival, composition, distribution and abundance of organisms of a habitat, introduction of such exogenous substance to the creek is expected to bring about environmental changes that will influence its flora and fauna stability such as zooplankton structure and composition, among others.

Zooplankton as source of food to organisms of higher tropic levels (Davies et. al., 2009) such as fish is an established fact. Some of the impacts of hydrocarbon waste on aquatic environment include habitat destruction, increased BOD, depletion of oxygen, short and long term toxicity, bioaccumulation and biomagnification at higher levels of food chain (Canada Gazzette, 2010).

Materials and Method

Study Area

The study was done in Ekerekana and Okariama communities of Okrika, Nigeria. A reconnaissance visit during low tide enhanced the establishment of 4 sampling stations presented in Table.1.

Table.1: Geo-referenced sampling station of the Ekrikana/Okariama community Creek of Okrika, South-South Nigeria.

Station	Co-ordinate Latitude (N)	Longitude (E)
1.	04º 44´ 601¨	007º 06´ 056¨
2.	04º 44´ 253¨	007º 05´ 934¨
3.	04º 44´ 229¨	007º 05´ 761¨
4.	04º 44´ 177¨	007º 05´ 403¨

Source: Field data.

Several activities including dredging, fishing and navigation take place in the creek. The creek bank's macro-flora consisted of Avecenna, Rhizophora and Nipa fructican, that appeared to be introduced in recent times, while macro-faunal composition was Crassostrea gasar, Periopthalmus, Cesama uzadi, banacles, Calinectis, harmit and ghost crabs. Fish juveniles preyed upon occasionally by fisher birds were also found. Sample collection was during mid tidal level (MTL) in 2 months of February and August, representing both dry and wet seasons. 50 liters of samples were strained with plankton net of 55µm mesh size and preserved in wide mouth plastic containers with 5% formalin solution after proper labeling and stained with few drops of eosin solution for visibility during microscopy.

Physical parameters measured were temperature, flow rate, depth and transparency. Measurements were according to The American Public Health Association (APHA) 1976. Temperature was determined with mercury-in-glass thermometer. Readings was taken after five minutes of thermometer immersion and rounded off to the nearest 0.1ºC.

Flow rate was determined using a floating cork and 30cm meter rule. Both the 30cm rule and cork were placed on the water surface and the time taken for the cork to float through the 30cm taken. Water samples for dissolved oxygen (DO) were collected using narrow necked 250ml DO bottles submerged 8-12 cm deep below the surface and corked while still submerged to avoid after waiting for about 5 minutes to eliminate water bubbles. Samples were immediately fixed with 5 drops of Winkler-1 and Winkler-2 reagents respectively, corked in situ, afterwards, transported to the laboratory in ice-cold box for analysis. In the laboratory, samples were acidified and titrated against standard sodium thiosulphate solution using starch indicator. BOD_5 in all station were collected, diluted and incubated at 25ºC temperature for 5 days after which, fixed with 5 drops each of Winkler-1 and 2 reagents. This was followed by titration with standard sodium thiosulfate solution to determine the change in dissolve oxygen level in relation to the initial dissolved oxygen of the sample with minimum oxygen detection limit of 0.1mg/l. pH was determined with a digital sensor, Coleman- pH- meter. Salinity determination was by the Chloride method with silver nitrate solution after appropriate treatment was given samples. Silver nitrate reacts with chromate and the first appearance of chromate's brick red colour indicates end point to the reaction.

Result

Results of the study are presented in Fig.1 to 8. Temperature ranged from 25ºC to 34ºC with mean values of 28.5ºC ± 1.5 during rainy season and 30.7ºC ± 3.4 during the dry season. Highest value was 34ºC and least, 25ºC recorded in the month of February at stations 3 and 2. Highest mean value (30.7ºC ± 3.4) was recorded in the month of February (dry season) while least mean value (28.5ºC ± 1.5) was recorded in the month of August. Flow rate ranged from 3.8cms^{-1} to 15cms^{-1} with mean range of 8cms^{-1} ± 4.1 and 8.7cms^{-1} ± 4.3. The highest value (15cms^{-1}) was in the month of February, station 2 and August, station 4; while the least value (3.8cms^{-1}) was observed in the month of August and station 2. The highest mean value 8.7cms^{-1} ± 4.3 was observed in the month of August (rainy season) while the least mean value 8cms^{-1} ± 4.1 was observed in the month of February (dry season). Depth values ranged from 95cm to 222cm with mean values ranging from 120cm ± 30.7 to 200cm ± 20.9. The highest value 222cm was observed in the month of August (station 1), while the least value (95cm) was observed in the month of February (station 3). The highest mean value (200cm ± 20.9) was recorded in the month of August (rainy season) while the least mean value (120cm ± 30.7) was observed in the month of February (dry season). pH values ranged from 7.01 to 8.09 with mean values of 7.0 ± 0.04 and 7.9 ± 0.14. The highest value 8.09 was observed in the month of February (station 4) while the least value 7.01 was recorded in the month of August (station 1). The highest mean value 7.9 ± 0.14 was recorded in the month of February (dry season) while the least mean value 7.0 ± 0.04 was recorded in the month of August (rainy season).
Salinity ranged from $21^0/_{00}$ to $25.1^0/_{00}$. Mean values were of the range $21.4^0/_{00}$ ± 0.2 to $23.6^0/_{00}$ ± 1.6. The highest and lowest values recorded were $25.1^0/_{00}$ in station 4 and $21^0/_{00,}$ station 1, respectively. The highest mean value of $23.6^0/_{00}$ ± 1.6 was observed in the month of February (dry season) while the least mean value $21.4^0/_{00}$ ± 0.2 was in the month of August (rainy season). Dissolved oxygen (DO) values ranged from 1.6mgl^{-1} to 13.4mgl^{-1} with mean values of 2.3mgl^{-1} ± 1.04 and 9.3mgl^{-1} ± 2.8. The highest value 13.4mgl^{-1} was recorded in the month of February (station 3) while the least value 1.6mgl^{-1} was recorded in the month of August (station 2 and 3). The highest mean value 9.3mgl^{-1} ± 2.8 was recorded in the month of February (dry season) while the least mean value 2.3 mgl^{-1} ± 1.04 was recorded in the month of August (rainy season). Biological oxygen

demand (BOD) values ranged from $0.6mgl^{-1}$ to 10.9mg/l with mean values of 0.8mg/l ± 0.1 and 6.9mg/l ± 4.2. The highest value 10.9mg/l was observed in the month of February (station 3 and 4) while the least value 0.6mg/l was recorded in the month of August (station 4). The highest mean value 6.9mg/l ± 4.2 was observed in the month of February (dry season) while least mean value 0.8mg/l ± 0.1mg/l was observed in the month of August (rainy season).

Highest density of organisms (24) was observed in Station one with a total of 10 species representing 33.3% of the total organisms in the sample during February. This was followed by station four with a total of 17 species representing 30.6%. The least (10) was recorded in station three with a total of 9 species representing 13.9% of total species of organisms found in the sample. Protozoa had highest species occurrence of 32 organisms representing 44.4% of 72 organisms. This was followed by Copepoda with a total of 19 organisms representing 26.39%, family Rotifera had the least number (9) of organisms representing 12.5% of 72 organisms. Data is further represented in table 4.11 and fig. 4.11. Highest density of organisms (43) was observed in station four with a total of 23 species representing 35.5% of total organisms in sample during August. This was followed by station one with a total of 22 species representing 33.1%. The least was recorded in station two and three with a total of 13 species representing 15.70% each of the total species of organism found in sample. Copepod had the highest species occurrence of 41 organisms representing 33.9% of 121 organisms. This was followed by protozoa with a total of 38 organisms representing 31.4%. The Family Rotifera had the least number (15) of organisms representing 12.40% of 121 organisms. There were variations of zooplankton community structure and composition within wet and dry months, with highest number (121 organisms in 71 species of 4 taxa of zooplankton. These include Protozoa, Rotifer, Copepod and Cladocera. Least was 50 species represented by 72 individuals in the dry month of February.

Discussion

Hydrographic study which showed variations between rainy and dry seasons in all parameters is usual. Observed temperature range of 27ºC to 30ºC with mean value of 28.5ºC ± 1.5 during rainy season was within the ranges of most studies of the Niger Delta region (Edoghotu, 1998; Chinda, and Amadi, 1993) and was favourable for zooplankton productivity (Agi, 2009). This resulted in increased number of zooplankton during the rainy season than dry season, with temperature range of 25ºC to 34ºC and mean value of 30.7ºC ± 3.4. High salinity observed during dry season in this study was attributed to the difference in freshwater input of both seasons. During rainy season, fresh water from land source drain is introduced into the estuary causing dilution and decrease in salinity. Conversely, saline sea water incursion invasion of the estuary will cause an increase in salinity during dry season. pH, an index of hydrogen ion concentration, reviled the environment was alkaline. It is an important environmental variable in bio-monitoring. During this study, pH was ≥7, an indication of alkalinity. This favoured growth and reproduction of most aquatic.

Increased dissolved oxygen (DO) observed during dry season and decrease during the rainy season was attributed to pollutant load from the petroleum refinery during rainy season. This have resulted in the decreased population of zooplankton in dry season and increased population of zooplankton in rainy season in accordance with the report of Clair et al (2003) that dissolved oxygen (DO) depletion is most likely to become evident during the initial aquatic microbial population explosion in response to large organic material. The result showed zooplankton was more during the rainy season, with a total of 123 organisms comprising of protozoa, Rotifera, Copepoda and Cladocera. Dry season with a total of 72 organisms, comprised of 4 taxas of Protozoa, Rotifera, Copepoda and Cladocera with protozoa (32 organisms) dominating, while Copepods were dominant during the rainy season with a total of 41 organisms. The dominance of a family in terms of abundance indicates pollution. Ruivo (1972) recommended that the use of organism for bio-monitoring be based on the premise that naturally unpolluted environments have equal abundance of organisms with no single organisms or family dominating.

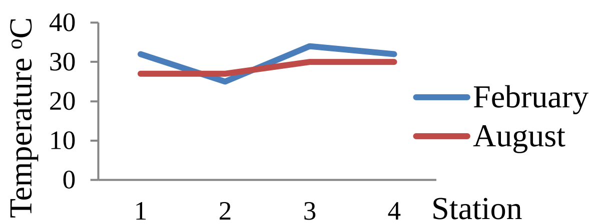

Fig.1 Temperature variations in the Okrika Creek during sampling

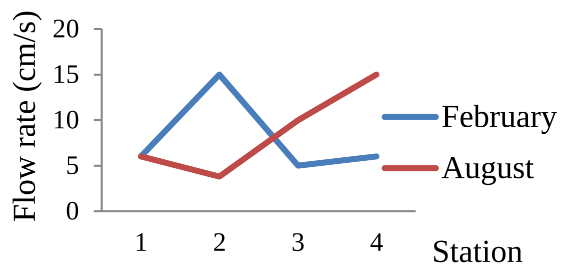

Fig. 2 Variations in water velocity per station of Okrika Creek during sampling

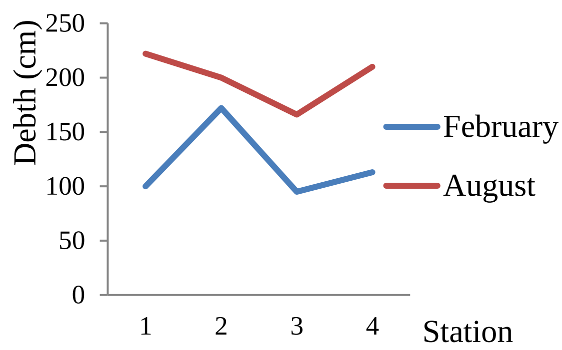

Fig. 3 Variations in depth profile Okrika Creek sampling

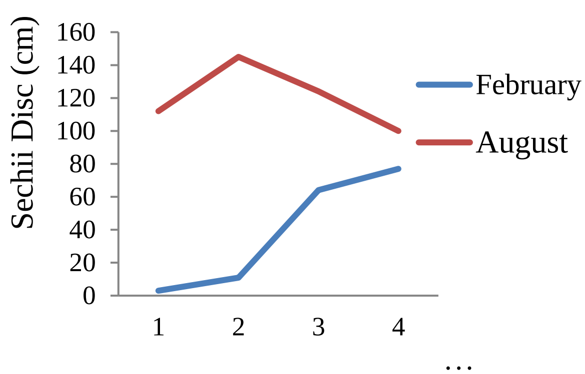

Fig. 4 Spatial variation in transparency of Okrika Creek during the period of study.

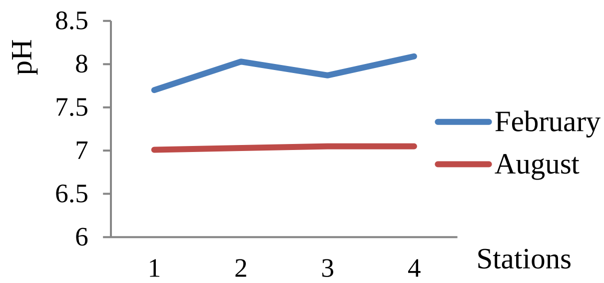

Fig. 5 Varition in pH values of the Okrika Creek within the period of study

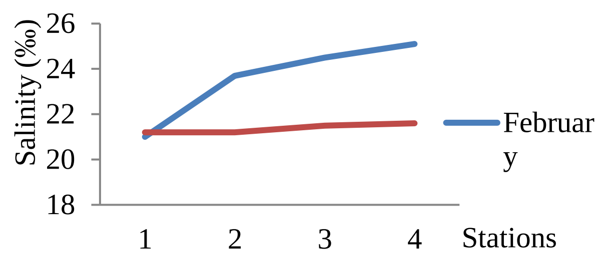

Fig. 6 Spatial variation in salinity in Okrika Creek during the study

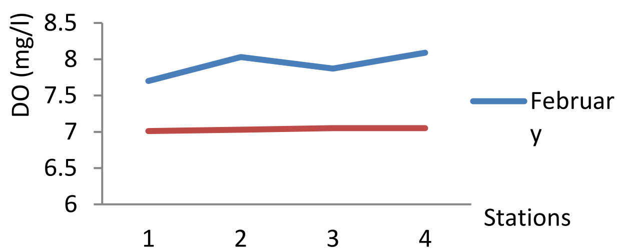

Fig. 7 Spatial variations in DO of Okrika Creek during the study

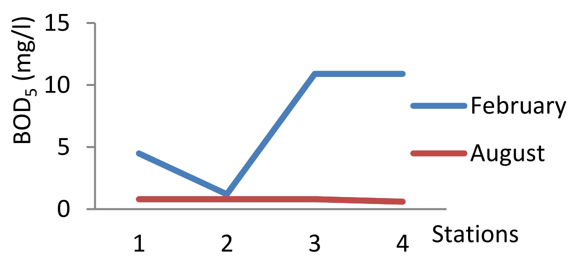

Fig.8 Spatial variation in biochemical oxygen demand (BOD_5) during the period of sampling

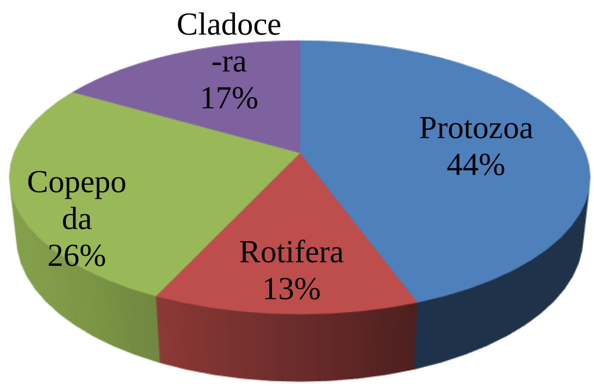

Fig.9: Zoplankton family relative abundance for the dry month of February

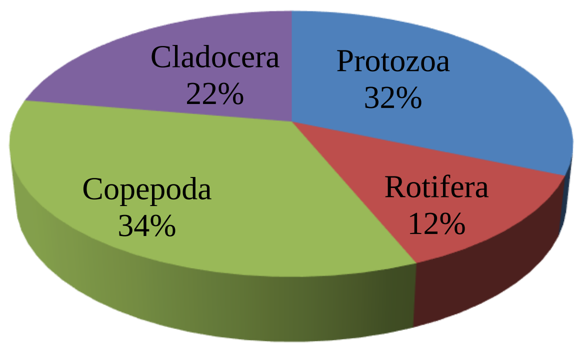

Fig.10: Zooplankton family relative abundance in the wet month of August.

Conclusion

The observations made in this study have shown that Ekrikana/Okariama Creek of Okrika is poor in zooplankton organisms during dry season, but improved abundance during rainy season with increased with dilution and flow rate. This study when compared to that of Agi (2013) in the Orashi River which had 157 taxa of zooplankton. The low abundance in this study depicted a polluted environment and resulted from the Okrika refinery effluent discharged and anthropogenic activities.

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