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Baseline Study of the Physico-Chemical Parameters and Plankton Productivity of Ibeno Atlantic Coastline, South Nigeria

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Abstract:- Baseline study of the plankton productivity of Ibeno Atlantic coastline, South south Nigeria was carried out every second week of the month for 13H/day beginning from 0600 to 1800 hours at both surface and interstitial waters from November 1996 to June 1998. Physicho-chemical parameters and major elements were analyzed. Moderate acidity during the dry season and alkaline medium during the wet season were observed. Wet season turbidity, D.O., colour, NO_3, PO_4, Silicate decreased sharply from those of the dry season while pH and NH_4 did not vary significantly between seasons. Peak phytoplankton production of five classes, 35 genera and 42 species occurred in October 1997 with Bacillariophyceae dominance while peak zooplankton species (28) belonging to 21 genera, 19 of which was from the class Copepoda were observed. High plankton densities were identified between 0600 and 0800 and 1300 to 1600 hours. At interstitial water depths of 0cm, 10cm, 20cm and 30cm, plankton densities decreased with depth. Plankton productivity took a sinusoidal curve and was not unconnected with the tidal changes. Chlorophyll-a values ranged from 0.00002 to 0.0008 mg/l. Grazing by zooplankton was evident.

Keywords:- *Physico-Chemical, Plankton, Productivity, Grazing, Interstitial.*

I. INTRODUCTION

Coastlines, the world over are characterized by high productivity, fishing, transportation, sports and associated maritime activities (Ehlin, 1995; Mackey, *et al.*, 2010) as well as high human population densities resulting in uncontrollable dumping and discharge of domestic, municipal and industrial wastes. Economically, the coastal zone of Nigeria, a stretch of over 800 km from Bakassi in the South South to Badagry in the west contributes to the domestic fish supply and about 23, 486,000 tons of oil per annum (World Resources, 1990). Ibeno coastline where the study was carried out covers a distance of about 10 km of the Atlantic coastline. Water is the physical habitat wherein fish dwell and carry out their life metabolic processes such as swimming, breeding, feeding, digestion, excretion and relaxation (Bronmark & Hansson, 2005). These metabolic processes are affected primarily by temperature, oxygen demand and life activities. Besides the fact that fish requires good water to thrive in (Bhatnagar & Devi, 2013), it should be noted that fish equally contribute a lot to the poor quality of their immediate environment through the release of metabolic wastes. Water quality which is the totality of chemical, physical and biological contents of the water has to be optimum for fish survival and growth. Man and nature's contributions via nutrition determine the quality of water. Water qualities may also be affected by low water flow, municipal effluents and industrial discharges (Chitmanat & Traichaiyaporn, 2010) as well as the fish's metabolic wastes. Some physical and chemical parameters such as pH, temperature, dissolved oxygen, total suspended solids, total dissolved solids, total alkalinity, acidity, salinity, conductivity, nutrients and heavy metals contamination in one way or the other limit the survival of aquatic flora and fauna (Soni & Thomas, 2013). All aquatic lives including plankton have tolerable limits of water quality parameters in which they perform optimally. A sharp drop or an increase within these limits has adverse effects on their body functions (Davenport, 1993; Kiran, 2010; Ajah, 2010) and existence (Ekpo, 2013). Some contaminants can accumulate to the point where it threatens human health even in low quantities and cause no obvious adverse effects (Philminaq, 2014). Aquaculture, fish-trawling, chemical pollution, and sewage discharges are the most common sources of human impacts that affect biodiversity and the goods and services it provides at regional scales (EEA 2006). So far, there has been no documented planktonic research in the Ibeno Coastal Waters. Researches carried out so far centered on metals in tar balls (Asuquo, 1991; Asuquo, Ukpabio & Ehrhardt, 1996) and surface water chemistry Qua Iboe River, Ibeno Coastal waters (Asuquo, 1997). Knowing the state of the environment, structure and function of the communities in the ecosystem is of essence while drawing up management plans which will in turn reduce negative effects of unsustainable development and eventual pollution. Due to the fragile nature of planktonic organisms, this premiere study in Ibeno South Atlantic waters seeks to investigate the water quality by analyzing the physicochemical parameters and hence the plankton biodiversity and productivity at seasonal and tidal levels to serve as baseline data bank to assist in future management policies.

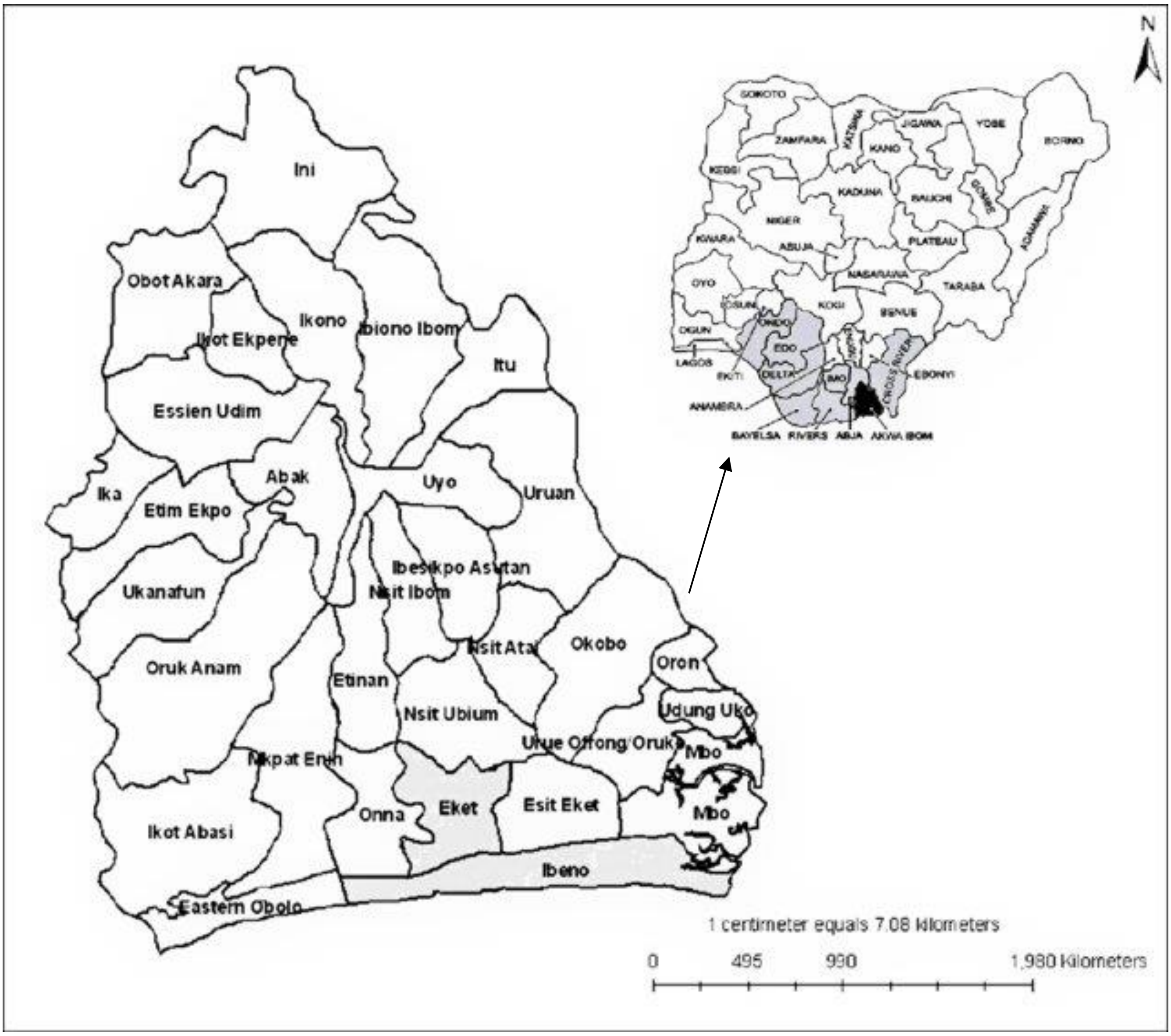

Figure 1. Map of Akwa Ibom State showing the location of the study area (Ibeno Atlantic coastline)

II. MATERIALS AND METHODS

The Ibeno Atlantic coastline lies between latitude 4^{o}32” and 4^{o}36” N and longitude 8^{o}00” and 8^{o}16” E covering 10 km out of the 800 km of the Nigerian coastline that begins from Bakassi to Badagry in the west. Ibeno beach has a flat foreshore known for its low gradient nature with fine grain sand and a lot of beach ridges.

The research which covered a period of 21 months started in November 1996 and terminated in June 1998. Both the surface and interstitial coastline waters at 0 cm, 10 cm, 20 cm and 30 cm depths were monitored during the second week of every month at hourly intervals (13 hours per sampling day) at designated station determined by the use of GPS model for plankton and physico-chemical parameters. Sampling was done in four phases- early dry season October, November and December, late dry season- January, February and March, early rainy season- April, May and June and late rainy season-July, August, and September.

The following physicochemical parameters (pH, temperature, Dissolved Oxygen-D.O, conductivity, total dissolved solute- TDS, total alkaline, Total Hydrocarbon-THC, Hardness, Colour, Salinity), and nutrients- (P-PO_4^{--}, N-NO_3^-, N-NO_2, N-NH_4^+/NH_3, SO_4^{--}, Biochemical Oxygen Demand- BOD_5, Chemical Oxygen Demand- COD, Silicon Si,), and two major elements –(Calcium- Ca, and Magnesium- Mg) were monitored. pH meter was used to measure the pH, Ice chest was used to transport samples for chlorophyll-a analysis by spectrophotometric determination after sedimentation (Parson, *et al*, 1984). Primary production using the chlorophyll a method (UNESCO (1966) and the direct count method for qualitative and quantitative determinations were carried out.

The species identified were further analyzed to determine their abundance, density, percentage composition and species richness using Gleason’s index (Margelef 1968).

Gleason's index (D') = S-1/In N
Where: S = the total number of taxa, and N = the total number of individuals.

III. STATISTICS

The mean values of physicochemical and plankton communities were subjected to Analysis of variance (ANOVA) to determine their level of significance at probability level p=05.

IV. RESULTS AND DISCUSSIONS

The physicochemical parameters of Ibeno South Atlantic surface water between the dry season and wet season are represented in Figure 1. No statistically significant difference (p>0,05) was observed amongst the physico-chemical parameters. The pH, temperature, D.O, Turbidity, colour, and BOD_5 of surface water were always higher than interstitial (Figur5) waters while total alkalinity, chloride, salinity, nitrate, silicate and total hardness of interstitial waters were always higher than those of surface waters as shown in Figure 6. Conductivity was higher in interstitial waters than surface waters in the dry season. The reverse was the case during the wet season. Ekelemu and Zelibe (2006) while working on Lake Ona in Asaba, Nigeria, observed significant inter-seasonal variations (P<0.05) changes only with water temperature, water level, total alkalinity, calcium ion, dissolved oxygen, conductivity, phosphate as well as transparency, other water parameters did not correlate significantly with season (P>0.05). The present research observed clear seasonal differences in most of the parameters. pH for surface water and interstitial waters ranged from 6.68(5.65) to 6.7(6.53) during the dry season and 7.2(7.35) to 8.35(8.2) during wet season. High temperature ranges from 29.1 to 29.8 and 28.4 to 29.3 °C, respectively, for dry season surface and interstitial and 25.3 to 28.3 °C (surface) and 24.7 to 26.6 °C (Interstitial) during the wet season. Dissolved oxygen (D.O) for dry and wet season surface water ranged from 5.3 to 5.9 and 1.55 to 3.9 mg/l while in interstitial waters dry season ranged from 3.04 to 3.58 and wet season from 0.98 to 3.92 mg/l. Turbidity rose as high as 252.6 FTU during the dry season to a low of 28.6 FTU during the wet season for surface waters while interstitial waters was 140 to 24.8 FTU respectively. Salinity was generally diluted from a high of 22.4 and 23.5 ‰ to a low of 7.4 and 6.87 ‰, respectively, for dry and wet season's interstitial waters and surface water. Ammonium peaks were 4.38 mg/l surface and 5.20 mg/l interstitial in November during the dry season and reduced to 3.93 mg/l surface to 2.70 mg/l interstitial at the early rains in May and finally to 3.22 surface and 2.81 mg/l interstitial in August 1997. Sulphate ranged from 1173.9 to 1554 mg/l surface and 974.7 to 1174 mg/l for interstitial waters during the dry season to all time high 1818 mg/l surface water in May with the lowest values of 536.6 and 572.7 mg/l respectively for surface and interstitial waters in August 1997. Nitrate values were higher in the dry season in both surface and interstitial waters 4.39 to 4.91 mg/l and 5.08 to 5.20 mg/l respectively, decreased to 0.19 to 0.44 mg/l from May to August for surface and 0.29 to 2.12 mg/l for interstitial water. Phosphate was the limiting nutrient at both surface and interstitial waters. Silicate ranged from a minimum of 0.3 mg/l on surface water in May to 0.499 mg/l in January 1997. The least value of 0.505 mg/l in interstitial water was in January 1997 while the highest value (0.86 mg/l) was recorded in August 1997. All time high total hydrocarbon of 25.56 mg/l was observed in November (Figures 3 & 4). Moderate acidity during the dry season and alkaline medium during the wet season were observed which agrees with Dunbar (1979). Wet season turbidity, D.O, colour, NO_3, PO_4, Silicate decreased sharply from those of the dry season while pH and NH_4 did not differ much between seasons. Ram (2000) while working on tropical inter tidal sediment observed increase of PO_4^{3-}P, NH_4^+-N, pH, Cl and Total alkalinity with increase in depth whereas NO^{3-}-N did not decrease with depth. Murray, Grundmanis and Smethie (1978) also noticed increase of ammonia and alkalinity with increase in depth while sulfate and organic carbon decreased with depth.

Results of phytoplankton (Figure 7) and zooplankton (Figure 8) communities of Ibeno South Atlantic Ocean showed heteroscandicities giving rise to October peak at 09.00H followed by 18.00H and thirdly 16.00H for zooplankton and phytoplankton peak at 09.00H followed by 18.00H and thirdly at 10.00H. Hourly variations in productivity were not unconnected with the tidal changes. Overall, 22 phytoplankton species from 19 genera basically of Bacillariophyceae and 28 zooplankton species of 21 genera with the highest abundance from class Copepoda were observed. Table 1 gives a run view of the species of plankton community present in the study area. Chlorophyll a value ranged from 0.002 to 0.0008 mg/l. In general, high plankton densities were recorded at 0800, 1300, 1400 and 1500 hours. Plankton community in the interstitial waters decreased with depth. Plankton productivity took a sinusoidal curve most likely due to the tidal changes in the ecosystem. Species richness using Gleason's index (D') was 6.945 and 3.892 for phytoplankton and zooplankton, respectively.

Between September and November 1997, the highest number of 35 genera and 42 species of phytoplankton were observed in the month of October. The classes also increased from three to five. Bacillariophyceae, Chlorophyceae, Desmonkontae, Euglenophyceae and vascular plants (Tracheophyta). The class Bacillariophyceae was still dominant over others. The zooplankton community had 19 genera and 19 species with the class Copepoda still the dominant class followed by Oligochaeta then Ostracoda. The result so far depicts grazing of zooplankton on phytoplankton. The peak periods of plankton abundance were observed between 0600, to 0800 and 1400 to 1600 hours. Chlorophyll a values increased slightly from 0.0008 to 0.001 mg/l. Hourly variations in productivity were still not unconnected to the tidal changes. Interstitial waters at 0 cm, 10 cm, 20 cm, and 30 cm depths had fewer planktonic organisms than the coastal waters and decreased in abundance with increase in depth. A generally sigmoidal pattern of plankton abundance was equally observed with tidal changes. The differences in high and low tides were greatest every two weeks when spring tides occurred and smallest during the alternate weeks when neap tides occurred.

The state of environment, structure and functional communities of Ibeno South Atlantic Ocean as elucidated will invariably assist in drawing up management plans of this ecosystem and in turn help to ameliorate any subsequent negative effects of unsustainable development and eventual pollution. Planktonic organisms which are fragile in nature have been used for this study to investigate the water quality by analyzing the physicochemical parameters and hence the plankton biodiversity and productivity at seasonal and tidal levels thus serving as base data bank to assist in future management policies of the Ocean.

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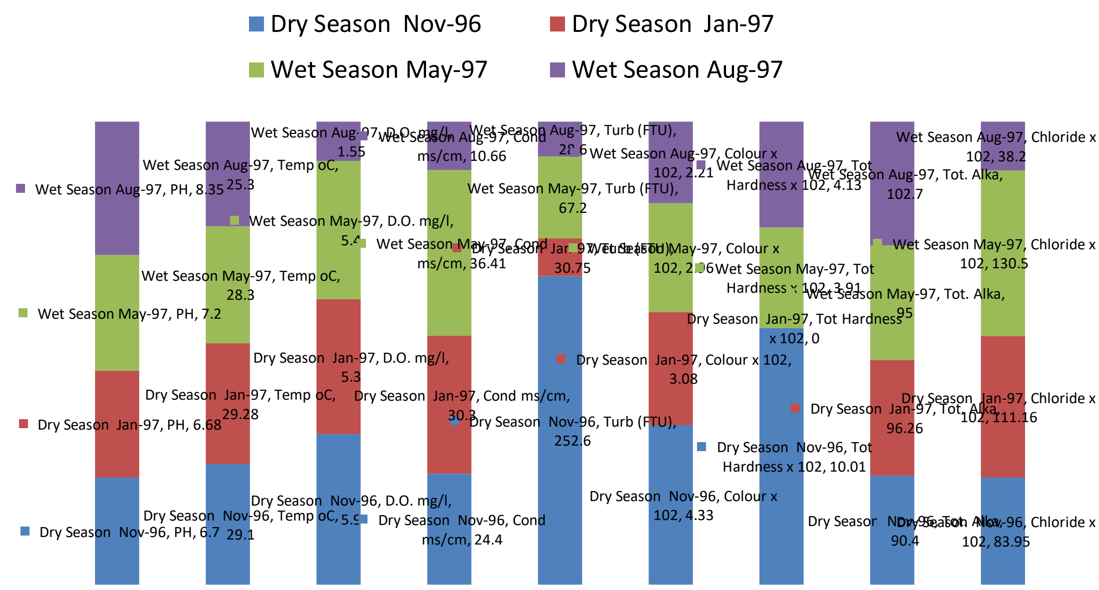

Figure 1. The physicochemical parameters of surface water Ibeno South Atlantic Ocean during the dry and wet seasons of 1996 and 1997.

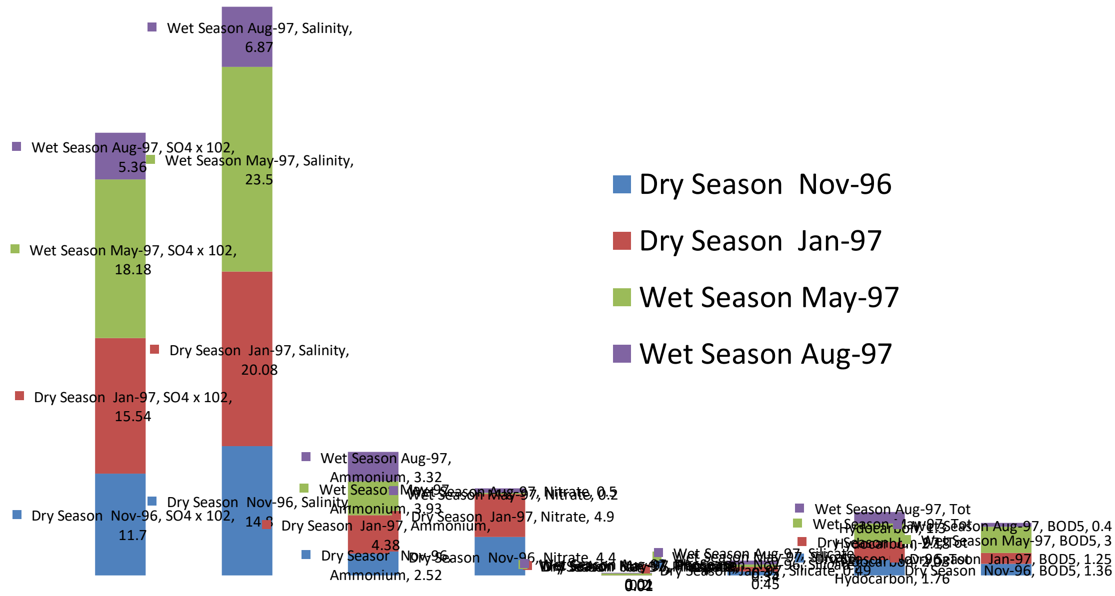

Figure 2. The physicochemical parameters of interstitial water Ibeno South Atlantic Ocean during the dry and wet seasons of 1996 and 1997.

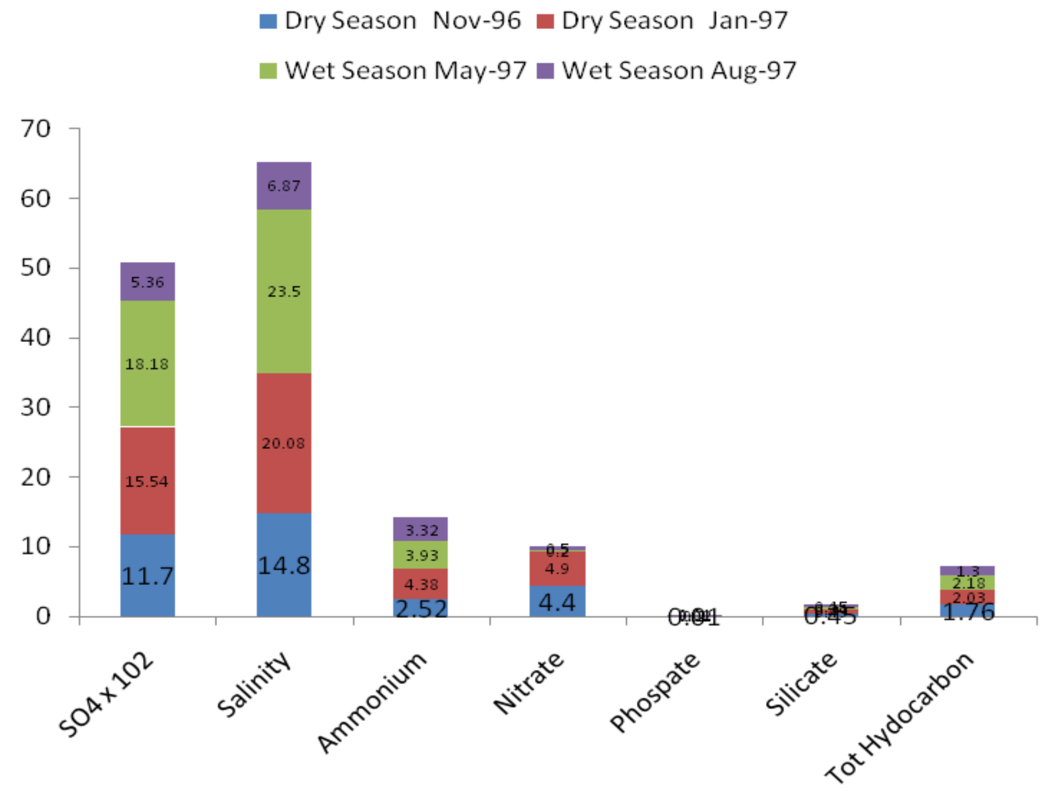

Figure 3. The nutrients and total hydrocarbon of surface water of Ibeno South Atlantic Ocean during the dry and wet seasons of 1996 and 1997.

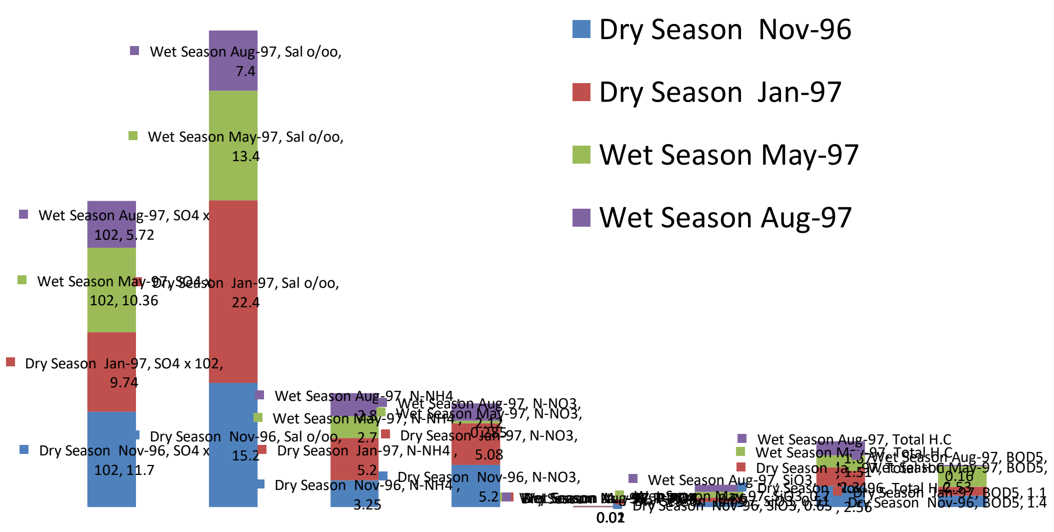

Figure 4. The nutrients and total hydrocarbon of interstitial water of Ibeno South Atlantic Ocean during the dry and wet seasons of 1996 and 1997.

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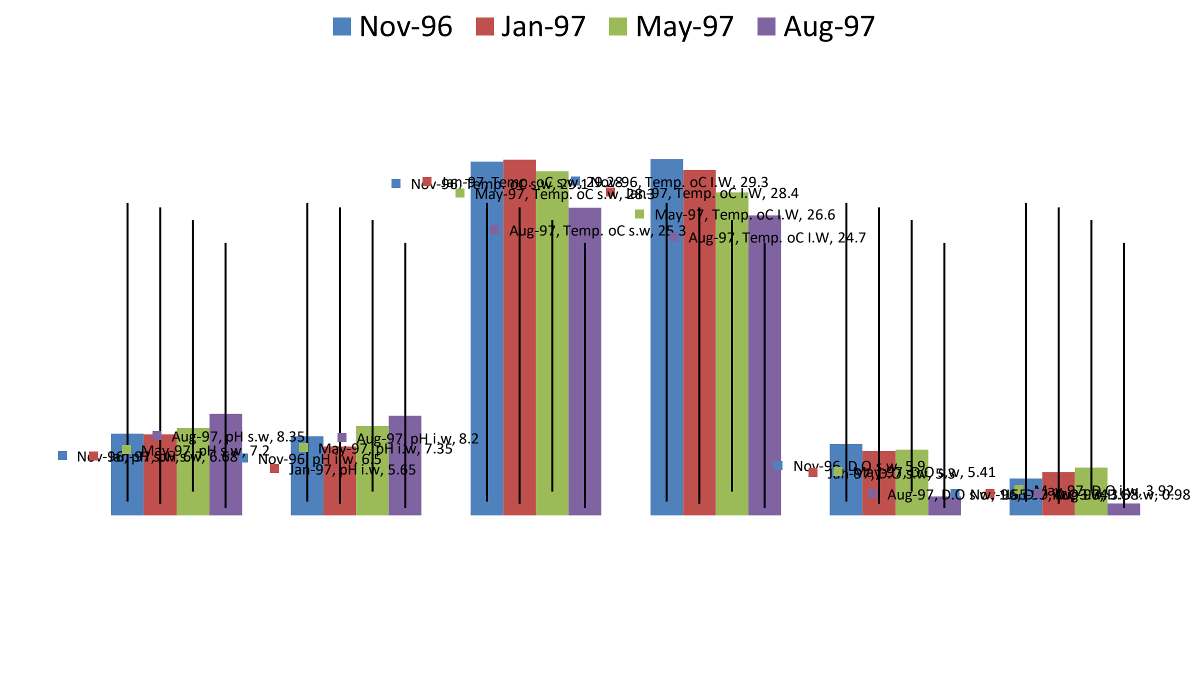

Figure 5. Comparative plot of pH, Temp and D.O (±S.D) at both surface and interstitial waters of Ibeno South Atlantic ocean.

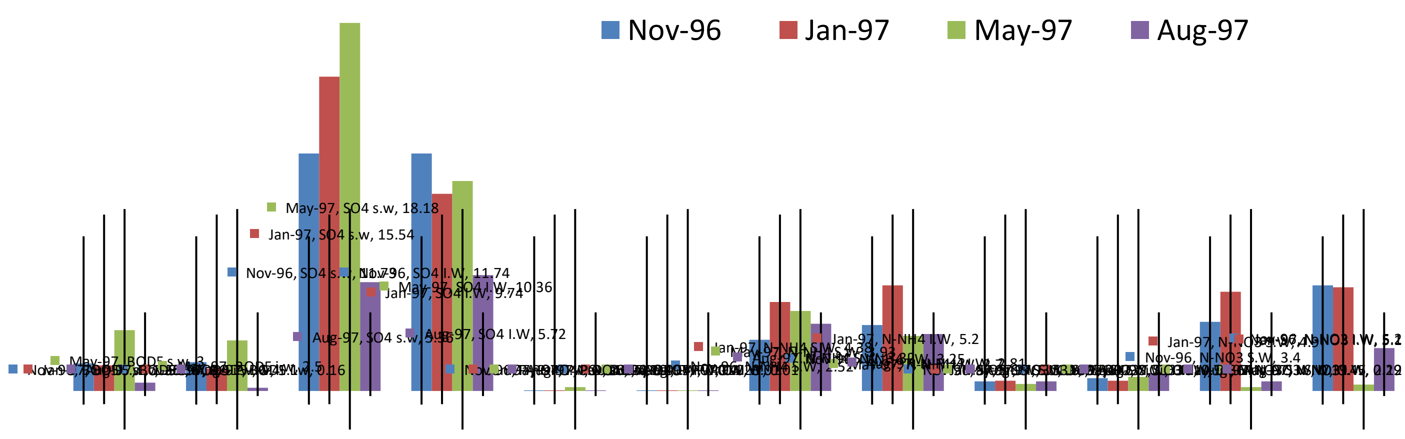

Figure 6. Comparison of nutrient contents (± S.D) between surface and interstitial waters of Ibeno South Atlantic Ocean.

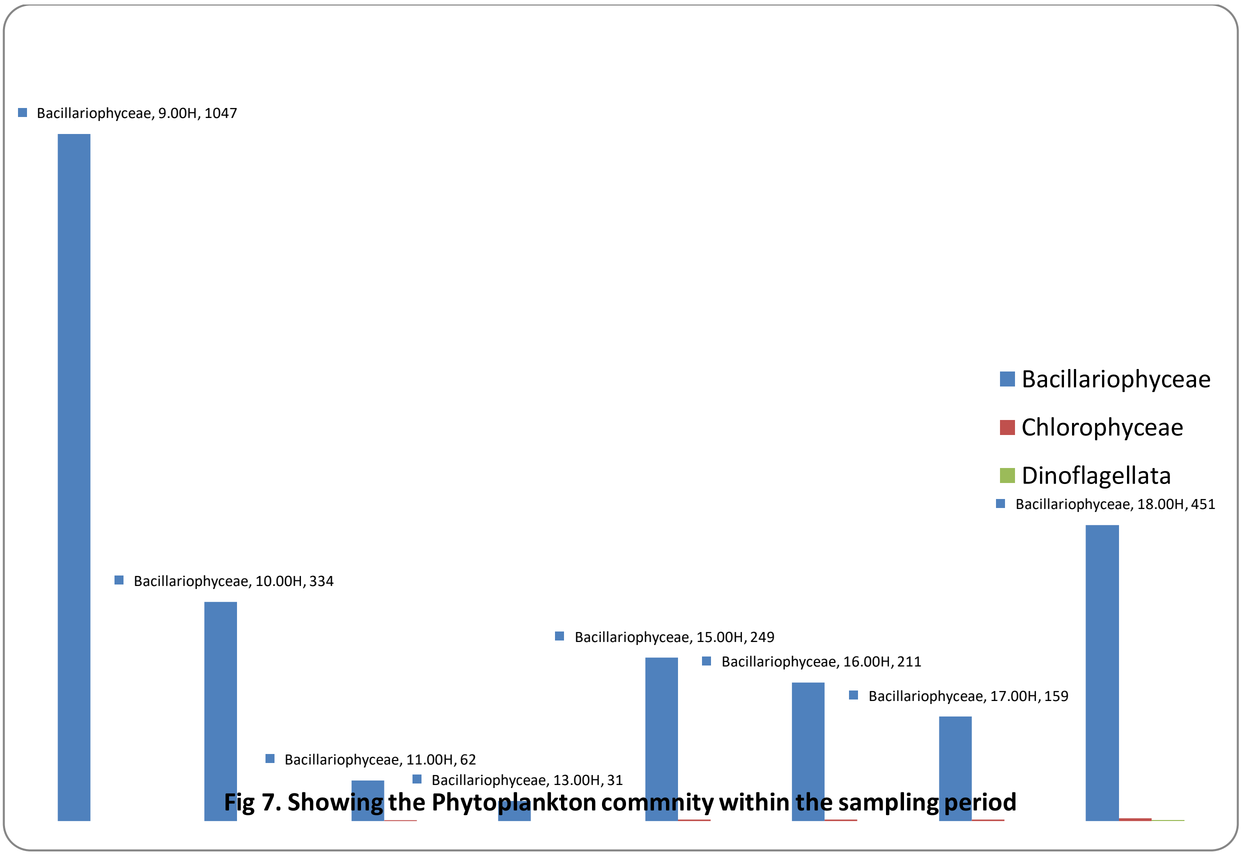

Fig 7. Showing the Phytoplankton commnity within the sampling period

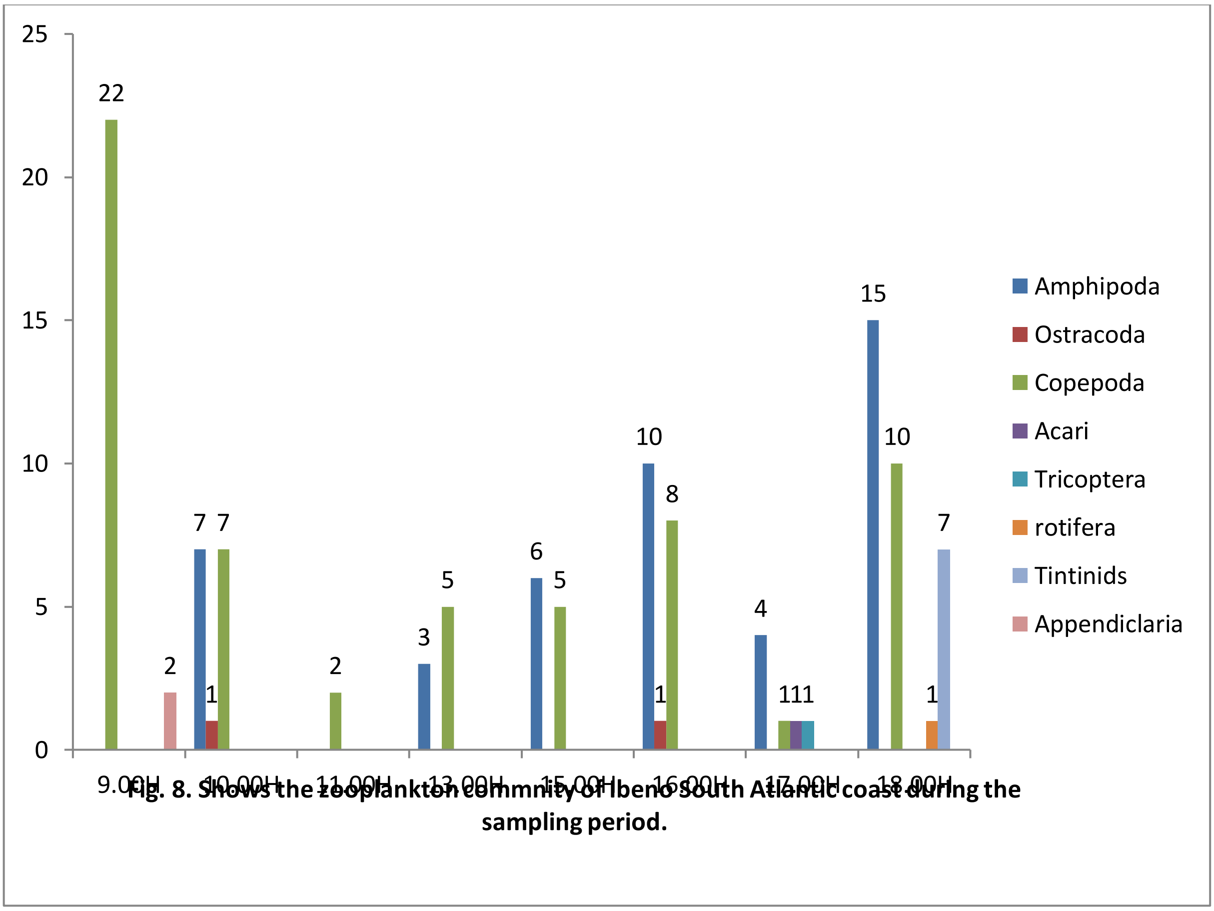

Fig. 8. Shows the zooplankton commnity of Ibeno South Atlantic coast during the sampling period.

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Table 1. Shows representative species abundance from the study site within the sampling periods.

Bacillariophyceae			**Zooplankton**	
Coscinodiscus excentricus 840	*Asterionella formosa 1*	*Denticum brightwellii* 4	*Tropocyclops prasimus* 7	*Ergasiloides* sp 1
Melosira 24	*Thalassionema nitzschioides* 1	*Sphaeroplea* 2		*Synchaeta pectinata 1*
Pinnularia nobilis 11	*Coscinodiscus radiatus* 33	*Synura* 8	Copepoda 4	*Mesocyclops* Bodanicola 1
Biddulphia sinensis 26	*Biddulphia mobilensis 10*	*Goniochloris sculpta* 3	*Gammarus* sp 3	*Harpaticus chelifer* 2
Halosphaera. viridis 20	*E. americanus 1*		*Calanus finmarchinus* 20	*Eucalamus elongatus* 2
Biddulphia. aurita 5			Appendicularia: *Fritillaria pellucida* 2	*Cyclops magnus* 1
			Eudiaptomus gracilis 3	*Balanus balanoides 1*
			Microcyclops 1	