

## Effect of Water Quality on the Distribution of Phytoplankton in Tin Can Island Creek of the Lagos Lagoon, Nigeria.

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### Abstract

Plankton samples were collected at the Tin Can Island creek once a month for five months (May-September 2018). Some Physico-chemical parameter were analysed. The pH value varied between low acidic and low alkaline with a mean value of  $7.11 \pm 0.34$ . The Water temperature fluctuated slightly at all stations with a mean value of  $28.60 \pm 1.55^\circ\text{C}$ . Conductivity fluctuated from May to September at all the stations with a mean value of  $11059.49 \pm 6003.44 \mu\text{S/cm}$ . There were wide variations in salinity among the stations in May, June and August with a mean value of  $7.47 \pm 4.93\%$ . Total dissolved solids fluctuated significantly throughout the months and recorded a mean value of  $6554.33 \pm 3495.04 \text{mg/L}$ . There were considerable variations in the TSS recorded across the stations for each month with a mean value  $14.73 \pm 13.16 \text{mg/L}$ . There was slight variation in the turbidity across the three stations throughout the months and the mean value recorded was  $13.94 \pm 11.42 \text{NTU}$ . DO values showed variation from May to September at all stations with a mean value of  $3.89 \pm 1.42 \text{mg/L}$ . BOD fluctuated across the stations in the five months with mean value of  $43.07 \pm 52.04 \text{mg/L}$ . The phytoplankton of Tin Can Island Creek belonged to 5 divisions: Bacillariophyta, (49.45%), Chlorophyta (14.3%) and Cyanophyta (20.88%), Euglenophyta (7.69%) and Miozoa (7.69%). The most frequent genera were the *Microcystis aeruginosa* which recorded the highest abundance and occurred in all months. This study indicated that the generally low population of some species of phytoplankton as recorded within the area and time covered by the research may be generally due to the poor light penetration. Poor light penetration is therefore considered a key parameter that might have adversely affected these species of phytoplankton of the creek from thriving; consequently, generally limiting the creek's phytoplankton species composition profile and abundance.

**Key words:** Chlorophyll-a; Chlorophyll-b; Physico-chemical Parameter; Tin Can Island Creek

### Introduction

The Greek word 'planktos' which means *to wander* is used to refer to a collection of organisms that are carried about by the movements of the water rather than by their own ability to swim (Tait *et al.*, 1998). Plankton are a multitude of living creatures that lie afloat in the world's water bodies, and they move at the mercy of the water currents, unlike the nekton such as fish, squid and marine mammals that swim actively in the water and control their position in the environment. Plankton can also be categorized based on their sizes ranges, from the biggest, called Megaplankton (20-200cm) e.g. Pteropods, Macroplankton (2-20mm) e.g. Cephalopods, Mesoplankton (0.2m-20mm) e.g. Copepods, Microplankton (20-200  $\mu\text{m}$ ) e.g. Foraminiferans, Nanoplankton (2-20 $\mu\text{m}$ ) e.g. Femtoplankton, bacteria (Nybakken, 1988). The vast community of organisms comprises the planktonic ecosystems, 98% of the ocean's living biomass make up for the invisible multitude of plankton, the other

2% are animals that we can see like fish, squid, octopus and marine mammals. Plankton are grouped into the phytoplankton, zooplankton and bacterio-plankton based on their ecological energy source.

Phytoplankton are the plant-like microscopic floating organisms in any water body, they play a very important role in the aquatic ecosystem as the primary producers and consist mainly of diatoms and dinoflagellates, and are also called algae (Lee, 1999). They are responsible for the productivity in an aquatic ecosystem, they form the base of the food chain (Blum, 1956). All other living forms at higher trophic levels directly or indirectly depend on phytoplankton for energy supply and food. Any negative effect on their population may have detrimental consequences in the food chain and the entire community of the aquatic ecosystem (Larbi, 2017). Phytoplankton traps energy from sunlight in the presence of some nutrients, such as nitrogen in form of nitrates and phosphorous, to manufacture their own food in a process known as photosynthesis (Lee, 1999). They also play an important role in assessing pollution in a water body, in that, they are indicators of changes in water quality of an area (Onyema, 2007). Phytoplankton usually inhabit the upper layers of aquatic bodies known as the euphotic zone which varies widely (50-100m) depending on the clarity, latitude and season (Lee, 1999). In terms of numbers, the most abundant group of phytoplankton includes the diatoms, cyanobacteria and dinoflagellates. Although, many other groups of phytoplankton are represented such as the euglenoids, chrysophytes and chlorophytes. According to Nwankwo (1988, 1990), of all the algal phyla groups, diatoms are the most prevalent in the coastal waters of Southwest Nigeria.

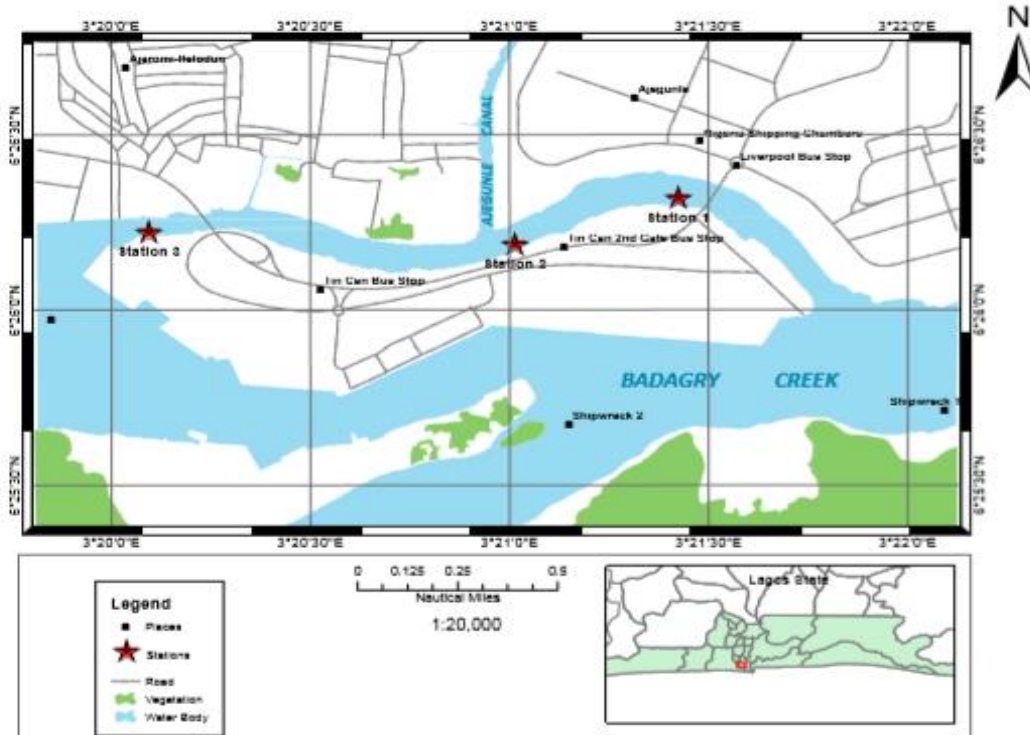
According to Nwankwo (1986), knowing the plankton community for any water body is not only important in assessing its productivity but would permit a better understanding of the population dynamics and life cycle of the fish community. Continuous monitoring and relevant studies on the aquatic environment is required for sustainability and mitigation of some negative impact. Information dealing with plankton species of the Lagos Lagoon and its environment is quite scanty. The work is aimed at investigating the phytoplankton in the wet season in relation to the environmental characteristics. The evaluation of the physicochemical effect on phytoplankton in Tin Can Island Creek would give useful evidence of the impact of the activities carried out in that area such as sand mining, domestic waste and inflow of effluents from the surrounding industries in the creek. The study will provide necessary information that can help environmentalists and the law enforcement agencies to arrive at sustainable monitoring steps of this aquatic ecosystem and adjoining water bodies.

## **Materials and Methods**

### **Study Area**

Tin Can Island is located in Lagos, Nigeria with an estimated terrain elevation of above sea level is 7metres. It lies between Latitude N 6°26'2" and Longitude E 3°21'23". It is a shallow at some point and is open all-year round through the Lagos Harbour. Sea water associated with the semi-diurnal tidal oscillation experienced in the entire Gulf of Guinea Coast, and fresh water from the adjoining wetlands are important factors that determine the hydrological conditions and hence, the plankton of the creek (Onyema *et. al.*, 2003). While freshwater inflow dilutes the water during the rains, increasing brackish/marine conditions from the harbour marks the dry season. The tidal range recorded is low (between 0.4 m and 0.9 m), and tidal effects are delayed inland in proportion to the distance from the harbour. Surrounding it is a dense rainforest vegetation preceded by littoral mangrove assemblages characterize this area especially in places with reduced anthropogenic influence around the

region. This riparian mangrove community is also typified by mangrove swamps which possess mudflats, mud banks and mangrove roots which are inhabited by polychaetes, amphipods, isopods, barnacles, oysters, periwinkles, fiddler crabs, sea cucumbers, hermit crabs, crabs, mudskippers and shrimps among others. The notable macro-floral species present here include the floating aquatic macrophytes which are *Lemna paucicostata* (duckweed), and *Eichhornia crassipes* (Mart.) Solms (water hyacinth). Others includes *Avicennia geminanas*, *Acrotiscum aureum*, *Cocos nucifera* (coconut tree), *Paspalum virginatum*, *Rhizophora racemosa* (red mangrove), *R. harrisoni*, water fern, *Laguncularia racemosa* (Linn.) Gaertn, *Phoenix reclinata*, *Elaeis guineensis*, *Raphia hookeri* and *Pinus* sp. (pine tree).



**Fig. 1:** The Map of the study area of Tin Can Island Creek in Lagos, Nigeria

### Collection of Water Samples

The samples were taken once monthly during the wet season (May- September 2018). Water samples were collected each time using 75cl plastic containers with each indicating the month of collection at the study site. Sampling was carried out between 09.00 and 12.00 hours on each sampling day. The plastic bottles were dipped into the water to collect the water samples and were taken to the laboratory for physical and chemical analysis.

### Collection of Plankton Samples

Plankton samples were collected at the study site once a month for five months (May-September 2018). On each occasion, a horizontal plankton haul was made using a standard plankton net of 55  $\mu$ m mesh size tied onto a motorized boat and towed at low speed (<4 knots) for five minutes. Plankton samples were concentrated and stored in well-labelled 500 ml plastic jars with screw caps, and preserved in 4% unbuffered formalin. Samples were preserved in diluted 10% formalin and transported to the laboratory for physical and chemical analysis of the plankton samples.

### Determination of Physico-chemical parameters

The Physico-chemical parameters such as pH, Temperature, Conductivity, Salinity, Total Dissolved Solids (TDS), Total Suspended Solids (mg/L) (TSS) and Turbidity (NTU) of the water were measured using Laboratory benchtop meter (860033 model), Dissolved oxygen (DO) was measured with the Milwaukee dissolved oxygen meter (MW 600 Model) and the biochemical oxygen demand (BOD) was determined by the 5-day BOD test (APHA, 2005).

### Determination of Biomass Using Chlorophyll *a* (mg/L)

200mL, each of de-ionized water (blank) and samples ( $V_{\text{filtered}}$ ) were filtered through 0.45  $\mu\text{m}$  glass fiber filters. Each filter was removed and placed in labeled polypropylene tubes. To each tube was added 3 ml 90% acetone solution, and macerated at 500 rpm for 1 min, steeped in the dark for 2 h at 4°C and clarified by filtration and then adjusted to 20 ml ( $V_{\text{extract}}$ ) with 90% acetone solution. The extract was capped and then stored in the dark until analyzed. Then 3 ml of the clarified sample extract was transferred to a cuvette and the absorbance measured at 750, 665, 664, 647 and 630 nm, using a spectrophotometer (HACH DR 3900). Thereafter, the extract in the cuvette was acidified with 0.1 ml of 0.1M HCl solution, gently agitated and allowed to stand for 90 sec. The absorbance of the acidified extract was read at 750 and at 665 nm. Test results were validated with chlorophyll calibration standards (5-20 $\mu\text{g/L}$ ). The pigments concentrations were calculated as follows:

$$1. \quad \text{Chlorophyll } a \text{ } (\mu\text{g/L}) = \frac{26.7 * (A_{664b} - A_{665a}) * V_{\text{extract}}}{V_{\text{filtered}} * L}$$

$$2. \quad \text{Phaeophytin-}a \text{ } (\mu\text{g/L}) = \frac{26.7 * [1.7(A_{665a}) - A_{664b}] * V_{\text{extract}}}{V_{\text{filtered}} * L}$$

$$3. \quad \text{Chlorophyll } b \text{ } (\mu\text{g/L}) = \frac{21.03 * (A_{647b}) - 5.43 * (A_{664b}) - 2.66 * (A_{630b}) * V_{\text{extract}}}{V_{\text{filtered}} * L}$$

Where:

$V_{\text{extract}}$  = volume of extract (mL)

$V_{\text{filtered}}$  = volume of sample filtered (L)

$L$  = light path length or width of cuvette, cm

664b, 647b, 630b = corrected absorbance of extract before acidification

665a = corrected absorbance of extract after acidification

The value 26.7 is the absorbance correction factor ( $A \times K$ )

$A$  = absorbance coefficient for chlorophyll *a* at 664 nm = 11.0

$K$  = ratio expressing correction for acidification = 2.43

### Determination of Biomass in Terms of Numbers Using Counting Methods (individuals per ml)

#### Plankton Investigation

All plankton species were thoroughly examined and counted using an Olympus® binocular microscope with a calibrated eyepiece at different magnifications (5 X, 10 X and 40 X). Direct plankton counts were done using the drop count method described by Lackey (1938). Phytoplankton species were observed, identified and drawn using text. Several relevant texts and illustrations: (Nwankwo, 2004; Nwankwo and Onyema, 2003; Al-Yamani *et al.*, 2004; Al-Kandari *et al.*, 2009; Costello *et al.*, 2013; Onyema *et al.*, 2018) and World Register of Marine Species (WoRMS) were adequately consulted to confirm species identification.

### **Determination of Community Structure Analysis**

Species diversity index (d), (Shannon and Wiener, 1963), Menhenicks (D), Species richness (d) (Margalef, 1951), Evenness or equitability indices (j) (Pielou, 1975) and Simpson's Dominance index (C) were used to estimate the phytoplankton biodiversity.

### **Determination of Species Diversity Index (d)**

This is also known as the species diversity index. The species richness (Margalef, 1951) was given by the equation.

$$d = \frac{S - 1}{\ln N}$$

Where d = Margalef richness index or species diversity index

S = Number of species in the population

N = Total number of individuals in species.

### **Determination of Shannon and Wiener Diversity Index (Hs)**

This was proposed by Shannon and Wiener (1963) and it is given by the equation:

$$H_s = \frac{N \log N - (\sum P_i \log P_i)}{N}$$

Where Hs = Shannon-Wiener diversity index

$\sum$  = Summation

i = count denoting i<sup>th</sup> species ranging from 1 to n.

Pi = proportion that the i<sup>th</sup> species represent to the total number of individuals in the Sampling space.

### **Determination of Menhinick's Index (D)**

This was determined by the equation:

$$D = S/\sqrt{N}$$

Where D =Menhinick's index

S = Species total

$\sqrt{N}$  =Abundance

### **Determination of Equitability (j)**

Species equitability or evenness (Pielou, 1996) was determined by the equation:

$$j = \frac{H_s}{\log_2 S}$$

Where j = equitability index

Hs = Shannon-Wiener diversity index

S = number of species in the population.

### **Determination of Simpson's Dominance Index (C)**

Simpson's dominance index by Simpson (1949) using the equation:

$$C = \sum \left(\frac{n_i}{N}\right)^2$$

n<sub>i</sub> = the no. of individuals in the in the species

N = the total no. of individuals. (Sagar and Sharma, 2012)

### Statistical Analysis

The results of the physico-chemical parameters were subjected to one-way Analysis of variance (ANOVA) using the Statistical Package for the Social Sciences (SPSS Version 23) to determine significant differences. The Duncan Multiple Range Test was used to separate differences among means. Differences were considered significant at ( $P < 0.05$ ). The correlation between phytoplankton abundance and some environmental variable was determined by using Spearman Rank correlation analysis (Ogbeibu, 2005) and it is given by the equation:

$$r = \frac{1 - 6 \sum D^2}{n(n^2 - 1)}$$

Where  $r$  = correlation coefficient

$\sum D^2$  = sum of squares of difference of ranks

$n$  = Number of months

### Results

#### Physico-chemical Parameters

Data for these are presented in Tables 1

#### pH Value

pH value varied between low acidic and low alkaline. The lowest value (5.94) was recorded in September at Station 1, while the highest value (7.33) was recorded in July at Station 3. The mean and standard deviation is  $7.11 \pm 0.34$  (Table 1).

#### Temperature ( $^{\circ}\text{C}$ )

Water temperature fluctuated slightly at all stations during the period of study. The lowest value ( $26^{\circ}\text{C}$ ) was recorded in both June at Station 1 and August at Station 3, while the highest ( $30^{\circ}\text{C}$ ) was recorded across varying stations in all months except August. The mean and standard deviation is  $28.60 \pm 1.55$  (Table 1).

#### Conductivity ( $\mu\text{S}/\text{cm}$ )

Conductivity fluctuated in value from May to September at all three sampling stations. The lowest conductivity value ( $2760.00 \mu\text{S}/\text{cm}$ ) was recorded in September at Station 1, while the highest ( $24900.00 \mu\text{S}/\text{cm}$ ) was recorded in June at Station 3. Conductivity value at Station 1 dropped slightly in June, picked up in July through August and dropped drastically in September. At Station 2, the value dropped slightly in June, picked up again in July and plunged in August through September. At Station 3, the value rose in June, plunged in July, picked up slightly in August and plunged again in September. The mean and standard deviation is  $11059.49 \pm 6003.44$  (Table 1).

#### Salinity (‰)

There were wide variations in salinity values among the stations in May, June and August. Slight variations were recorded in the other months. The lowest value (1.50‰) was recorded in September at Station 1, while the highest value (18.40‰) was recorded in May at Station 3 (Fig. 5). The mean and standard deviation is  $7.47 \pm 4.93$  (Table 1).

#### Total Dissolved Solids (mg/L)

Total dissolved solids values fluctuated significantly throughout the sampling months. The value ranged between 1569.20 mg/L in September at Station 1 and 15189 mg/L in June at Station 2. The mean and standard deviation is  $6554.33 \pm 3495.04$  (Table 1).

#### **Total Suspended Solids (mg/L)**

Similar values (30 mg/L) were recorded in September at both Stations 1 and 2. There were considerable variations in the TSS values recorded across the stations for each month especially May, June, July and August. Values ranged between 1.00 mg/L in June at Station 3 and 48.00 mg/L in June at Station 1. The mean and standard deviation is  $14.73 \pm 13.16$  (Table 1).

#### **Turbidity (NTU)**

There was slight variation in the turbidity value across the three stations throughout the five months. The lowest value (2.72 NTU) was recorded in May at Station 1, while the highest value (39.20 NTU) was recorded in September at Station 1. The mean and standard deviation is  $13.94 \pm 11.42$  (Table 1).

#### **Dissolved Oxygen (mg/L)**

DO values showed variation in value from May to September at all three stations. The lowest DO value (0.36 mg/L) was recorded in September at station 1, while the highest (5.12 mg/L) was recorded in June at station 3. DO value dropped sharply in June at Station 1, picked up in both July and August, remaining steady, and then, dropped sharply again in September. There was a slight drop in value in June at Station 2. It rose slightly in July and remained steady through August with a sudden drop in September. It recorded a sharp rise in June at Station 3, remained steady with a gradual drop in August through September. The mean and standard deviation is  $3.89 \pm 1.42$  (Table 1).

#### **Biochemical Oxygen Demand (mg/L)**

BOD<sub>5</sub> value fluctuated across the stations in the five months under investigation. The lowest BOD<sub>5</sub> value (3.00 mg/L) was recorded in September at station 2, while the highest value (211 mg/L) was recorded in September at station 1. At Station 1, the value rose steeply in July, dropped slightly in August, and then, rose sharply in September. On the other hand, Station 2 experienced the sharpest drop in value in September, while Station 3 experienced a steady decline in value across all the months. The mean and standard deviation is  $43.07 \pm 52.04$  (Table 1).

**Table 1:** Mean values for physico-chemical parameters of the Tin Can Island Creek between May-September, 2018).

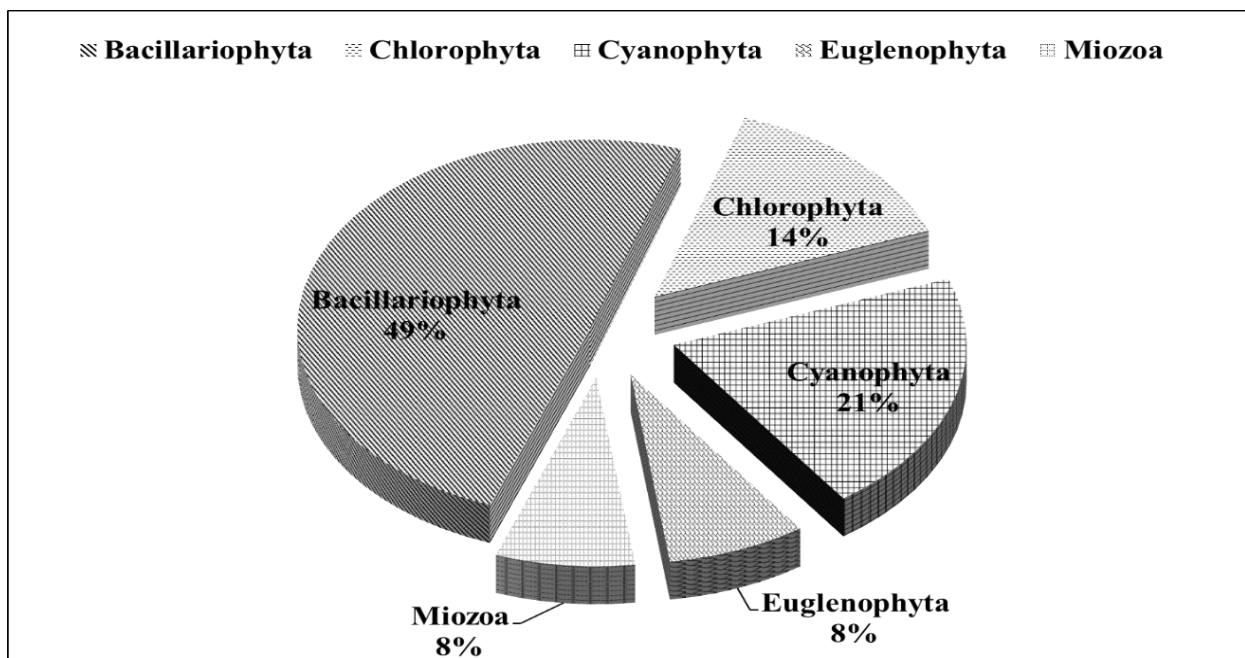
<b>Parameters</b>	<b>Mean <math>\pm</math> S. D.</b>
pH	7.10 $\pm$ 0.32
Temperature (°C)	27.60 $\pm$ 1.50
Conductivity ( $\mu$ S/cm)	11060.5 $\pm$ 6003.4
Salinity (ppt, at 25°C)	7.50 $\pm$ 4.94
TDS (mg/L)	6556.33 $\pm$ 3496.0
TSS (mg/L)	14.81 $\pm$ 13.15
Turbidity (NTU)	13.85 $\pm$ 11.4
DO (mg/L)	3.90 $\pm$ 1.41
BOD (mg/L)	43.10 $\pm$ 52.0

### Phytoplankton biomass and diversity

Fig. 1, 2, 3 and 4 shows graphical representation Percentage species diversity, Percentage abundance, Relative abundance and Relative abundance of Phytoplankton occurrence at Tin Can Island Creek (May - September, 2018).

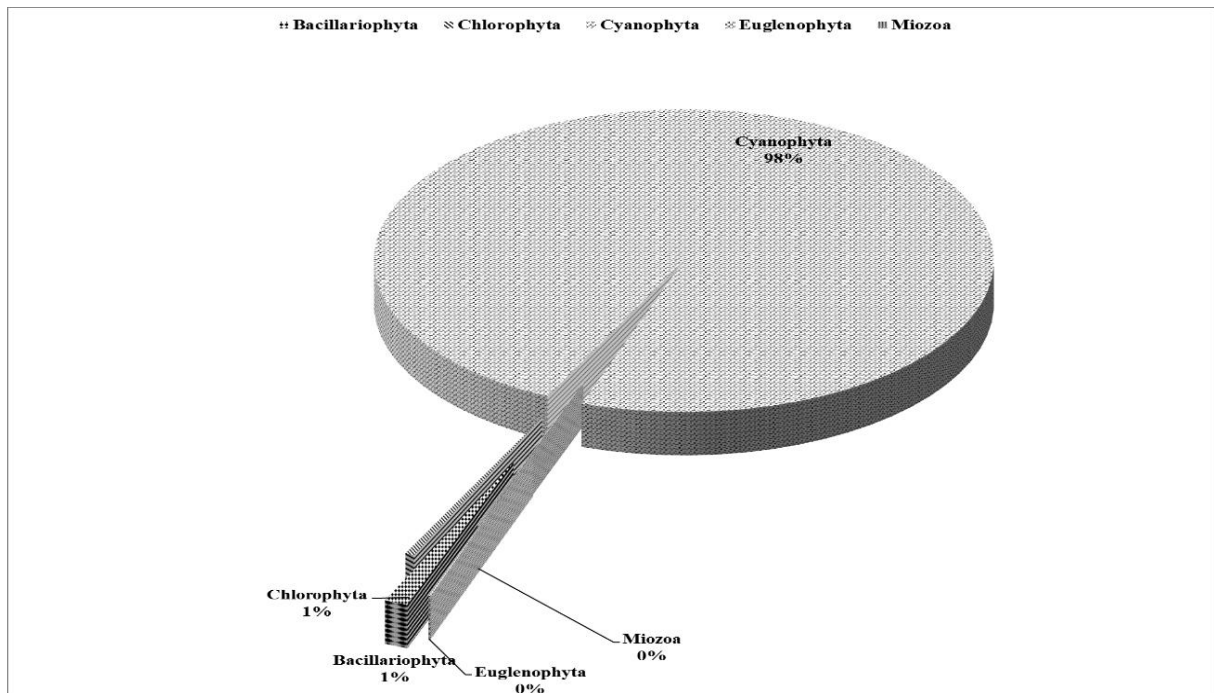
The phytoplankton of Tin Can Island Creek belonged to 5 divisions: Bacillariophyta, (49.45%), Chlorophyta (14.3%) and Cyanophyta (20.88%), Euglenophyta (7.69%) and Miozoa (7.69%). 14 orders were recorded. A total of 91 taxa belonging to 49 genera were observed. Throughout the sampling period, the highest 15150 individual/cell per ml (34.34%) phytoplankton occurrence was recorded in June, the least 4505 individual/cell per ml (10.81%) was recorded in September.

The more frequent genera were: *Microcystis aeruginosa*, which had the highest abundance and occurred in all months, *Oscillatoria tenuis* had a high number and occurred in only May and June. *Oscillatoria minima* had a relatively high abundance and occurred in all months except July, *Coscinodiscus centralis* occurred in all months except August, *Chlorella marina* occurred in all months except September. *Spirulina platensis* occurred in all months except July, while *Cyclotella comta* occurred in all months except August. Others included *Nitzschia palea* var. *hustedtiana* and *Coscinodiscus marginatus*. Among the euglenoids, *Trachelomonas hispida* was more prevalent.

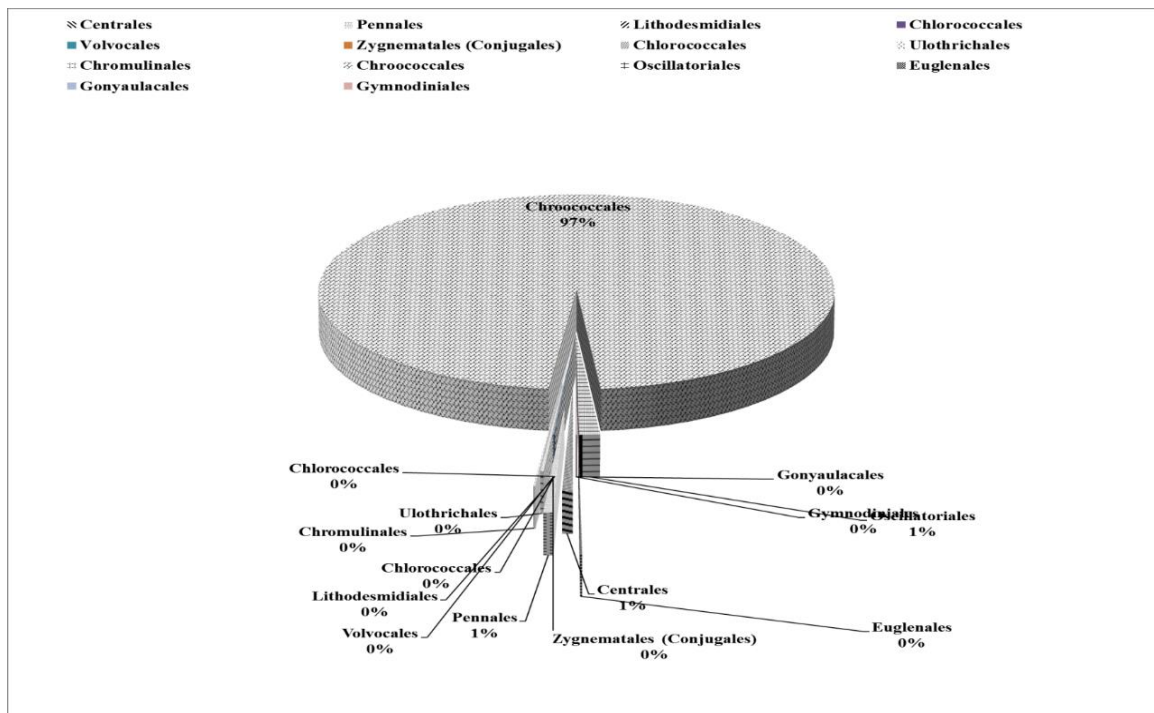


**Fig. 1:** Percentage species diversity of phytoplankton that occurred at Tin Can Island Creek (May – September, 2018).

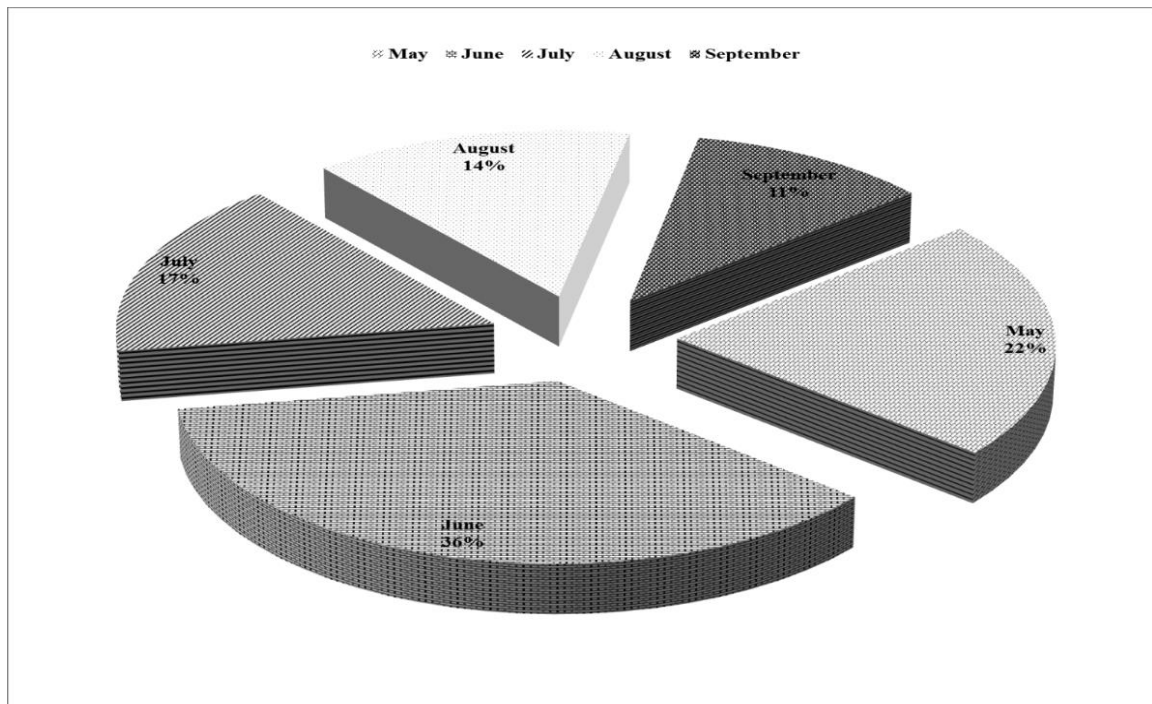




**Fig. 2:** Percentage abundance of phytoplankton that occurred at Tin Can Island Creek (May – September, 2018).



**Fig. 3:** Relative abundance of phytoplankton orders that occurred at Tin Can Island Creek (May – September, 2018).



**Fig. 4:** Relative abundance of phytoplankton occurrence per month at Tin Can Island Creek (May – September, 2018).

#### **Chlorophyll *a***

Chlorophyll *a* value ranged between 1 and 16  $\mu\text{g/L}$ . The highest value (16.4  $\mu\text{g/L}$ ) was recorded in May at Station 3, while the lowest value (1  $\mu\text{g/L}$ ) was recorded in May at Station 2 (Fig. 5). The mean and standard deviation is  $4.76 \pm 3.92$ .

#### **Chlorophyll *b***

Chlorophyll – *b* value ranged between 0.2 and 0.7  $\mu\text{g/L}$ . The highest value (0.7  $\mu\text{g/L}$ ) was recorded in July at Station 1 and August at Station 3, while the lowest value (0.2  $\mu\text{g/L}$ ) was recorded in May at Stations 1 and 2 and June Station 1 (Fig. 5). The mean and standard deviation is  $0.38 \pm 0.16$ .

#### **Pheophytin *a***

Pheophytin *a* value ranged between  $< 1$  and 0.3  $\mu\text{g/L}$ . The highest value (0.3  $\mu\text{g/L}$ ) was recorded in July at Station 3, August at Station 3 as well as September at Station 3, while the lowest value (1  $\mu\text{g/L}$ ) was recorded in June at Station 1 (Fig. 5). The mean and standard deviation is  $0.19 \pm 0.07$ .

#### **Community Structure Indices**

Three indices were measured in terms of the number of species present and their relative abundance: Margalef Index (d), Shannon-Wiener Information Index (H) and Species Equitability (j). Paleontological Statistics (PAST) software version 2.17c, Excel 2010 and IBM SPSS Statistics 20.0 were used to calculate the diversity indices, and are presented in Fig. 6.

#### **Margalef Index (d)**

Species Richness Index ranged between 0.26 and 5.30. The lowest (0.26) was recorded in August at Station 3, while the highest (5.30) was recorded in June at Station 1 (Fig. 6).

### Shannon-Wiener Index (Hs)

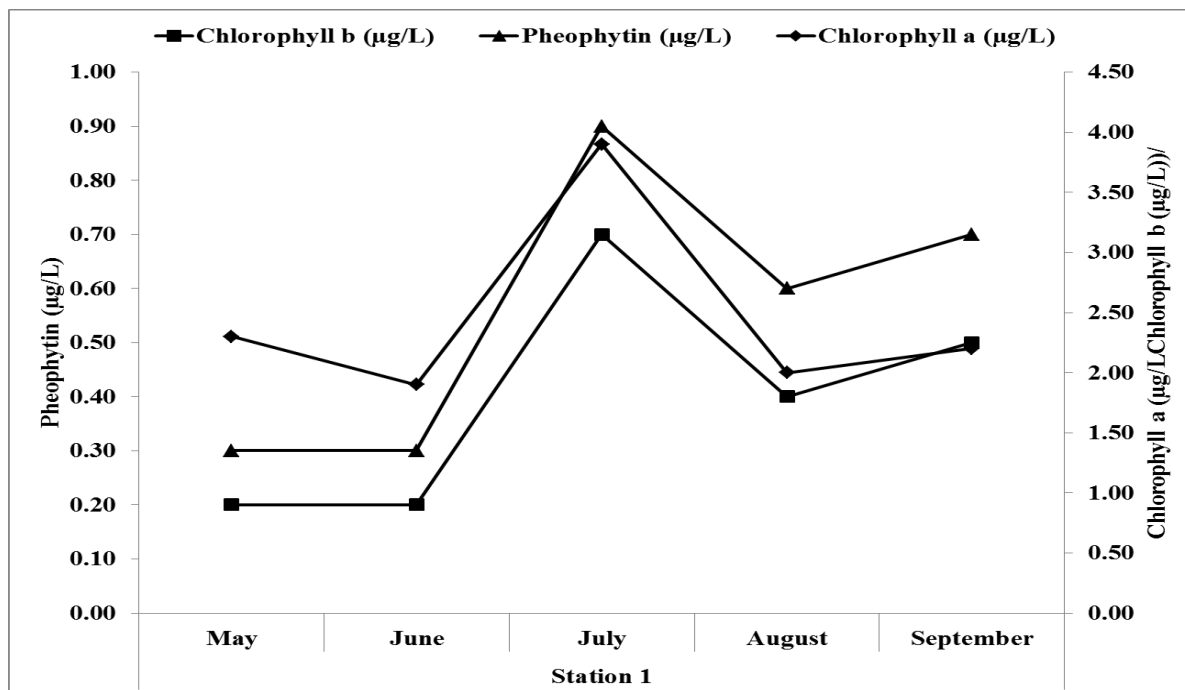
Shannon-Wiener Index ranged between 0.03 and 0.50. The highest (0.50) was recorded in August at Station 3 while the lowest (0.03) was recorded in May at Station 1 (Fig. 6).

### Equitability (j)

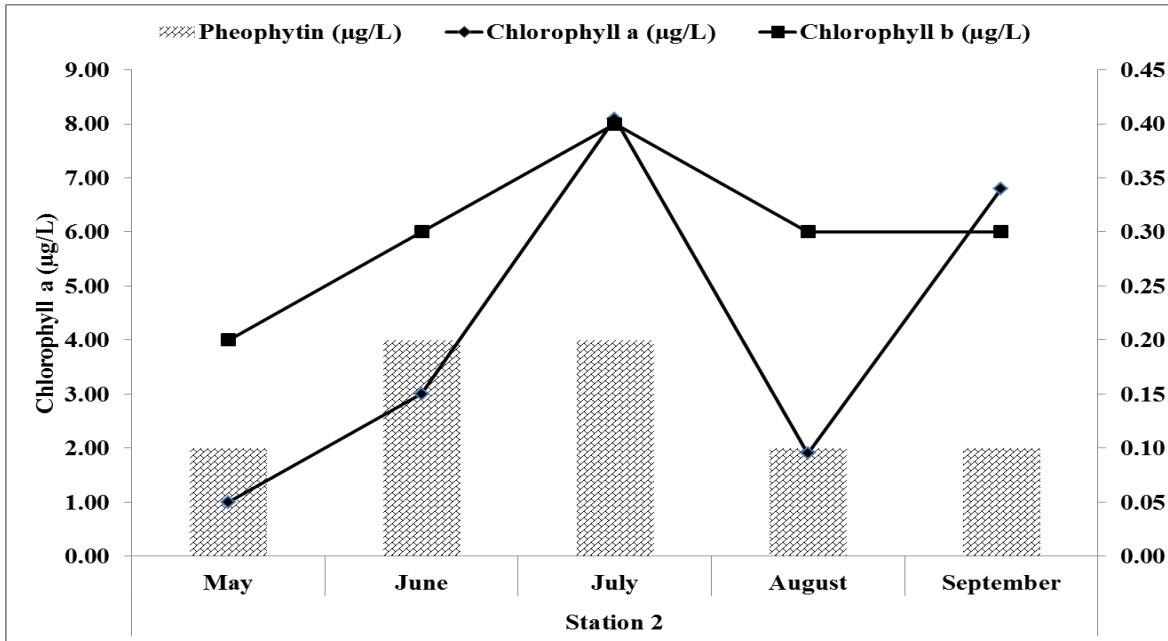
Equitability ranged from 0.23 to 0.03. The lowest value (0.03) was recorded in August at Station 3, while the highest (0.23) was in May Station 1 (Fig. 6).

### Similarity Index (S)

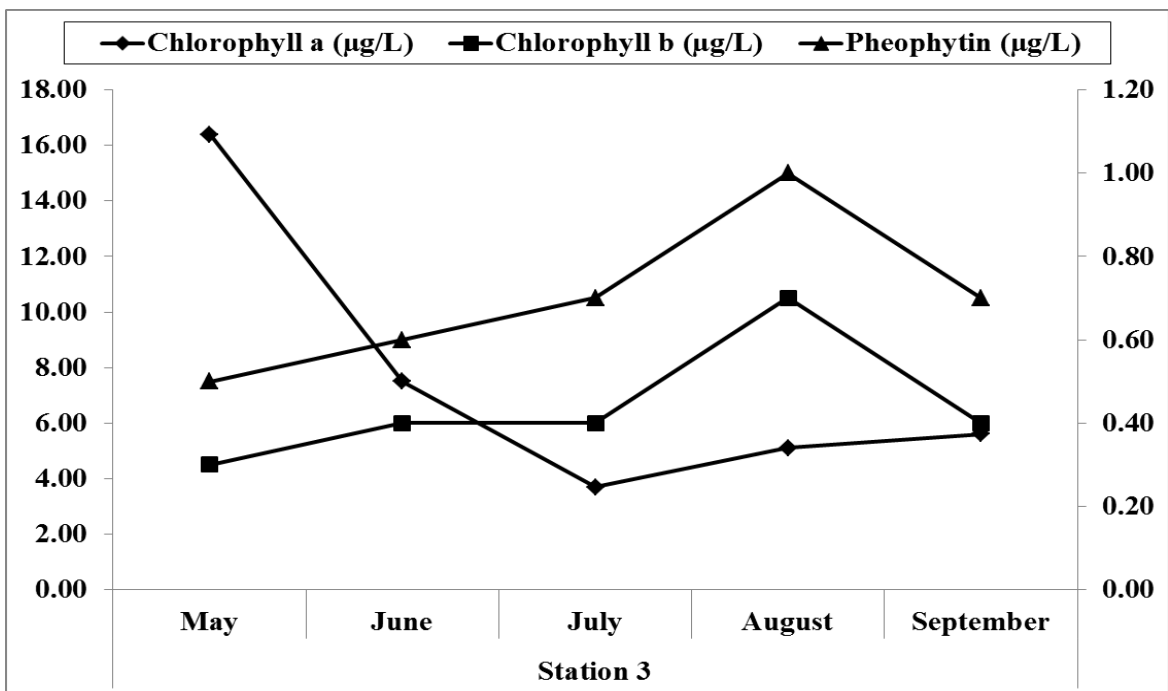
The highest Similarity (0.6) was observed in July between Stations 1 and 3, while the lowest (0.15) was recorded in May between Stations 1 and 3. The similarity between Stations 1 and 2 ranged between 0.18 and 0.4 with the lowest (0.18) recorded in June and the highest (0.4) recorded in September. The similarity between Stations 1 and 3 was lowest (0.15) in May and highest (0.6) in July. The similarity between Stations 2 and 3 was lowest (0.34) in June and highest (0.55) in September (Fig. 6).



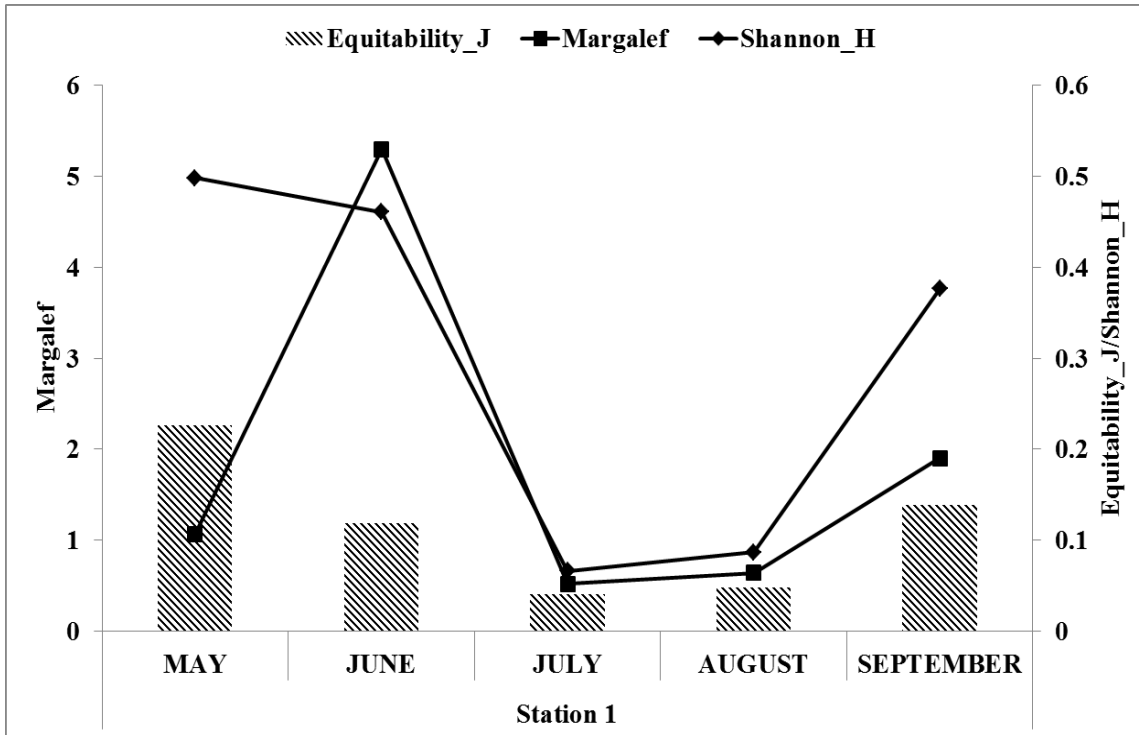
**Fig. 5a:** Monthly variation in chlorophyll *a*, chlorophyll *b* and pheophytin *a* at station 1 in Tinian Island Creek (May-September, 2018).



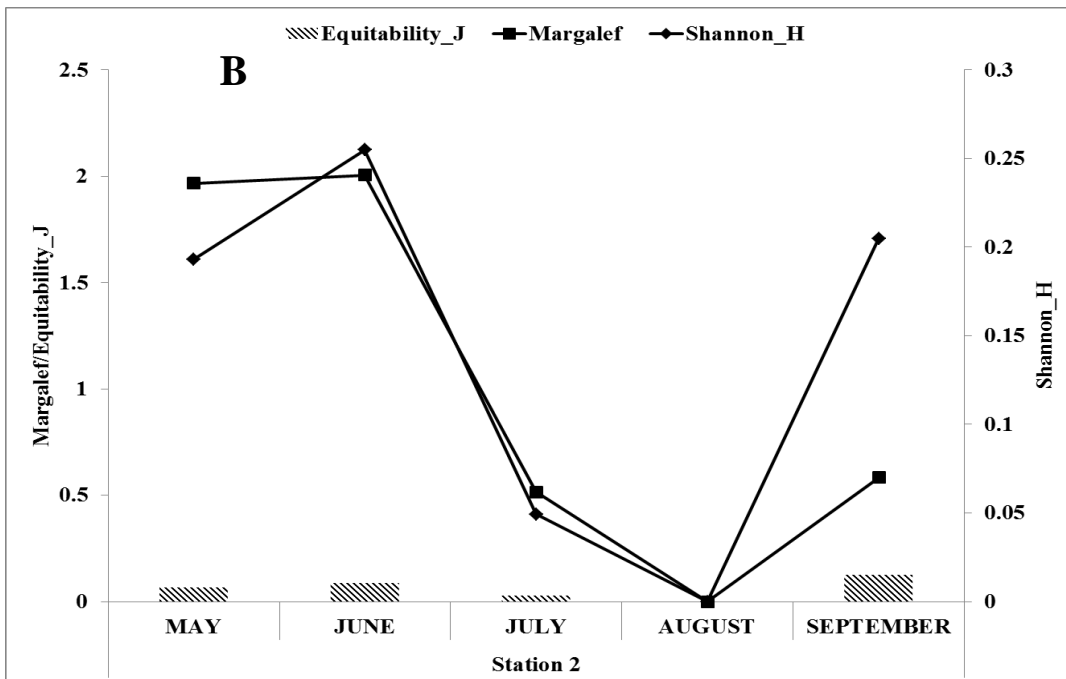
**Fig. 5b:** Monthly variation in chlorophyll *a*, chlorophyll *b* and pheophytin *a* in station 2 at Tin Can Island Creek (May-September, 2018).



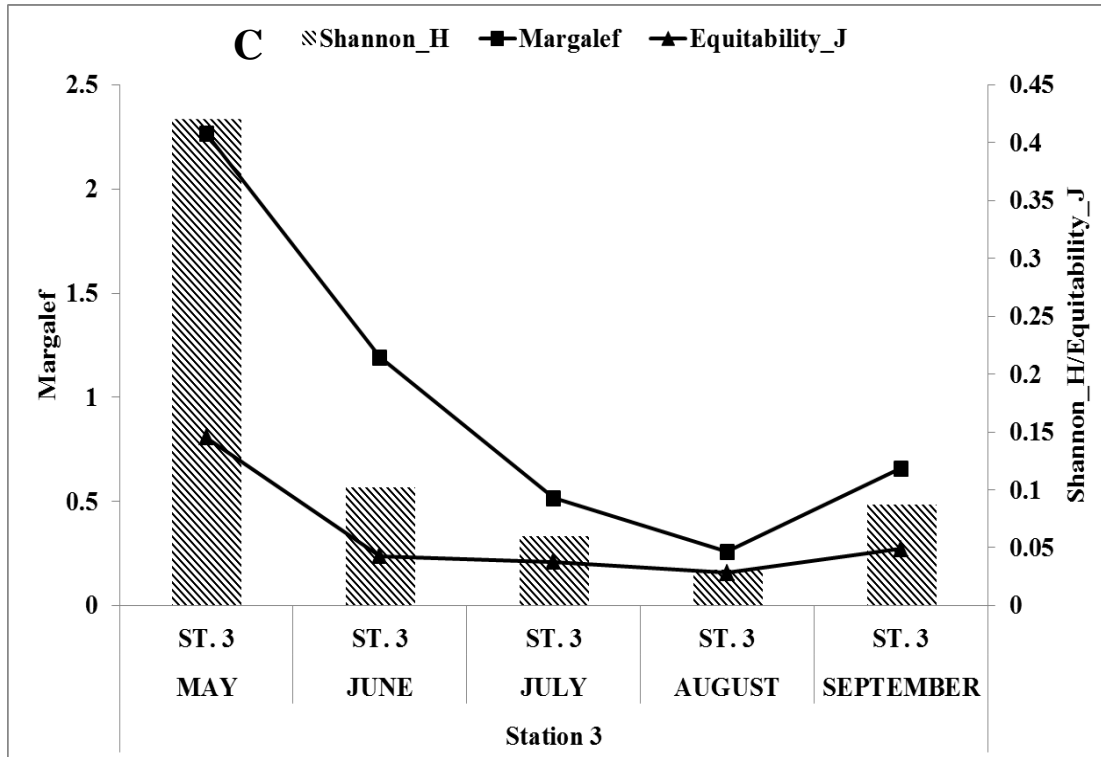
**Fig. 5c:** Monthly variation in chlorophyll *a*, chlorophyll *b* and pheophytin *a* in station 3 at Tin Can Island Creek (May-September, 2018).



**Fig. 6a:** Species richness, Shannon index and equitability of phytoplankton for Station 1 at Tin Can Island Creek (May – September, 2018)



**Fig. 6b:** Species richness, Shannon index and equitability of phytoplankton for Station 2 at Tin Can Island Creek (May – September, 2018)



**Fig. 6c:** Species richness, Shannon index and equitability of phytoplankton for Station 3 at Tin Can Island Creek (May – September, 2018)

### Discussion

The variations in the physico-chemical parameters as seen in Table 1 shows that the water parameters fluctuated slightly across all the stations during the period of study and this fluctuation affected the phytoplankton population of the creek. Although, most of the physicochemical parameters were very suitable for phytoplankton distribution and growth. This could also be attributed to why there were high nutrient loads in creek which could have led to the presence of large numbers of *Microcystis aeruginosa* in the creek. This observation is supported by the findings of Adakole *et al.* (2000), which attributed effective distribution and abundance of phytoplankton species as related to slight variation in physicochemical parameters.

The pH value varied between low acidic and low alkaline which appears to provide protection for the phytoplankton species (U.S.E.P.A, 2005). The little decrease in pH was probably due to the stirring effect of the incoming flood from the rivers that converged towards the creek resulting in the mixing of the poorly alkaline or acidic bottom water with alkaline surface water to reduce pH in the creek (Kumar and Bahadur, 2009). The increase in conductivity values is related to increase in phytoplankton and macrophyte population leading to increase in the uptake of nutrients. It was observed that there was an increase in conductivity as salinity increased at the study sites. Similar observation was also observed by Adesalu *et al.* (2010).

The paucity of phytoplankton population recorded in Tin Can Island Creek during this study may be due to poor light penetration into the highly turbid water, which reduced the photosynthetic depth. As observed in this study, the blue-greens were numerically more abundant (98.1%) as a result of the high number of *Microcystis aeruginosa* Kützing (96.8%). On the other hand, in terms of species diversity, the diatoms outnumbered all the other groups. The pennate diatoms (29 taxa) had more species occurrence than the centric diatoms (15 taxa), which may be a pointer to the scouring action of flood water on the substratum.

Chlorophyll *a* value observed were generally low, except in May (16.4 µg/L) where it rose sharply at Station 3 as well as in June (7.50 µg/L). This is in agreement with Kadiri (1993), and may be attributed to low light intensity in the wet months, more cloud cover and more unstable conditions which inhibited maximum use of available nutrients by the phytoplankton, hence a decrease in biomass (Ogamba *et al.*, 2004; Onyema and Emmanuel, 2009). There was a corresponding low dissolved oxygen level in all stations throughout the 5 months of sampling, since oxygen is a by-product of photosynthesis, which was at its lowest during this period under study (Onyema *et al.*, 2009).

The low population of phytoplankton at the Tin Can Island Creek may be due partly to poor light penetration into highly turbid water, which reduced the photosynthetic depth. Unlike previous observations that diatoms dominate the phytoplankton community (Imevbore 1965, 1968) and Egborge (1988) who worked on reservoirs of southwestern Nigeria and Nwankwo (1984) who carried out a survey of the Lagos Lagoon and the adjacent sea), in this study, the blue-greens – more importantly, the harmful, bloom forming blue-green alga, *Microcystis aeruginosa* – were more dominant in terms of number.

As reported by Smayda (1980); Nixon (1995); Richardson and Jorgensen (1996), global concerns over recent trends towards increased rates of eutrophication have been drawn to the issue of harmful algal blooms. Blooms of toxic algae in lagoons and estuaries have been blamed for a series of environmental problems including fish kills (Smayda, 1980, Steidinger *et al.*, 1998) and shellfish die-offs (Shumway, 1990).

Diversity values varied across the stations and with changes in phytoplankton composition. According to Karentz and McIntire (1977), the number of species in the phytoplankton assemblages and the degree of evenness are closely related to diversity. Dominance of phytoplankton samples by a few species was reflected by low equitability (*j*) values. This explains the lower '*j*' values recorded across some of the months. Since Margalef index (*d*) value is influenced by the number of species and individuals, periods of high '*d*' values reflected a high species number and a relatively low number of individuals. The Shannon-Wiener diversity index (*H'*) is influenced by both number of species and equitability. At the Tin Can Island Creek, the higher *H'* values observed could be attributed to high '*j*' values at that period.

### **Conclusion**

The study show that the water parameters fluctuated slightly across all the stations during the period of study and this fluctuation affected the phytoplankton population in Tin Can Island Creek and most of the physicochemical parameters were very suitable for phytoplankton distribution and growth. The blue-greens algae were numerically more abundant (98.1%) as a result of the high number of *Microcystis aeruginosa* Kützing (96.8%) and Chlorophyll *a* value observed were generally low. The low population of the other phytoplankton at the Tin Can Island Creek may be due to the fluctuations in the Physico-chemical parameters of the aquatic body which may have effect their distribution patterns. Reduction in the photosynthetic depth and eutrophication in the Creek may also have created a difficult environment for the other phytoplankton species to survive; consequently, altering the phytoplankton species composition which is also an important food item for fish in the Tin Can Island Creek.

### **Recommendations**

Based on these research findings the following recommendations are proposed:

- Strict compliance to approved regulatory standards by industries within the area to ensure that the effluents discharged into the Tin Can Island area of the creek does not lead to eutrophication.
- There is therefore need for strengthening of the implementation and enforcement capacity of the regulatory authorities in terms of effluents discharge monitoring to ensure compliance to approved guidelines and standards.
- Further research towards the seasonal variations and abundance of phytoplankton in the creek should be carried out to establish if there are seasonal influences on the physic-chemical parameters impact on phytoplankton distribution of the water body.
- General advocacy should be mounted for all stake holders towards ensuring they desist from indiscriminate dumping of organic wastes into the creek, which was observed to be a rampant act currently practiced in the area.

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