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PHYTOPLANKTON COMPOSITION AND ABUNDANCE IN THE NEW CALABAR RIVER

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ABSTRACT: *Studies on the microalgae of the New Calabar River were conducted in the months of March and April, 2014to ascertain the abundance and distribution of microalgae in the New Calabar River. The experimental approach was: the deployment of an ARC GIStool to select six geo-reference stations; the collection of water samples with 20µm plankton net and a light microscope to provide a quantitative account of microalgae and ahoriba water checker to investigate the physicochemical characteristics of the water body. The result forphysicochemical parameters ranged from 3.70mg/l to 7.08 mg/l (dissolved oxygen); 16.95cm to 78cm (turbidity); 24.0°C to 31.0oC (temperature); 17.20µScm to 2693µScm (conductivity); 10.34ppm to 2446.5ppm (total dissolved solid);4.98 to 7.05 (pH); and 2.20mg/l to 4.14mg/l (BOD). Analysis of Variance showed some level of variability between the physicochemical parameters tested in all stations. The microalgae recovered were a total of three classes, representing twelve genera. Bacillariophyceae had the highest number of genera (9) while Cyanophyceae (2) and Dinophyceae (1). Shannon-Weiner's and Margalef indices indicated that species diversity was maximum in station 2. Pielou's index of evenness revealed a more evenly distribution in station 2; while the lowest species evenness occurred in station 6. This study therefore, provided information on the diversity, distribution and abundance of microalgae in the study area. However, the abundance and distribution of microalgae were influenced by physicochemical variables and biogeography of the area. Thus, a regular account of the abundance and distribution of microalgae and physicochemistry is recommended to ascertain the dynamics of microalgae with respect to the increasing anthropogenic activities in the study area.*

KEYWORDS: Microalgae, Bacillariophyceae, Physico-chemical parameters, Shannon-Weiner

INTRODUCTION

Anthropogenic factors have led to the decline of biodiversity in the last century. This has led to increased ecosystem instability, reduced functioning and insufficient provision of ecosystem services. While loss of biodiversity in larger organisms is well studied, we know little about the effects of biodiversity loss for microorganisms such as microalgae. With microalgae being the base of aquatic food webs, a reduction in algal diversity may have a consequence on trophic levels. However, the global number of algal species have been estimated to be over a million species, only 60% have been described to date (Guiry MD, 2012).

Microalgae also known as phytoplankton, are microscopic algae found in the fresh water and marine water body in the water column and sediment. They are unicellular species that exist individually, in chains or in groups similar to terrestrial plants due to the presence of chlorophyll and they require sunlight in order to live and grow.The distribution, abundance and diversity of microalgae reflect the physicochemical conditions of aquatic ecosystem in general and its nutrient status in particular (Anene, 2003). The distribution, abundance, species diversity, species composition of the microalgae are used to access the biological integrity of the water body (Townsend *et.al*., 2000) while Inorganic nutrients such as nitrates, phosphates and sulphates are converted into proteins, fats and carbohydrates by the microalgae and are necessary for growth.

Various research studies have shown that phytoplankton species composition in Nigerian waters is dominated by diatoms. Nwadiaro and Ezefili (1986) reported 39 species as diatoms out of the total of about 67 species identified. 85% of the total phytoplankton in the Aluu section of the New Calabar River were said to be diatoms according to Erondu and Chindah (1991). High abundance of phytoplankton in Cross River estuary was reported by Akpan (1994). Ekeh (2000) also reported a high abundance of phytoplankton in the New Calabar River. Pritchard (1967) and Sarno*et al*., (1993) explained that the reason for increase in blue green algae density in estuaries was the intrusion of seawater bringing in organisms from the adjacent sea.

Sharma et al., (2007) stated that a minor change in physico-chemical parameters can influence the primary production; this tallies with what Hulyal and Kaliwal, (2009) stated thus: The physico-chemical parameters are the major factors that control the dynamics and structure of the phytoplankton of aquatic ecosystem.

Algae thrive might also be dependent on the feature of the river; tropical black waters especially the black water types of the Niger Delta are known to be less productive than other black water types. (RPI, 1985).

Nutrients contribute to the growth of microalgae and the presence of these nutrients in the water body most often than not are caused by anthropogenic activities. There is no doubt that the frequency of harmful algal blooms has increased globally together with anthropogenic loading of nutrients (Hallegraeff 2003;Sellner*et al*., 2003; Gilbert and Burkholder, 2006).

The abundance and distribution of microalgae largely depends on certain anthropogenic activities as well as the physicochemistry of the water body. Thus, this study aims at identifying these dynamics through a precise identification of microalgae along the water body.

MATERIALS AND METHOD

Study Area

The New Calabar River lies between longitude $006^{0}53$ 53086'E and latitude $04^{0}53'$ 19.020'N in Choba, Rivers State, Nigeria. It stretches across various communities from Iwofe through Ogbakiri, Ogbogoro, Choba and Aluu. This river is said to be a fresh water type and also a

black water. Also, it is surrounded by residential communities, oil companies, abattoirs, manufacturing companies and transportation is also paramount in this area.

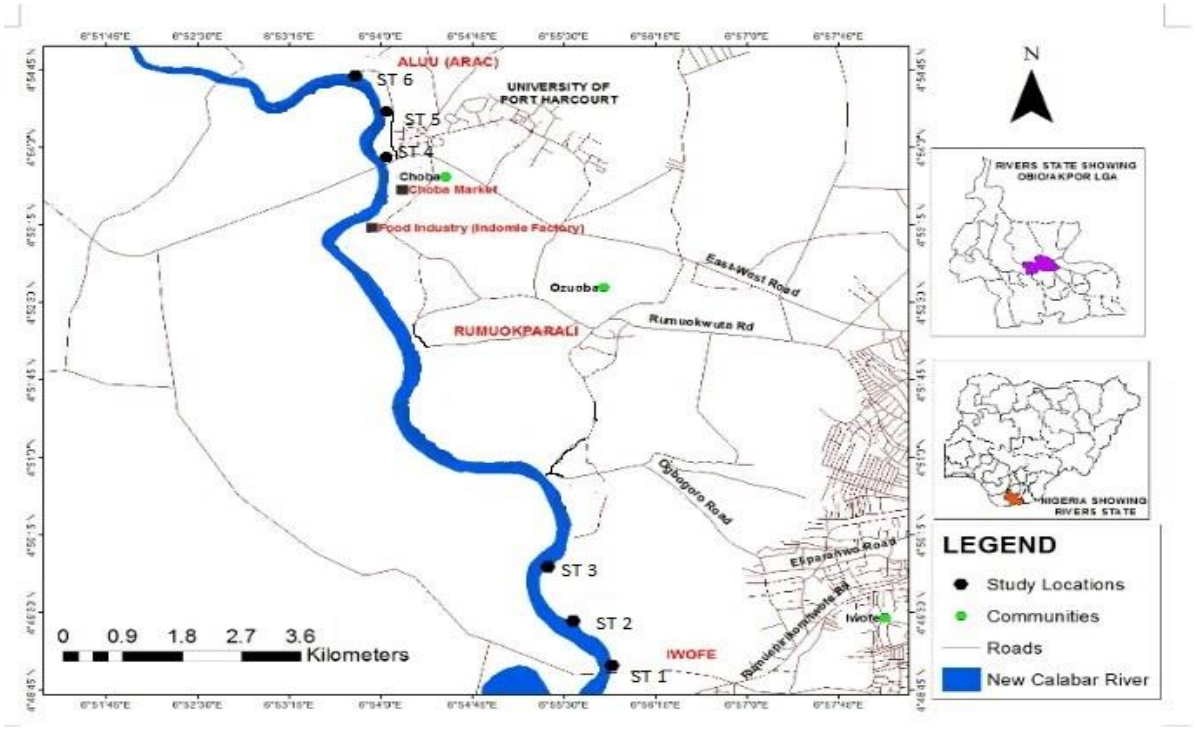

Figure 1: Map of the Study Area Showing the Sampling Stations

Sample Collection, Preparation And Analysis

Samples were collected from six geo-reference stations using the ARC GIS tool. Water samples were collected using a 20µm mesh sized plankton net to provide a quantitative account of the microalgae. Subsequently, the samples were fixed with 2% formalin and transported to the laboratory for analysis. In the laboratory, microalgae were sorted from the samples, identified and classified into different taxa. Physicochemical parameters such as: Temperature, Salinity, pH, Dissolved Oxygen and Total Dissolved Solids was measured in-situ using a Horiba water checker at each sampling location. Water samples were also collected in amber bottles and clear plastic bottles to test for BOD, Sulphate, Phosphate and Nitrate respectively. Microphotographs of microalgae were taken by employing a camera that was fixed at the top of the microscope Identification was done using the Phytoplankton guide (ROPME) Oceanographic Cruise Identification keys.

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RESULTS

Table 1: Physico Chemical Parameters of the New Calabar River

	MARCH						APRIL					
Parameter	1	2	3	4	5	6	1	2	3	4	5	6
DO (mg/L)	5.45± 0.03^{abc}	5.95± 0.58^{ab}	6.30± 0.20^{a}	6.25± 0.17^{a}	5.08± 0.21^{bc}	4.40± 0.48^{c}	5.55± 0.10^{b}	5.97± 0.07^{ab}	6.25± 0.19^{a}	6.35± 0.17^{a}	5.05± 0.20^{c}	4.55± 0.11^{d}
Tran (cm)	33.50± 1.80^{d}	42.00± 2.30^{c}	42.00± 0.81^{c}	65.50± 1.30^{b}	74.50± 1.80^{a}	72.00± 1.52^{a}	23.50± 0.87^{bc}	19.50± 0.83^{de}	18.25± 0.69^{e}	27.23± 0.84^{a}	21.00± 0.76^{cd}	25.50± 0.11^{ab}
Temp (˚c)	27.30± 2.03^{a}	27.00± 1.38^{a}	27.35± 0.28^{a}	27.10± 0.24^{a}	26.90± 0.61^{a}	26.00± 0.58^{a}	27.90± 1.67^{a}	26.43± 0.73^{a}	28.23± 0.54^{a}	26.85± 0.84^{a}	26.90± 0.66^{a}	27.00± 1.04^{a}
Cond (µs)	1374.66± 135.06^{c}	1857.50± 146.76^{b}	2616.33± 74.68^{b}	30.40± 0.42^{b}	25.35± 0.83^{d}	22.13± 0.84^{d}	1897.50± 60.12^{a}	1742.00± 87.93^{b}	667.33± 39.18^{c}	317.40± 27.26^{d}	20.32± 1.00^{c}	17.62± 0.23^{e}
TDS (ppm)	1002.98± 119.60^{b}	1283.50± 29.35^{b}	1889.50± 295.87^{a}	19.65± 0.41^{c}	16.57± 0.32^{c}	13.22± 0.42^{c}	1377.50± 108.19^{a}	1237.33± 90.12^{a}	952.45± 21.97^{b}	25.32± 0.76^{c}	12.62± 0.27^{c}	10.97± 0.31^{c}
pH	5.78± 0.45^{b}	5.94± 0.33^{ab}	6.08± 0.32^{ab}	6.83± 0.12^{a}	6.80± 0.10^{a}	6.10± 0.03^{ab}	5.94± 0.15^{ab}	6.19± 0.18^{ab}	6.15± 0.22^{ab}	6.44± 0.22^{a}	5.62± 0.20^{bc}	5.26± 0.18^{c}
BOD (mg/L)	2.50± 0.15^{a}	2.80± 0.15^{a}	2.60± 0.26^{a}	2.60± 0.10^{a}	3.00± 0.06^{a}	2.90± 0.23^{a}	2.60± 0.25^{b}	3.90± 0.13^{a}	2.60± 0.15^{b}	3.30± 0.19^{ab}	2.50± 0.17^{b}	2.90± 0.40^{b}
Nitr (mg/L)	2.96± 0.29^{b}	3.63± 0.33^{a}	1.30± 0.02^{d}	0.23± 0.01^{e}	1.48± 0.06^{d}	2.09± 0.10^{c}	1.82± 0.07^{a}	0.87± 0.05^{b}	0.22± 0.13^{c}	1.09± 0.22^{b}	1.38± 0.36^{ab}	0.84± 0.05^{b}
Sulp (mg/L)	4.31± 0.65^{c}	6.43± 0.18^{b}	7.07± 0.19^{a}	8.08± 0.65^{a}	1.17± 0.06^{d}	4.50± 0.38^{c}	4.04± 0.14^{a}	2.04± 0.04^{b}	0.93± 0.04^{c}	1.98± 0.10^{b}	1.07± 0.10^{c}	0.20± 0.00^{d}
Phos (mg/L)	3.07± 0.60^{c}	4.47± 0.26^{ab}	4.36± 0.12^{ab}	3.62± 0.06^{bc}	4.08± 0.30^{b}	5.27± 0.08^{a}	0.14± **0.01^{b}**	0.17± **0.01^{b}**	0.13± **0.01^{b}**	0.19± **0.01^{b}**	3.98± **0.07^{a}**	0.22± **0.01^{b}**
Flow rate (cm/s)	18.50± 2.09^{c}	10.80± 0.17^{e}	15.59± 0.12^{d}	13.50± 0.36^{de}	23.70± 0.26^{b}	36.30± 0.26^{a}	18.72± 0.64^{b}	18.71± 0.63^{b}	24.00± 1.68^{a}	17.84± 0.11^{b}	7.35± 0.20^{c}	6.26± 0.13^{c}

*Superscripts of the same alphabet are not significantly different (P<0.05)

**Superscripts of different alphabets are significantly different (P<0.05)

The physico-chemical parameters above show that Dissolved Oxygen was highest in Station 4 having a value of 6.35mg/l and lowest in Station 6 with a value of 4.40mg/l. Transparency values ranged from 18.25cm at Station 3 to 74.50cm at Station 5. Temperature values were between 26.00^{0}C in Station 6 to 28.23^{0}C in Station 3. Conductivity values were between 17.62µs at Station 6 and 2616.33µs at Station 3. Total Dissolved Solid ranged from 10.97mg/l at Station 6 to 1889.50mg/l at Station 3. pH values ranged from5.26 was at Station 6 to6.83 at Station 4. Biological Oxygen Demand ranged from 2.50mg/l at station 5 to 3.90mg/l at station 2. Nitrate values ranged from 0.22mg/l at station 3 to 2.96mg/l at station 1. Sulphate values were between 0.20mg/l at station 6 and 8.08mg/l at station 4. The highest phosphate value was recorded in Station 6 at 5.27mg/l and its lowest value in Station 3 at 0.13mg/l.

The microalgae species gotten from the different stations are classified in Table 2 below. The three major classes of algae identified in the study are Bacillariophyceae, Cyanophyceae and Dinophyceae which represents ten families and twelve genera. Bacillariophyceae had the

highest number of genera (9) while Dinophyceae and Cyanophyceae recorded one (1) and two (2) genera respectively.

Table 2: Microalgaetaxa in the New Calabar River

Class	Family	Species/taxa
Cyanophyceae	Microcoleaceae	*Trichodesmium sp.*
	Oscillatoriaceae	*Spirulina sp.*
Bacillariophyceae	Stephanodiscaceae	*Cyclotella sp.*
	Pleurosigmataceae	*Pleurosigma sp.*
	”	*Gyrosigma sp.*
	Lyrellaceae	*Petroneis sp.*
	Coscinodiscaceae	*Coscinodiscus sp.*
	Naviculaceae	*Amphiprora sp.*
	Pinnulariaceae	*Caloneis sp.*
	Bacillariaceae	*Cylindrotheca sp.*
	“	*Bacillaria sp.*
Dinophyceae	Prorocentraceae	*Prorocentrum sp.*

DISCUSSION

The values recorded for DO ranged from 3.70 to 7.08 mg/l.However, the range of DO was still within the acceptable limit for aquatic life (McNeely *et al.*,1979). The highest DO in station 4 and the lowest in station 6 may be attributed to low and high temperature respectively. This could be because at high temperature, the solubility of oxygen decreases while at lower temperature, it increases (Clerk, 1986). Transparency values recorded ranged from 16.95 to 78cm.Therefore, the reported values for water quality variables agreed with earlier reported works in Niger Delta waters (Sikoki and Zabbey, 2006; Hart and Zabbey, 2005; Davies *et al.,* 2007; Chindah and Pudo1999). The values obtained for temperature ranged from 24.0 to 31.0^{o}C. Temperature values obtained were in the same range as previous findings reported in the Niger Delta waters; Chindah (1998) reported temperature range of 26 ^{o}C and 30.5^{o}C, Sikoki and Zabbey (2006) 26^{o}C and 27.8^{o}C, Hart and Zabbey (2005) 25.8^{o}C and 30.4^{o}C, Dibia (2006) 25^{o}C to 27^{o}C and Jamabo (2008) reported a temperature range between 27^{o}C and 30^{o}C in the upper Bonny River in the Niger Delta.Also, Alabaster and Lloyd (1980) reported that the temperature of natural inland waters in the tropics generally varies between 25^{o}C - 35^{o}C.Conductivity values ranged between 17.20 and2693µScm across the 6 stations in March and April. This result agrees with Abowei (2010) who reported an increase in conductivity during the rainy season and attributed it to the influx of alloctonous organic and inorganic materials from the surrounding catchment areas during the rains.The values recorded for Total Dissolved Solids (TDS) ranged from 10.34 to 2446.5ppm. The values observed were around the range with the recommended value for water bodies (McNeely *et al.*,1979). This is indicative of organic pollution from anthropogenic sources (Saad*et al.,* 1994). pH values recorded were between 4.98 and 7.05. The recorded values were observed to be in range with the values reported by Ajao and Fagade (2002). In addition, the values obtained were also within the range of values

stipulated as standards for water quality; where permissible limit of pH is 5.0 – 9.0. This confirms that the water is suitable for aquatic life (Zhou *et al.,* 1999). The values recorded for Biological Oxygen Demand (BOD)ranged from 2.20 to 4.14mg/l. Nitrate levels ranged from 0.20 to 4.09mg/l. The values recorded in March and April were below the more than 100 mg/l expected to be found in natural surface waters (McNeely *et al.,* 1979). The values recorded for Sulphate ranged from 0.20 to 9.34mg/l. Station 6 recorded the least value of sulphate in September while station 4 recorded the highest value of sulphate in August. The low value in station 6 could be due to the level of inactivity in this station. Phosphate values as shown in table 4.1 ranged from 0.10 to 5.41mg/l. the lowest value was recorded in station 3 in April while the highest value was recorded in station 6 in March. It was observed that the phosphate levels were higher than the acceptable limit of 0.01 mg/l in flowing water recommended by United State Environmental Protection Agency (1976). Decomposition of organic matter might be seen as a factor to the level of phosphate in the water body.

Distribution of the microalgae species across the six stations were the same. Most of the Bacillariophyceae were observed to have a fair distribution across the stations although subsequently having varying abundance across the stations. All 6 stations had equal number of taxa (12) while station 3 had the highest number of individual species and station 6 had the least number of individual species. The high number of individuals observed in station 3 may be attributed to the lack of activity in the area, the high value recorded for Dissolved Oxygen and the level of sulphate which is higher than 0.5mg/l which encourages algal growth. The low number of individuals observed in station 6 may be due to the low level of Dissolved Oxygen which may be attributed to the breakdown of vegetation litter by microorganisms in the station. The result of the diversity index adopted from Shanon-Wieners diversity index (H) and Pielou's index of evenness (j), shows a high species evenness and this may be traced to anthropogenic activities. This conforms to Hart (1994)'s theory that the frequency of disturbances rises when there are low growth rates, diversity becomes low since some species have been eliminated but with higher growth, a higher diversity will be achieved because population are able to recover from disturbances. There is a gradual reduction in Pielou's index of species evenness and a gradual increase in Margalef's index of richness across the 6 stations respectively. This is asserted by Legendre (2002), where he stated that species evenness and species richness are negatively related. The maximum value of taxa richness observed in station 6 could be attributed to the rate of inactivity observed in the station. Since, the Shannon-Weiner diversity index in the study ranged between 1.822 to 2.166 in the stations studied, therefore, the water body oscillates between moderately polluted to highly polluted as proposed by Shekhar*et al*., (2008).

CONCLUSION

This study revealed the interrelationship between the physicochemical parameters and the organisms found across the six stations studied taking into consideration the diversity, abundance and richness of species over a period of two months. Observations were also made on the negative relationship between species evenness and species richness as revealed in the diversity index analysis. The key findings of the study include;

i. The data on water quality parameters were similar to those reported by earlier studies conducted within the Niger Delta region.

ii. The geo-referenced sites revealed significant spatial variation between some stations for all water quality parameters tested.

iii. The month of March displayed higher values for the Physicochemistry than the month of April.

It is therefore concluded from this study that the variation in some water quality parameters may have influenced microalgae species abundance and distribution in the study area.

Microalgae in the New Calabar River

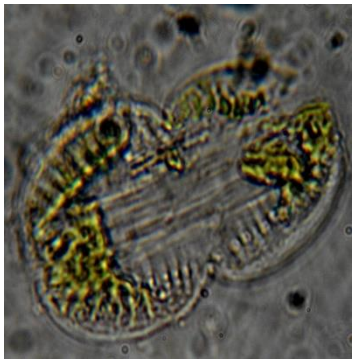

PLATE I

CLASS: Bacillariophyceae
FAMILY: Naviculaceae
GENERA:*Amphiprora sp.*

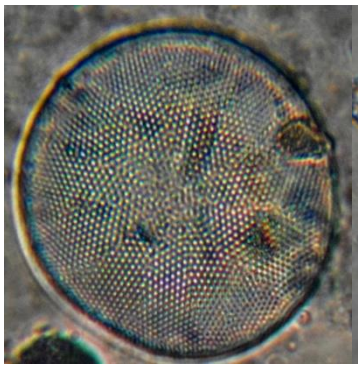

PLATE II

CLASS: Bacillariophyceae
FAMILY: Coscinodiscaceae
GENERA: *Coscinodiscus sp.*

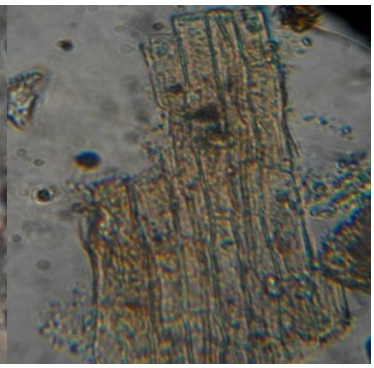

PLATE III

CLASS: Bacillariophyceae
FAMILY: Bacillariaceae
GENERA: *Bacillaria sp.*

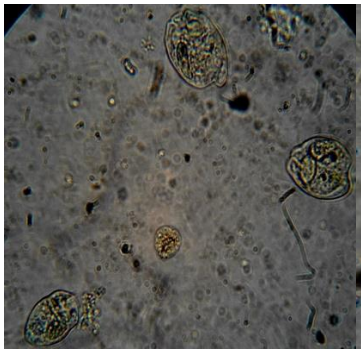

PLATE IV

CLASS: Dinophyceae
FAMILY: Prorocentraceae
GENUS: *Prorocentrum sp.*

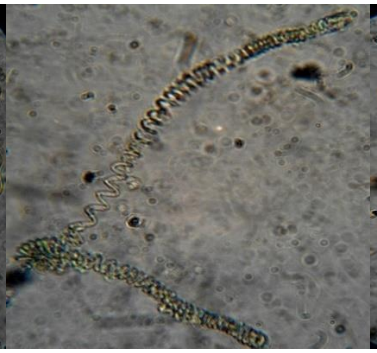

PLATE V

CLASS: Cyanophyceae
FAMILY: Oscillatoriaceae
GENUS: *Spirulina sp.*

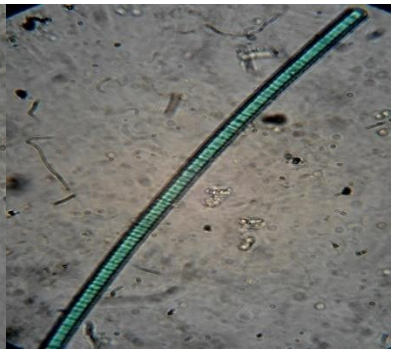

PLATE VI

CLASS: Cyanophyceae
FAMILY: Microcoleaceae
GENUS: *Trichodesmium sp.*

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