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Comparative study on Distribution of Phytoplankton according to seasonal variation at Buffalo Island (Hospital area) and Koddamunai New Bridge area of Batticaloa Lagoon

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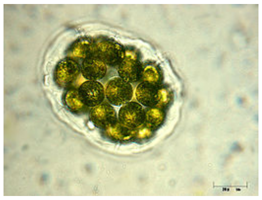
Abstract- Phytoplankton fluctuation analyzed at two sampling regions namely Buffalo Island (Hospital area) (A) and Koddamunai New Bridge area *(B)* according to seasonal variation in the year 2014. Sampling region B is a shallow area. The following Physiochemical parameters have to be taken for estimation; Water temperature, Conductivity, Salinity, pH, Nitrate and Phosphate were taken into the account. Samples were collected in dry (June) and rainy (November) seasons. During dry season (June) comparatively species diversity was higher than the rainy (November) season and the physiochemical parameters also highly reduced during rainy season. Moreover no algal bloom was recorded during the study period.

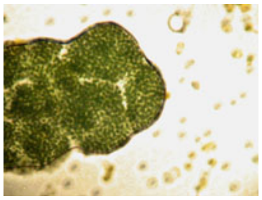
Index Terms- Phytoplankton, algal bloom, physio-chemical, species diversity.

I. INTRODUCTION

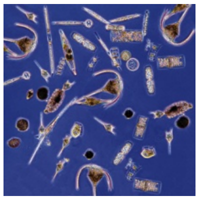
1.1 Phytoplankton

Phytoplankton, a flora of freely floating, often minute organisms that drift with water currents. Like land vegetation, phytoplankton uses carbon dioxide, releases oxygen, and converts minerals to a form animals can use. In fresh water, large numbers of green algae often colour lakes and ponds, and cyanobacteria may affect the taste of drinking water.


Green algae (*Pandorina Sp.*)

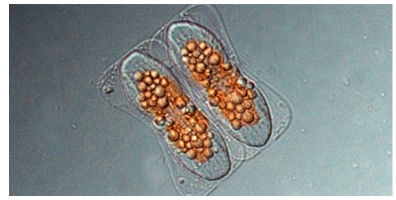

Cyanobacteria (*Microcystis Sp.*)

Oceanic phytoplankton is the primary food source, directly or indirectly, of nearly all sea organisms. Composed of groups with siliceous skeletons, such as diatoms, dinoflagellates, and coccolithophores, phytoplankton varies seasonally in amount, increasing in spring and fall with favorable light, temperature, and minerals.


Dinoflagellates


Coccolithophores

Phytoplankton populations in the oceans have been shown to rise and fall according to cycles lasting several years to decades. However, scientists examining records of phytoplankton kept from 1899 to 2008 noted that phytoplankton biomass fell by 1 percent per year in 8 of Earth's 10 ocean basins, resulting in a cumulative loss of roughly 40 percent. Rising sea surface temperatures over the same period are thought to be the primary cause of this decline.



1.2.Phytoplankton as Bio-indicators

Biological indicators are species used to monitor or assess the health and environmental integrity of an ecosystem (Odiete, 1999). Indicator organisms in perturbed ecosystems are known to provide valuable information with regard to water quality peculiarities of aquatic systems. Changes in water quality could be reflected by the type of species present, abundant, absent or their distributive pattern. According to Onyema (2007a) planktonic microalgae satisfy conditions to qualify as suitable indicators in that they are simple, capable of quantifying changes in water quality, applicable over large geographic areas and can also furnish data on background conditions and natural variability.

Lagoons in south-western Nigeria are generally of two types namely oligohaline and mesohaline lagoons. A few reports exist with regard to available literature on the use of phytoplankton as bio-diagnostic components in assessing water quality status in lagoons of South-western, Nigeria. For instance where as Nwankwo and Akinsoji (1989) investigated and provided a list of pollution tolerant species in an eutrophic creek, Nwankwo and Akinsoji (1992) recorded few species reflecting notable water quality situations in some aquatic systems and associated to the water hyacinth in Southwestern Nigeria. Furthermore, Nwankwo (2004b) gave record of a number of blue-green algae indicative of a range of polluted scenarios and reported 28 species. Nwankwo *et al.*, (2003) also reported 16 species as harmful algal species for the region. More recently, Onyema and Nwankwo (2006) enunciated 134 species from a polluted tidal creek where as Onyema (2007b) and Onyema and Nwankwo (2009) reported at least 49 and 19 species respectively from suspected polluted aquatic systems in the Lagos area.

Phytoplankton has been long used as an effective water bio-indicator [1-2] that is sensitive to environmental changes [1]. Some species thrive in highly eutrophic waters, whereas some species are very sensitive to environmental changes [1]. Rivers with weak water currents always contain phytoplankton in division Chlorophyta, such as *Pandorina* and *Eudorina*, and in division Euglenoplyta, such as *Euglena* and *Trachelomonas* [3].

Melosira and *Cyclotella* are usually found in clean water, whereas *Nitzschia*, *Microcystis* and *Aphanizomenon* are usually found in polluted waters [1]. *Chlamydomonas*, *Euglena*, *Scenedesmus* [4] and *Microcystis* [4-5] are indicators of eutrophic waters. *Aphanizomenon*, *Microcystis* and *Ceratium* are usually found in high phosphate waters, while *Anabaena* is found in waters with slight nitrogen content [6]. Palmer [2] listed sixty genera of plankton which are the most organic pollution-tolerant. *Euglena*, *Oscillatoria*, *Chlamydomonas*, *Scenedesmus*, *Chlorella*, *Nitzschia*, *Navicula*, and *Stigeoclonium* are the top eight genera which can indicate organic pollution in the waters.

1.3.Batticaloa Lagoon

Batticaloa Lagoon is a very large estuarine lagoon in Batticaloa District, Eastern province, Sri Lanka. The city of Batticaloa is located on land between the lagoon and the Indian Ocean. Batticaloa district is flourished with three lagoons, such Batticaloa lagoon, Valaichchenai Lagoon and Vakari Lagoon. Among them, Batticaloa lagoon is the largest lagoon in Batticaloa District. Batticaloa lagoon is a long and narrow lagoon situated in the east coast of Sri Lanka with the total area of approximately 11,500 ha of water.

The lagoon is 56 km long. This lagoon extends from Eravur (Batticaloa district) in the north to Kalmunai (Ampara district) in the south. This lagoon opens in to the sea at two points. One in the southern end of the lagoon at Kallar and the other is midway of the lagoon at Palameenmadu which is close to the Batticaloa town. Both are narrow and approximately 200 m wide. The width of the water flow at their openings varies with the seasons. During the dry season the width of the bar mouth of the lagoon decreases and gradually it get closed with the onset of the north east monsoon which piles up the sand bar by the end of dry season. Later with the rains and with the lagoon mouth closed.

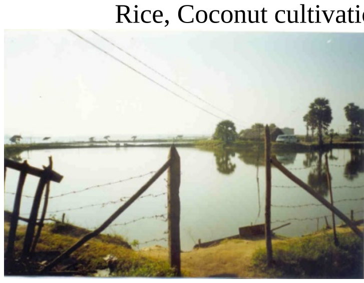

Palameenmadu. Sathurukkondan. Batticaloa Fort View

The lagoon is fed by a number of small rivers. It is linked to the sea by two narrow channels, one at Batticaloa and the other at Periyakallar. During the dry season these channels are blocked by sand bars.

Bar Mouth opened during rainy season and closed during dry season at Palameenmadu

The lagoon is surrounded by a densely populated region used for cultivating rice, coconut and other crops. The surrounding land is used for shrimp farming and rice cultivation. The lagoon has extensive mangrove swamps and some sea grass beds. The lagoon attracts a wide variety of water birds.


Rice, Coconut cultivation Inundated paddy land in 10th January 2011



Shrimp farm and dumping ground at Thirupperunthurai Impact on lagoon water



Mangrove vegetation and destroying mangrove vegetation at Puliyanthivu variety of migrated water birds at Saththurukkondan

1.4.Geographical Location

Batticaloa is a city in the Eastern Province of Sri Lanka. It lies in 580824.828 M, North and 598832.632 M East in the global positioning system (G.P.S) coordinates. It has a heritage of its own. The city of Batticaloa is bounded on the North by the Eravur Pattu Pradeshiya Saba, on the East by Bay of Bengal, on the South by Kattankudy Urban Council and on the West by Batticaloa lagoon which separates the Manmunai West Divisional Secretariat division and Manmunai North Divisional Secretariat division. The Eastern side of the city is sandy and the Western side is sandy and gravel. The city is flat with the exception of Puliyantivu which is a little higher than the rest of the area. The city is between 1.20 M and 4.0 M above M.S.L. with scrub jungle and mangrove on the Northern side bordering the lagoon. The annual rainfall is from 864 mm and 3081 mm brought by the seasonal North – East monsoon and inter monsoon. The rainy season is between October and January. The temperature is recorded between 25° C and 36° C. Batticaloa Municipal Council limit coincides with the Manmunai North D.S. Division.

II. OBJECTIVE

The phytoplankton composition, species diversity and species density were estimated in the year 2013 at Seelamunai and Kallar. This year (2014) another two different sampling stations have been selected to estimate the above mentioned biological parameters. This comparative study might give a different phytoplankton fluctuation according to seasonal variation.

The objective of the present study is;

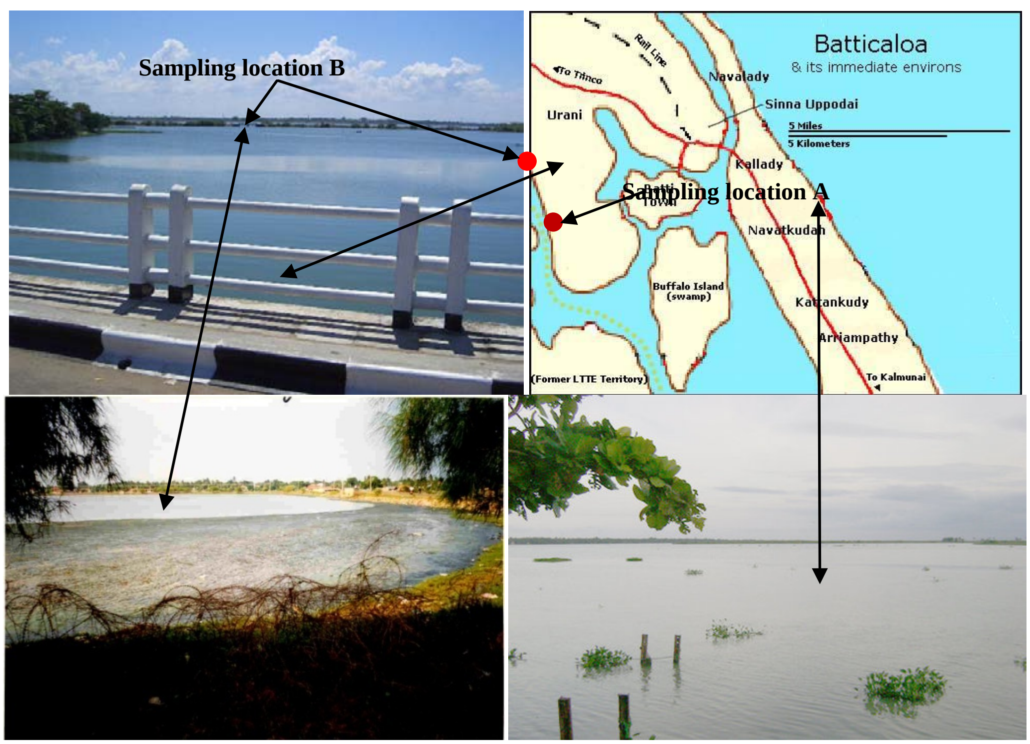
1. to determine the phytoplankton composition, species diversity & the density of different phytoplankton species at Buffalo island (hospital area) and Kottamunai new bridge area.

3. to determine the possibility of using phytoplankton species as environmental bio-indicators in the selected locations of Batticaloa lagoon for the prediction of water quality.

III. METHODOLOGY

3.1. Study area and Sampling regions

The study area is the Batticaloa lagoon. It is categorized into three basins, which are Northern basin, Southern basin and Intermediate basin. During 2014 investigation period, in June (dry season) and November (rainy season) water samples were collected and both sampling regions are located at Intermediate basin which are Buffaloa island area (A) [which receives drainage from Batticaloa hospital and Mantheevu hospital also reaching the surrounding area of buffalo island] and Kottamunai new bridge area (B) in which the water movement is highly reduced due to the construction of a bridge. Water samples were collected at 10 m distance away from the shore by using a boat at the secchi disk level. So from each season two samples, totally 4 water samples were collected and analyzed. The algal members were identified at genus level.



In this study the Batticaloa lagoon and its catchment was considered as an interacting ecosystem. Any activity within the catchment may influence the quality of water in its inlets thus causing changes in the phytoplankton assemblage of the lagoon. These changes could cause changes in the phytoplankton biomass within the lagoon. Therefore specifically two sampling regions were selected to represent seasonal variation of phytoplankton in the lagoon.

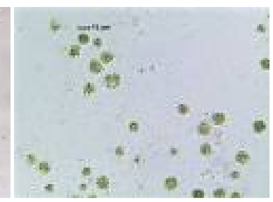
3.2. Collection of water samples, Sampling procedure and Estimation of Species

Sampling was done in June (dry season) and November (rainy season) at buffalo island area and Koddamunai new bridge area respectively during the investigation periods 2014. At each sampling region secchi depths were determined using a black & white disc of 0.25 m in diameter, operated from the boat at 10 am. to 11.00 am. for comparative purposes. Then at each region, water samples were collected at secchi disc level 10 m away from the shore by using a Ruttner sampler with a volume of 2.5 L operated from the boat. The collected water samples were immediately transferred to sterile bottles and 100 ml of collected samples were again transferred to another sterile bottle then fixed with 1 ml Lugol's solution and covered with aluminium foil and placed in undisturbed box. The collected water samples were transferred to laboratory as quick as possible and maintained for 24 hrs under undisturbed condition. Then the sedimented phytoplankton mass were carefully separated by using a micro pipette and estimated the species composition by using haemocytometer.

IV. Result and Discussion

Species indentified during the study period 2014 given below:



Nitzchia *Microcystis* *Aphanizomenon* *Chlamydomonas*




Euglena *Scenedesmus* *Ceratium* *Anabaena,*

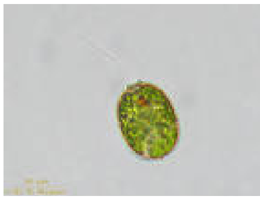


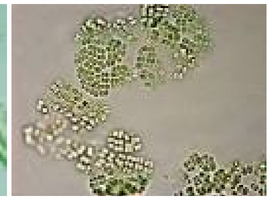

Oscillatoria *Chlorella* *Navicula* *Phacus*





Stigeoclonium *Rhizosolenia* *Monoraphidium* *Pandorina* *Eudorina*

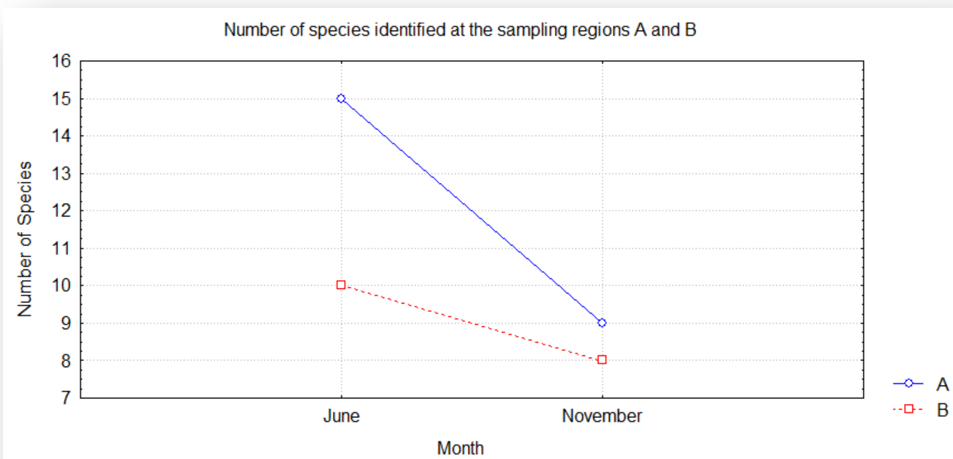





Trachelomonas *Phomidium* *Merismopedia* *Eucoconeis,*

Crataulina.

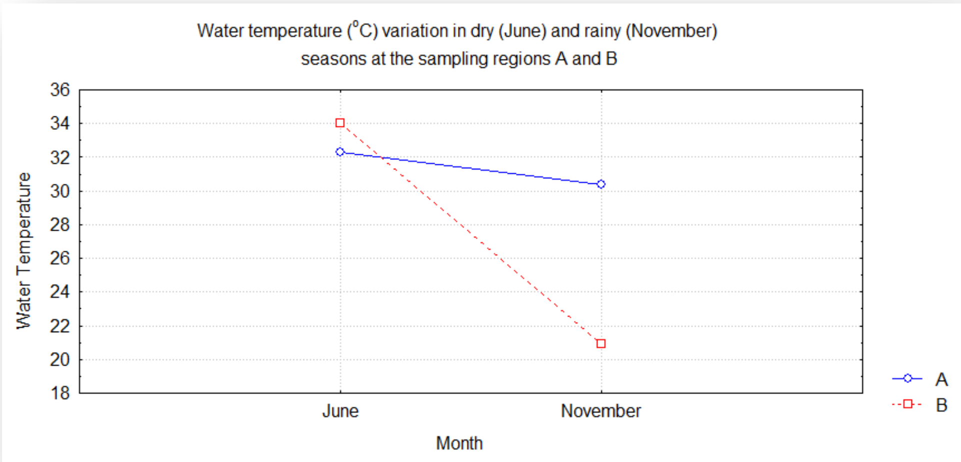
During the study period comparatively high number of species recorded in dry (June) season at the sampling region A and B which was 15 and 10 respectively and low number was recorded in the rainy (November) season at the sampling region A and B which was 9 and 8. The Composition of phytoplankton community of the ponds agreed with reports that blue-green algae and green algae dominate most tropical water bodies (Adebisi, 1981; Ayodele & Ajani, 1999)



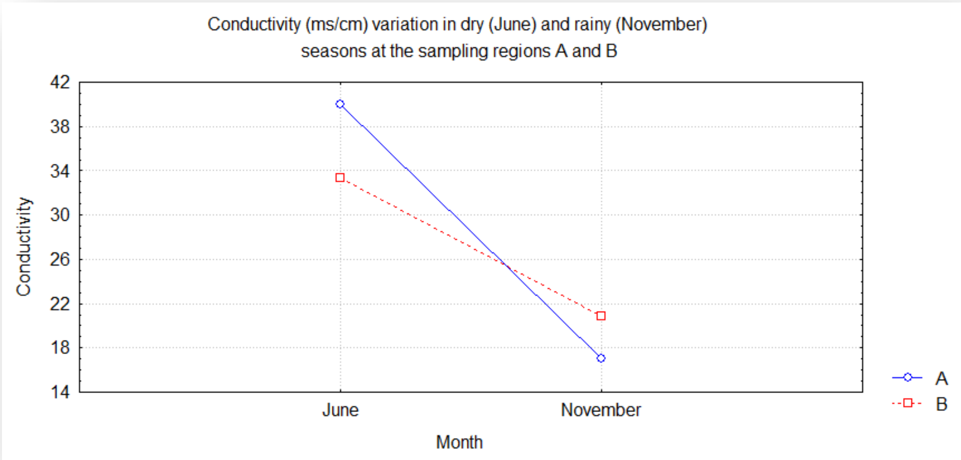
<u>June 2014 (Dry season) – Buffalo Island (A)</u>
Number of Species – 15. In 1x10^{-4} ml water sample.
Nitzchia, Microcystis, Aphanizomenon, Chlamydomonas, Euglena, Scenedesmus, Ceratium, Anabaena, Oscillatoria, Chlorella, Navicula, Phacus, Stigeoclonium, Rhizosolenia, Monoraphidium.
<u>June 2014 (Dry season) – Koddamunai Bridge area (B)</u>
Number of Species – 10. In 1x10^{-4} ml water sample.
Pandorina, Eudorina, Trachelomonas, Chlamydomonas, Phomidium, Oscillatoria, Navicula, Nitzchia, Scenedesmus, Aphanizomenon.
<u>November 2014 (Rainy season) - Buffalo Island (A)</u>
Number of Species – 9. In 1x10^{-4} ml water sample.
Trachelomonas, Merismopedia, Anabaena, Eucoconeis, Crataulina, Euglena, Microcystis, Nitzchia, Navicula.
<u>November 2014 (Dry season) – Koddamunai Bridge area (B)</u>
Number of Species – 8. In 1x10^{-4} ml water sample.
Pandorina, Eudorina, Trachelomonas, Oscillatoria, Scenedesmus, Euglena, Chlamydomonas, Phomidium

Physio-Chemical parameters in **dry season (June) 2014** at the sampling region Buffalo Island (A) and Koddamunai New Bridge area (B)						
Sampling Region	Water Temp. °C	Conductivity ms/cm	Salinity %	pH	Nitrate ppm	Phosphate ppm
A	32.3	40	18.7	9.02	0.3252	0.01222
B	34	33.3	23.5	9.00	0.2232	0.01122

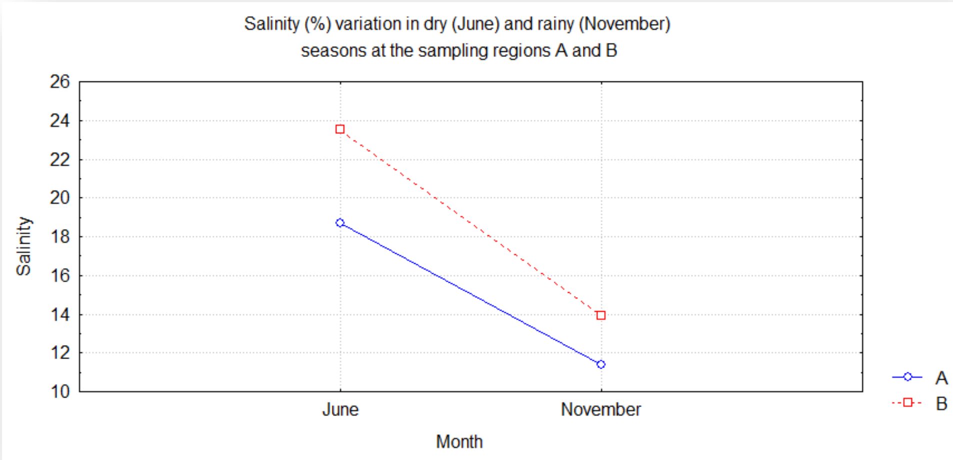
Physio-Chemical parameters in **rainy season (November) 2014** at the sampling region Buffalo Island (A) and Koddamunai New Bridge area (B)						
Sampling Region	Water Temp. °C	Conductivity ms/cm	Salinity %	pH	Nitrate ppm	Phosphate ppm
A	30.4	17.03	11.4	7.14	0.0413	0.01611
B	29	20.9	13.9	7.46	0.0112	0.01212



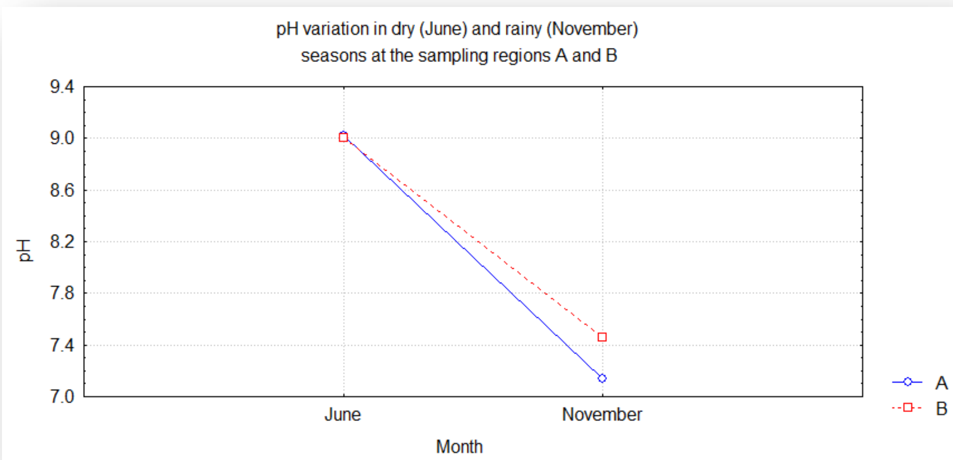
During study period high water temperature was recorded during dry season (June). Increased temperature, sunlight and tropholytic activities as a result of low water level coupled with frequent movement of water from the deep, nutrient-rich sediments into the tropholytic zone, increased the abundance of phytoplankton during dry season. Dominance of *Chlorophyceae* in the ponds in the dry season had been attributed to the presence of sunshine and extensive catchment area draining phosphate rich agriculture land (Uttah, 2008; Kurasawa & Shiraishi, 1954).



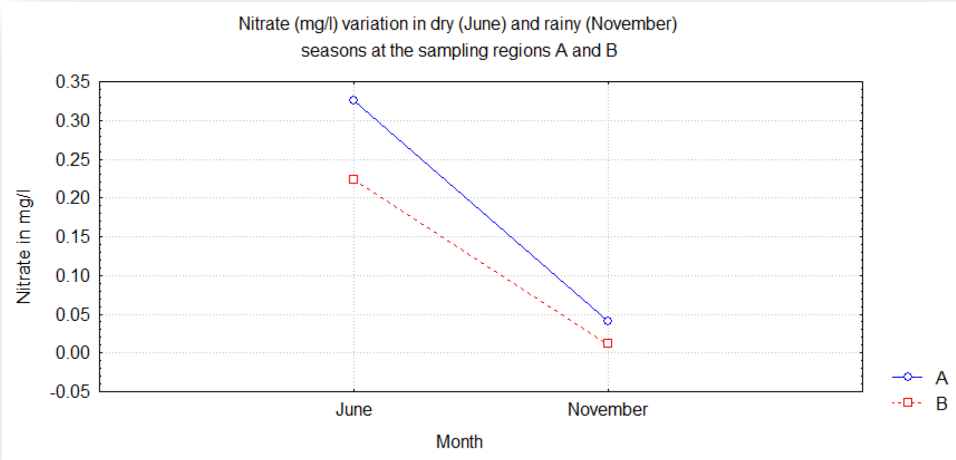
During study period high conductivity was recorded during dry season (June). When water level is reduced by evaporation or excessive use for irrigation, the amount of nutrients become more concentrated (Abolude, 2007; Abolude et al ., 2009; Chia et al ., 2011b; Adakole & Abolude, 2012). This increased nutrient load means a higher carrying capacity for the aquatic environment, thereby promoting a corresponding surge in diversity and density of phytoplankton.



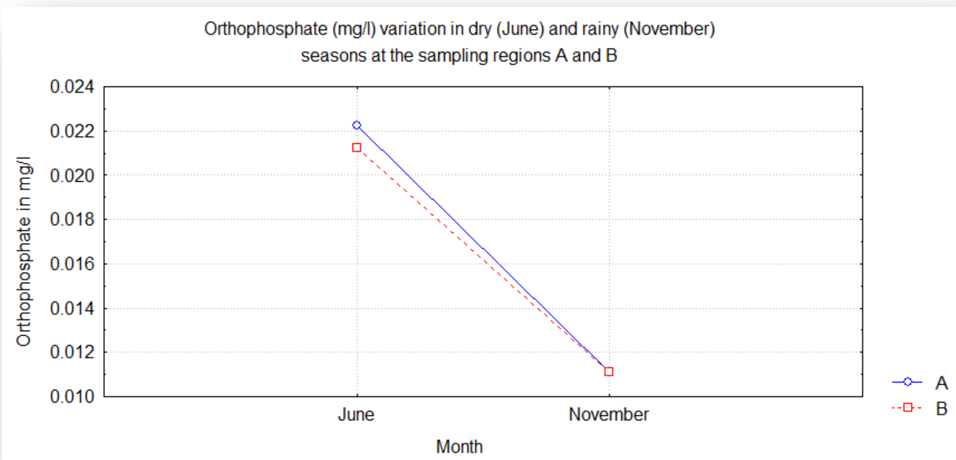
During study period high salinity was recorded during dry season (June). Bajpai (1997) reported that the low diversity of the species would be due to the disturbance such as heavy raining and flooding. The increase in the abundance of cells in 2009 derive from human influence and the high density of phytoplankton ,that are also due to the large amounts of organic matter caused by eutrophication (Badsi et al., 2010).



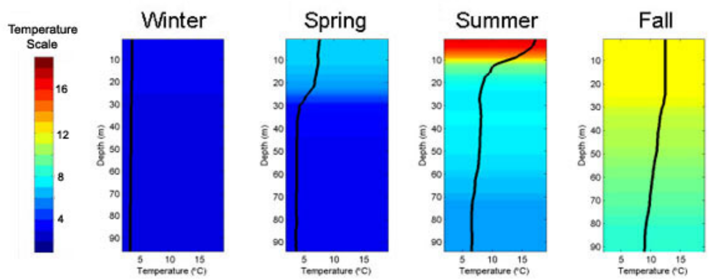
During study period slight increase of pH was recorded during dry season (June). The higher salinity tolerance range of the cyanobacteria was attributed to enhanced synthesis of zeaxanthin as a protective xanthophyll against the osmotic stress. However, the effect of pH was not as dramatic as salinity where green algae and cyanobacteria from the same freshwater system showed a considerable acclimation towards fluctuating pH. These findings are environmentally relevant to understand the likely impact of salt water intrusion and pH variation on phytoplankton communities in a tropical freshwater system.



During study period slight increase of Nitrate was recorded during dry season (June). Nitrogen is an essential element for phytoplankton growth. Almost all chlorophyll-containing algae will grow on either nitrate or ammonium, and in general the amides, urea, glutamine and asparagine, are also utilized (Syrett 1981). Syrett (1981) suggests that there is no clear relationship between the ability to use a particular group of nitrogen compounds and taxonomic class. However, Robert et al. (1986) found that diatom growth was promoted by inorganic nitrogen sources, and flagellate growth was promoted by urea.



During study period slight increase of orthophosphate was recorded during dry season (June). Nutrients play an essential role in supporting a phytoplankton bloom. Phytoplankton rely on sunlight and available nutrients for energy and growth. Carbon dioxide, water, and light are necessary for photosynthesis. Nitrate, phosphate, silicate, and carbonate are all important in the production of plant matter. Silicon, phosphorus, and nitrogen also play a key role in growing plants. Because their concentrations fluctuate, nitrogen and phosphate influence the rates of phytoplankton production in the ocean. Concentrations of nutrients in the water column vary depending on the time of year, density of water, how they entered the ocean, and how much mixing has taken place during that season. In addition, each of these constituents have different residence times, or time remaining in the water column. This factor has a direct influence on the intensity of the phytoplankton bloom. Density stratification is the formation of layers, with each deeper layer being denser (weighing more per unit of volume) than the layer above it (Garrison, 2005).



Seasonal variations in the water column

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