# Seasonal Association of Physico-Chemical Parameters and Phytoplankton Density in Mbo River, Akwa Ibom State, Nigeria

M. A. Essien-Ibok and I. A. Umoh

***Abstract*—A one year research (December, 2009 to November, 2010) was carried out to assess the effect of environmental variables on phytoplankton density in Mbo River. Phytoplankton composition and water quality parameters were determined, all using standard methods. The hypothesis tested was that shift in season affect the water quality characteristics and plankton density, and is modulated by the temporal rainfall changes. The databases obtained were subjected to Pearson correlation matrix. The result of the correlation matrix indicated that some variables (dissolved oxygen, air temperature, conductivity, total dissolved solids and nitrate-nitrogen) had a good, positive (≥0.45) relationship with phytoplankton irrespective of the seasons. Contrary to this some other parameters (water level, color and total suspended solids) had good but negative (≥0.45) correlation with phytoplankton density in the two seasons. The observation and information from this research will serve as baseline data for future reference and in formulating policies and regulatory frame work for sustainable management of Mbo River.**

***Index Terms*—Correlation, Mbo river, physico-chemical parameters, phytoplankton.**

## I. Introduction

According to [1], aquatic organisms such as plankton cannot be separated from the effects of physico-chemical characteristics of their aquatic habitat. The knowledge of the physico-chemical regime of a water body is of great value in the determination of its productivity, usefulness and other characteristics which influence the vertical and horizontal migration of organisms, their distribution, diversity, composition and feeding pattern [2].

Rivers are one of the most intensively human influenced ecosystems, serving for water supply, power generation, transportation and as source of food and sinks for waste products.

Although several literature exist on the hydrobiology of the rivers and estuaries in Akwa Ibom State, Nigeria, there is sparse published work on the hydrobiology of Mbo River.

### A. Morphometric, Physical and Chemical Parameters

Morphometric parameters were measured using appropriate procedures [3],[4]. The chemical analysis of the waters was done using standard and analytical methods of water analysis [5], [6].

### B. Plankton Sampling

Water samples (1,000ml) were collected from approximately 20cm below the water surface mid-stream at each sample site in new, clean 100ml polyethene sample bottles, clearly and permanently labeled. The samples was fixed with approximately 5ml of 4% formaldehyde solution and taken to the laboratory for analysis. The sample bottles for plankton were allowed to stand for 48 hours before decanting the supernatant leaving an aliquot of known volume. The concentrated samples were homogenized before 1ml of sub-sample from the original stock was collected with sample pipette [11]. The pipette content was transferred unto a Sedgewick – Rafter counting chamber for species enumeration at a microscope magnification of 400x using the synopsis of [7]-[10].

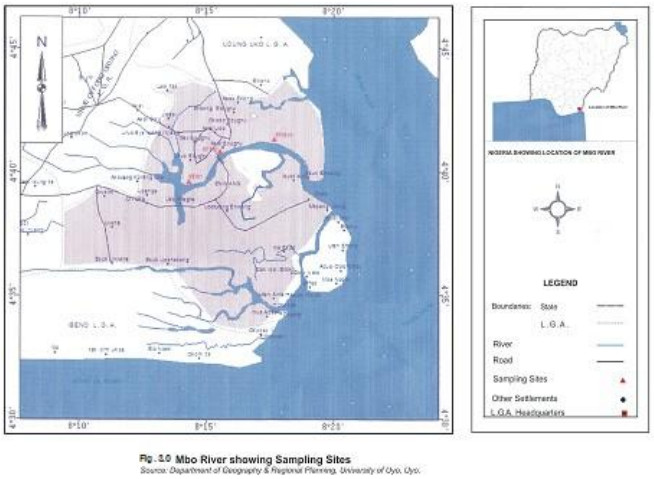


Fig. 1. Mbo river showing sampling sites

Qualitative estimation of plankton was made using a 30cm square mouthed 70mm mesh bolting silk net (Griffin) and collections were made in triplicate. Plankton samples for qualitative analysis were obtained by placing the net below the water surface (20cm) and the net towed for 5 minutes until a sufficient quantity of plankton was collected.

Samples were fixed immediately for zooplankton with 4% hexamine buffered formalin to preserve the organisms. Sample was then concentrated by centrifuging and adjusting to 10ml. All organisms were identified and enumerated using a light compound microscope.

## II. Results and Discussion

Bacillariophyceae recorded a total of 20 species in Station

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I, 13 species in Station II and 12 species in Station III. Dinophyceae had its highest number of species richness in Station I and recorded three species each in Stations II and III. Station I also had the highest number of species in terms of chlorophyceae with 9 species while Stations II and III had 8 species each. Cyanobacteria and Xanthophyceae recorded 5 and 1 species respectively in each of the stations. Bacillariophyceae, therefore, had the highest species richness in all the stations during the sampling period, recording 45 species making it a total of 44.12% of the species richness (Fig. 2). Chlorophyceae concentration contributed to 24.51% of the total phytoplankton recorded with 25 species. Cyanobacteria followed with 15 species contributing to 14.71% of the species richness. Dinophyceae with 14 species, made up a total of 18.71% and Xanthophyceae with a total of 3 species contributed 2.94% of the total phytoplankton species richness observed.

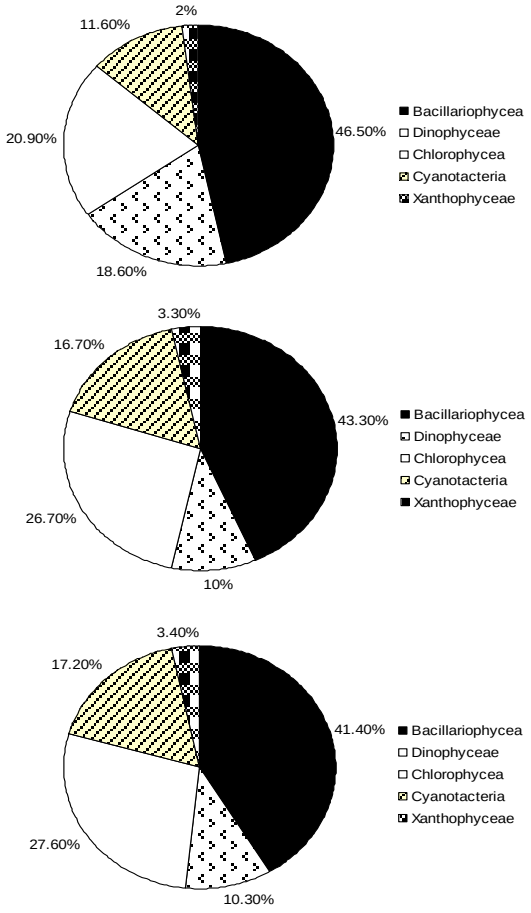


Fig. 2. Species richness of phytoplanktons in the three sampling stations in Mbo river (Station I=*a*, Station II=*b* Station III=*c*)

Spatially, Station I had the highest value of species richness making up 42.16% with 43 species (Fig. 2). Station II recorded 30 species making up 29.41% and Station III contributed to 28.43% of the sample with 29 species.

Data of correlation matrix of physico-chemical parameters and phytoplankton density for both seasons is shown in Table I. The good correlation amongst the physico-chemical parameter was indicated in bold coefficient values and had been selected by the coefficient value up to three or greater.

In general, some variables showed a positive correlation with phytoplankton density for the two seasons (Table II). These variables are air temperature, dissolved oxygen, conductivity, nitrate-nitrogen, NH4, total dissolved solids and total solids. The high and positive correlation coefficient (r) values between phytoplankton density and these parameters indicate a direct relationship between phytoplankton density and these parameters.

Contrary to this, other physico-chemical parameters had negative correlation coefficient (*r*) values with phytoplankton density in the surface of water in the two seasons. Such parameters include water level, color, total alkalinity and total suspended solids. The negative values of (*r*) indicate that increase in these parameters invariably led to a decrease in the phytoplankton density in the two seasons.In the wet season, phytoplankton density showed a good positive correlation coefficient with nitrate-nitrogen ($r$=0.57; $P$=0.008), nitrite-nitrogen ($r$=0.45; $P$=0.04) and NH4 ($r$=0.32; $P$=0.16). This showed that an increase in the above named nutrients resulted in a significant increase in the density of phytoplankton during the sampling period.

TABLE I: SEASONAL CORRELATION COEFFICIENTS (R) OF PHYTOPLANKTON DENSITY AND PHYSICO-CHEMICAL VARIABLES BY SEASON

| Physico-Chemical Parameters | Dry season | Wet Season |
|---|---|---|
| Current Velocity ($cmsec^{-1}$) | -0.11 | 0.41 |
| Water Level (m) | -0.47 | -0.58 |
| Color (NTU) | -0.43 | -0.24 |
| Air Temperature ($^0C$) | 0.52 | 0.43 |
| Dissolved Oxygen ($mgl^{-1}$) | 0.62 | 0.53 |
| Total Alkalinity($mgl^{-1}$) | -0.61 | -0.34 |
| pH | -0.30 | 0.42 |
| Water Temperature ($^0C$) | 0.56 | 0.04 |
| Conductivity ($\mu Scm^{-1}$) | 0.57 | 0.30 |
| Transparency (cm) | 0.46 | 0.06 |
| Chemical Oxygen Demand ($mgl^{-1}$) | -0.52 | -0.02 |
| Nitrate-Nitrogen ($\mu gl^{-1}$) | 0.50 | 0.57 |
| $NH_4$ – N ($\mu gl^{-1}$) | 0.62 | 0.32 |
| Sulphate ($mgl^{-1}$) | -0.62 | 0.06 |
| Total Suspended Solid ($mgl^{-1}$) | -0.66 | -0.34 |
| Total Dissolved Solids ($mgl^{-1}$) | 0.65 | 0.46 |
| Total Solids ($mgl^{-1}$) | 0.53 | 0.61 |
| Biochemical Oxygen Demand ($mgl^{-1}$) | 0.19 | 0.33 |
| Nitrite-Nitrogen ($\mu gl^{-1}$) | -0.05 | 0.45 |
| Total hydrocarbons ($mgl^{-1}$) | 0.02 | 0.85 |

Good positive correlation (≥0.50) recorded for total phytoplankton and dissolved oxygen, conductivity, nitrate-nitrogen, ammonium-nitrogen, total dissolved solids and total solids, in the dry season and dissolved oxygen, nitrate-nitrogen, total solids and total hydrocarbons in the wet season are likely indicators of clear responses of phytoplanktons to changing hydro - climatic characteristics.

## III. CONCLUSIONS

The location of Mbo River in the rainforest of Nigeria places the river under direct impact by seasonal rainfall which was shown in this study to be the major factors driving

the physical and chemical attributes of the river and the biological abundance and distribution, thus the hydrobiological state of the river. Based on the above conclusions the following recommendations are made.

## IV. Recommendation

The physical, chemical and biological base data of Mbo River is not sufficient considering the depth of the data collected. Thus, these studies and research should be highly encouraged. There is also an urgent need to develop state, regional and national data bank of species specific and river/region specific information, which should be easily made available to anyone who wants to use it.

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