



## Changes in phytoplankton size-class abundance and species composition on the Niger River; a data comparison between 1999 and 2011

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### Abstract

**Background: Aim:** This study was carried out to evaluate changes in phytoplankton abundance and species composition as a reflection of the ecological status of a catchment on river Niger over a period of 12 years. **Method:** Water samples were analysed in both dry and wet seasons of the years 1999 and 2011 for phytoplankton. Diversity indices were used to analyse the data. **Results:** *Bulldalphia regia* accounted for the most number of species (21) in the dry season of the year 1999. While *Skeletonema* sp. accounted for the most number of species (298) in the wet season. In 2011 *Nitzschia acicularis* and *Dictyosolen fragilissimus* both contributed 14 species each accounting for the most species in the dry season and wet season respectively. Species abundance in 1999 was highest (1,852 cells/ml) in the wet season. Bacillariophyta accounted for (1,210 cells/ml) and (50 cells/ml) in wet and dry seasons of the year 1999. Also, in 2011 Bacillariophyta accounted for the most individuals (69 cells/ml) and (63 cells/ml) in the wet and dry seasons respectively. Diversity indices showed that Bacillariophyta had the highest Taxa<sub>S</sub> (21) at STA in 1999. Shannon<sub>H</sub> and Simpson<sub>1-D</sub> indices showed diversity of 2.23 and species evenness of 0.87 at STB in 2011. In Cyanophyta, dominance was highest at STA in the year 2011. The result of this study showed significant changes in the phytoplankton size-class abundance and species composition of the lower Niger River over a period of 12 years. The catchment under study was polluted with Cyanophyta in the year 1999 and Pyrrophyta in 2011.

**Keywords:** River Niger, Phytoplankton, Diversity indices, Kogi state

### Introduction

River Niger is a freshwater flowing river that transverses four countries. Being Africa's third longest river, it shapes a corridor of productivity that has for thousands of years provided people with dynamic and rich livelihood, and has made human survival possible even in times of desolate drought (World Wide Fund for Nature, 1986). Conservation of freshwater bodies is constantly under threat due to human population growth blowing out of proportion and the unsustainable use of natural resources. Water run-off and discharge of sewage into rivers are two common ways that various nutrient enter the aquatic ecosystem resulting in the pollution of those systems (Adeyemo, 2008).

Analyses involving physical and chemical components provide valuable information on water quality at the time the measurements are taken, thereby making them critical especially when the subject of study happens to be a lotic system where self-purification occurs at each point. Intermittent measurement over time tends to increase significantly the value of information on physical and chemical methods (Lobo *et al.*, 2002). The physical and chemical properties of water immensely influence its use, the distribution and richness of the biota (Unanam and Akpan, 2006). Hence, knowledge of the physical, chemical and biological properties of an affected ecosystem is of critical value (Xavier, 2005).



Phytoplankton is composed of varieties algae having diverse forms and highly evolved life cycles that help them to increase their productivity. They include genera such as *Microcystis*, *Anabaena*, *Nodularia*, *Planktothrix*, *Aphanizomenon*, *Cylindrospermopsis*, *Trichodesmium*, possessing gas vacuoles making them float above water, or benthic genera such as *Lyngbya*, *Phormidium*, *Oscillatoria*, and *Schizothrix* that are mostly found on sediments (Codd, 2005). Planktons occur in all natural water as well as artificial impoundments, thus, environmental variables such as temperature and pH plays a decisive role in altering the phytoplankton diversity. In lakes and other water bodies, the status of living organisms has been studied according to the phytoplankton community structure (Jun *et al.*, 2019; Zakariya *et al.*, 2013).

In recent times phytoplanktons such as cyanobacteria have been involved in blooms. Such blooms have been reported to be responsible for variety of environmental disturbance, including a reduction aquatic productivity, deterioration of water quality (Chen *et al.*, 2019). Therefore, monitoring long term trends in phytoplankton abundance and distribution is crucial to the understanding of the biological response to anthropogenic and natural oscillation within the aquatic ecosystem.

Sustainable and equitable management of the Niger River is fundamental for the environmental and social security of Nigeria as a country and much of the states it flows through. Hence, this study was carried out to evaluate changes in ecological status via changes in phytoplankton abundance and species composition in relation to the physical and chemical properties of the water body over a period of 12 years.

## Materials and Methods

### Study Area

This study was conducted on a catchment of River Niger cutting across Koton Karfe, Lokoja and Ajaokuta Local Government areas of Kogi state. Data obtained in the year 1999 was courtesy of Environmental Impact Assessment (EIA) report on the dredging of the lower Niger River which was in line with the principle of sustainable development and specifications of EIA decree No. 86 of 1992. The study area was in segment 4 of the EIA project; hence the sample stations; SG4/W5 (Midway between Ajaokuta and Lokoja), SG4/W6 (Ganaja village) and SG4/W7 (Koton Karfe). These sample stations were renamed for the purpose of this study. In 2011, the sample stations were named; STA (Midway between Ajaokuta and Lokoja), STB (Ganaja village) and STC (near Koton Karfe town).

The area is characterised by agricultural, fishing, washing and transportation activities. The area experiences two seasons, wet season that begins in late April and ends in early October. The dry season begins in October and ends in April of each year.

### Sample Collection

Water samples were collected for two seasons i.e. dry and wet season. In 1999 phytoplanktons were collected using a conical shaped plankton net fasten to the weld craft of a flat bottom boat with an outboard engine capacity of 75 HP of which each collected sample was emptied into a 250 ml plastic bottle. Samples were preserved by adding 40% formalin solution. In 2011, phytoplanktons were collected using conical shaped plankton net with 50ml collecting vial attached to it as described by Perry (2003).

Microscopic examination for phytoplankton collection in both years was done by drop count method as described (Vollenweider, 1969; Barber and Haworth, 1981; Perry, 2003). Phytoplankton identification was carried out by comparing with relevant texts and monographs (Hendy, 1954, 1961; Foged, 1966; Patrick and Reimer, 1966-1975; Prescott, 1961).



## Statistical analysis

Results were presented using tables and figures. Palaeontology statistics (PAST) ver. 18 was used to describe the diversity and composition of phytoplankton.

## Results

In 1999, the highest number of species (21) was observed in the dry season at STA with *Bulldalphia regia* accounting for the most number of species (Table 1). *Acnastrum* sp., *Fragillaria* sp., *Oscillatoria* sp. and *Oscillatoria messentilofera* recorded (10) species each in the dry season. In the same year, the wet season saw *Trichodesmium* sp., *Bulldalphia aurita* and *Skeletonema* sp. accounting for the most number of species across all the sample stations (Table 1). *Skeletonema* sp. accounted for the most number of individual species (298) at STC. Second to it was *Trichodesmium* sp. at STB. *Consinodiscus concinnus*, *Hemiadulua membranaceous*, *Consinodiscus regia* all recorded 12 individual species each (Table 1). In 2011, *Nitzschia acicularis* was observed to have the highest number of individual species (14) in the dry season occurring at STC. It was closely followed by *Synedra actinastroides* and *Melosira italic* with (6) individual species each at STA, STB and STC respectively (Table 1). Similarly, in the wet season, the highest number of individuals species (14) was recorded for *Dictyosolen fragilissimus* at STA. *Nitzschia palea*, *Pediastrum duplex* recorded (3) individuals each at STB and STA respectively, while *Microcystis aureginosa*, *Durvillia antarctica*, *Nitzschia closterium*, *Spirogyra* sp., *Eutetramorus furtii*, *Pediastrum duplex* all recorded (2) individual species each across the sample stations (Table 1).

In terms of species abundance, the wet season of the year 1999 was observed to have the highest abundance of species (1,852 cells/ml) across the sample stations (Table 2). STA had the highest abundance (684 cells/ml) which was immediately followed by STB and STC with 596 cells/ml and 572 cells/ml respectively. Division Bacillariophyta accounted for 1,210 cells/ml across the sample stations with STA accounting for (476 cells/ml), the most highest. Second to it was division Cyanophyta accounting for a total of (558 cells/ml) with STB recording the most number of cells/ml (204). In the dry season, Bacillariophyta also accounted for the most number of cells/ml (50) and second to it was division Cyanophyta. Division Pyrrophyta did not contribute to the total number of cells/ml (125) observed in the dry season (Table 2). In 2011, a total of (83 cells/ml) was recorded in the dry season (Table 2). Bacillariophyta accounted for the highest number of cells/ml (63) in the dry season. Second to it was division Chlorophyta which accounted for (12 cells/ml) across the three sample stations. STC and STA recorded the most number of cells/ml (29) and (11) for Bacillariophyta and Chlorophyta respectively. In the wet season, a total of (69 cells/ml) was observed during the study, with Bacillariophyta accounting for the most number of cells/ml (43). Second to it was the division Chlorophyta which accounted for (13 cells/ml). Both divisions (Bacillariophyta and Chlorophyta) recorded the highest abundance at STA (Table 2).



Table 1: Phytoplankton species composition and distribution across sample stations and seasons

season (2011)	Dry season (1999)			Wet season (1999)			Dry season (2011)			Wet		
	Stations			Stations			Stations					
	STA	STB	STC	STA	STB	STC	STA	STB	STC			
<b>Cyanophyta</b>												
<b>STA</b>	<b>STB</b>	<b>STC</b>										
<i>Anabaena</i> sp.	11	0	0	0	0	0	0	0	1	0	0	0
<i>Oscillatoria</i> sp.	0	0	10	0	6	4	0	0	0	0	0	0
<i>Oscillatoria</i>	0	8	10	0	0	0	0	0	0	0	0	0
<i>messentilofera</i>	0	0	0	170	198	180	0	0	0	0	0	0
<i>Trichodesmium</i> sp.	0	0	0	0	0	0	1	0	0	0	0	2
<i>Oscillatoria tenuis</i>	0	0	0	0	0	0	0	0	0	2	0	0
<i>Microcystis</i>	0	0	0	0	0	0	0	0	0	0	1	1
<i>aeruginosa</i>	0	0	0	0	0	0	0	0	0	0	1	0
<i>Aphanocapsa</i>	0	0	0	0	0	0	0	0	0	0	1	0
<i>endoplaitica</i>	0	0	0	0	0	0	0	0	0	0	0	1
<i>Oscillatoria</i>	0	0	0	0	0	0	0	0	0	0	0	2
<i>agardhi</i>												
<i>Aphasiizomenon</i>												
<i>flos-aquae</i>												
<i>Merismopedia</i> sp.												
<i>Durvillia antarctica</i>												
<b>Bacillariophyta</b>												



<i>Pinnularia gibba</i>	0	0	0	0	0	0	2	0	0	0	0	0
<i>Fragillaria</i> sp.	0	0	10	0	0	0	0	0	0	0	0	0
<i>Cymetopleura solea</i>	0	0	0	0	0	0	0	0	2	0	0	0
<i>Gyrosigma</i> sp.	0	0	0	4	0	0	0	0	0	0	0	0
<i>Bulldalphia regia</i>	21	0	19	0	0	0	0	0	0	0	0	0
<i>Bidulphia aurita</i>	0	0	0	194	128	34	0	0	0	0	0	0
	0	0	0	2	0	0	0	0	0	0	0	0
<i>Chaetoceros</i> sp.	0	0	0	12	12	4	0	0	0	0	0	0
<i>Coscinodiscus</i>	0	0	0	2	0	0	0	0	0	0	0	0
<i>concinus</i>	0	0	0	2	2	0	0	0	0	0	0	0
<i>Dictyocha</i> sp.	0	0	0	2	0	0	0	0	0	0	0	0
<i>Ditylum brightwelli</i>	0	0	0	4	8	4	0	0	0	0	0	0
<i>Phaetoceros</i> sp.	0	0	0	4	12	8	0	0	0	0	0	0
<i>Eucampia zodiacus</i>	0	0	0	2	0	0	0	0	0	0	0	0
<i>Hemidulua</i>	0	0	0	2	0	0	0	0	0	0	0	0
<i>membranceous</i>	0	0	0	14	32	0	0	0	0	0	0	0
<i>Hemidulus indicus</i>	0	0	0	2	0	4	0	0	0	0	0	0
<i>Hemidiscus</i>	0	0	0	8	4	0	0	0	0	0	0	0
<i>hardmanianus</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Navicula</i> sp.	0	0	0	2	2	4	0	0	0	0	0	0
<i>Nitzschia</i> sp.	0	0	0	182	138	298	0	0	0	0	0	0
<i>Bidulpphia senensis</i>	0	0	0	0	2	0	0	0	0	0	0	0
<i>Rhizosolenia</i> sp.	0	0	0	18	6	0	0	0	0	0	0	0
<i>Podolampas</i>	0	0	0	4	2	0	0	0	0	0	0	0
<i>spinifera</i>	0	0	0	12	10	8	0	0	0	0	0	0
<i>Skeletonema</i> sp.	0	0	0	4	0	2	0	0	0	0	0	0
<i>Streptotheca</i>	0	0	0	0	8	2	0	0	0	0	0	2
<i>thanesis</i>	0	0	0	0	0	0	4	0	4	0	0	0
<i>Synedra crystui</i>												
<i>Thalassiothrix</i>												
<i>longissima</i>												
<i>Coscinodiscus</i>												
<i>regia</i>												
<i>Nitzschia serriata</i>												
<i>Nitzschia</i>												
<i>closterium</i>												
<i>Fragillaria</i>												
<i>crotonensis</i>												
<i>Melosira</i>												
<i>ikapoensis</i>												
<i>Synedra</i>												
<i>actinastroides</i>												
<i>Melosira</i> sp. <sub>1</sub>												
<i>Cylindrotheca</i>												
<i>closterium</i>												
<i>Navicula ambigua</i>												
<i>Nitzschia acicularis</i>												
<i>Nitzschia</i>												
<i>sigmoidea</i>												



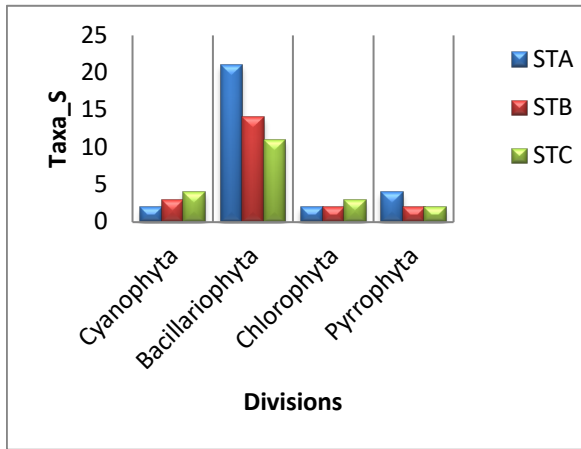
<i>Melosira italica</i>	0	0	0	0	0	0	3	1	0	0	0	0
<i>Melosira</i> sp.3	0	0	0	0	0	0	6	0	6	0	0	0
<i>Fragillaria</i> sp.1	0	0	0	0	0	0	5	0	0	0	0	0
<i>Melosira distans</i>	0	0	0	0	0	0	0	2	0	0	0	1
<i>Nitzschia sigma</i>	0	0	0	0	0	0	0	2	0	0	0	0
<i>Dictyosolen fragilissimus</i>	0	0	0	0	0	0	0	1	14	1	4	0
<i>Meuniera membranacea</i>	0	0	0	0	0	0	0	6	0	0	0	0
<i>Leptocylindrus danicus</i>	0	0	0	0	0	0	0	0	2	0	0	0
<i>Dictyocha fibula</i>	0	0	0	0	0	0	0	0	0	1	0	0
<i>Nitzschia palea</i>	0	0	0	0	0	0	0	0	0	14	6	0
<i>Brachysira vitrea</i>	0	0	0	0	0	0	0	0	0	1	1	0
<i>Cymbella similis</i>	0	0	0	0	0	0	0	0	0	1	0	0
<i>Stephenodiscus cartonensis</i>	0	0	0	0	0	0	0	0	0	0	3	0
<i>Meuniera</i> sp.1	0	0	0	0	0	0	0	0	0	0	0	1
<i>Meuniera</i> sp.2	0	0	0	0	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	0	0	0	0	1
<b>Chlorophyta</b>												
<i>Achnanthes</i> sp.	0	0	10	0	0	0	0	0	0	0	0	0
<i>Coelastrum</i> sp.	11	0	0	0	0	0	0	0	0	0	0	0
<i>Desmodium</i> sp.	0	6	0	0	0	0	0	0	0	0	0	0
<i>Nestagata africana</i>	0	0	9	0	0	0	0	0	0	0	0	0
<i>Pediastrum</i> sp.	0	0	0	10	6	8	0	0	0	0	0	0
<i>Volvox globator</i>	0	0	0	0	0	0	1	0	0	0	0	0
<i>Gonatozygon</i> sp.	0	0	0	0	0	0	1	0	0	0	0	0
<i>Ulothrix subconstricta</i>	0	0	0	0	0	0	5	0	0	0	0	0
<i>Volvox aureus</i>	0	0	0	0	0	0	3	0	0	0	0	0
<i>Volvox</i> sp.	0	0	0	0	0	0	0	0	0	3	0	0
<i>Pediastrum duplex</i>	0	0	0	0	0	0	0	0	0	2	0	0
<i>Spirogyra</i> sp.	0	0	0	0	0	0	0	0	0	2	0	0
<i>Eutetramorus furtii</i>	0	0	0	0	0	0	0	0	0	1	0	0
<i>Staurastrum</i> sp.1	0	0	0	0	0	0	0	0	0	1	0	0
<i>Staurastrum</i> sp.2	0	0	0	0	0	0	0	0	0	1	0	0
<i>Staurastrum</i> sp.3	0	0	0	0	0	0	0	0	0	1	0	0
<i>Closterium lanceolatum</i>	0	0	0	0	0	0	0	0	0	2	0	0
<i>Pediastrum simplex</i>												
<b>Pyrrophyta</b>												



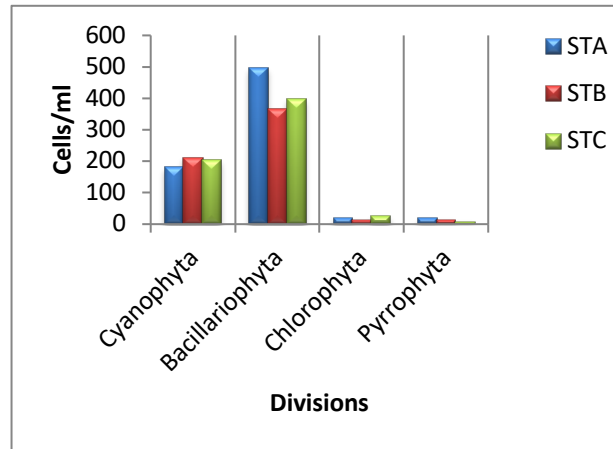
<i>Amphisolenia</i>	8	8	0	0	0	0	0	0	0	0	0	0
<i>bidentata</i>	2	0	4	0	0	0	0	0	0	0	0	0
<i>Enuviella</i> sp.	2	0	0	0	0	0	0	0	0	0	0	0
<i>Gymnodinium</i> sp.	2	0	0	0	0	0	0	0	0	0	0	0
<i>Salpingella</i>	0	0	0	0	0	0	2	0	0	0	0	0
<i>acuminata</i>	0	0	0	0	0	0	0	1	0	0	0	1
<i>Amphidinium</i>	0	0	0	0	0	0	0	0	0	0	0	1
<i>sphenoides</i>												
<i>Ceratulina pelagica</i>												
<i>Micracanthodia</i>												
<i>claytonii</i>												

Table 2: Phytoplankton abundance and distribution by divisions

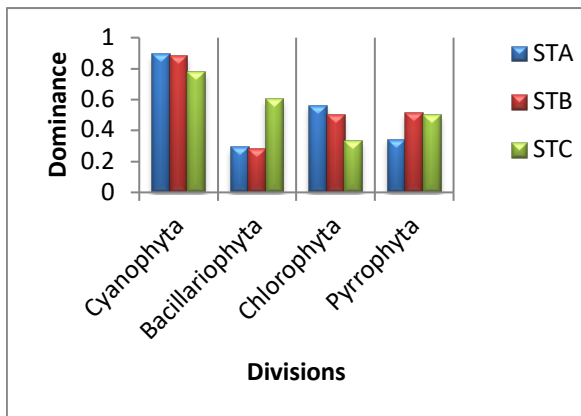
YEARS	SEASONS	STATIONS	DIVISIONS				TOTAL ABUNDANCE
			Cyanophyta	Bacillariophyta	Chlorophyta	Pyrrophyta	(Cells/ml)
<b>1999</b>	Dry season	STA	11	21	11	0	43
		STB	8	0	6	0	14
		STC	20	29	19	0	68
			<b>39</b>	<b>50</b>	<b>36</b>	<b>0</b>	<b>125</b>
<b>1999</b>	Wet season	STA	170	476	10	28	684
		STB	204	366	6	20	596
		STC	184	368	8	12	572
			<b>558</b>	<b>1210</b>	<b>24</b>	<b>60</b>	<b>1852</b>
<b>2011</b>	Dry season	STA	1	20	11	5	37
		STB	1	14	1	1	17
		STC	0	29	0	0	29
			<b>2</b>	<b>63</b>	<b>12</b>	<b>6</b>	<b>83</b>
	Wet season	STA	2	20	13	0	35
		STB	3	15	0	0	18
		STC	6	8	0	2	16
			<b>11</b>	<b>43</b>	<b>13</b>	<b>2</b>	<b>69</b>



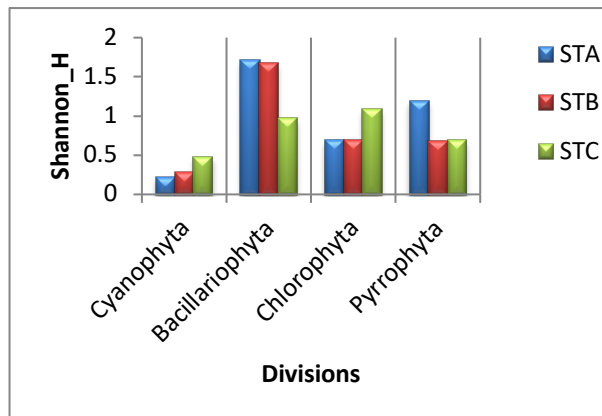
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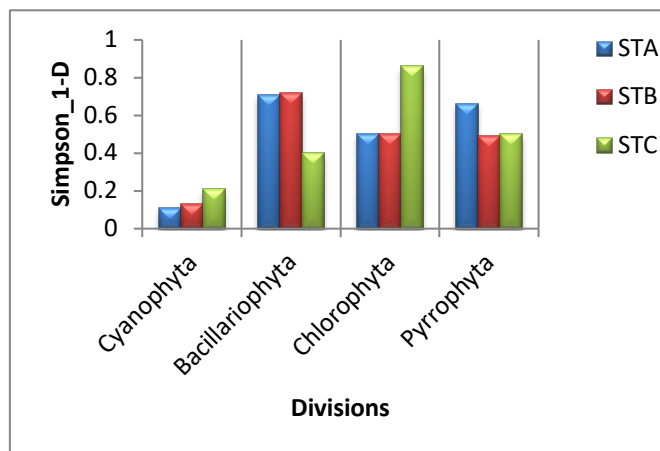
B



C



D



E

Figure 1: Diversity indices of phytoplankton in the year 1999



Diversity indices showed that Bacillariophyta had the highest Taxa\_S (21) and number of cells/ml (497) at STA in the year 1999 (Fig. 1A). While in 2011, STC and STA were observed to have the highest Taxa\_S (14) and number of cells/ml (40) as shown in Fig. 2A. Shannon\_H diversity index and Simpson\_1-D evenness were greatest in 2011 having the highest value of 2.23 and 0.87 at STB (Fig. 2D and E) compared to the values recorded in 1999 (Fig. 1D and E). The lowest dominance (0.13) was recorded at STB in 2011 (Fig. 2C).

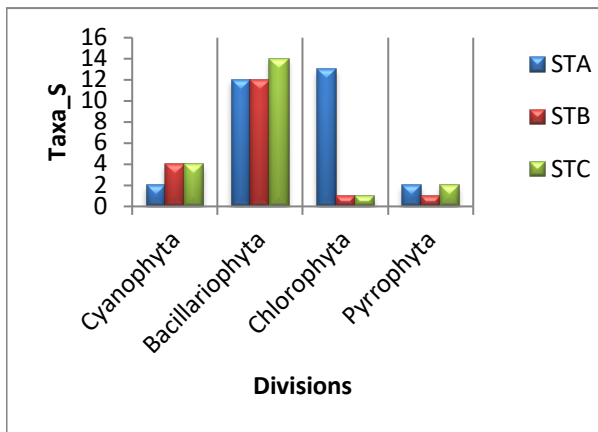
Cyanophyta had the highest Shannon\_H diversity (1.39) and Simpson\_1-D evenness (0.75) at STB in 2011 (Fig. 2D and E) when compared to the values recorded in 1999 (Fig. 1D and E). The highest number of cells/ml (212) and Taxa\_S (4) were recorded at STB in 1999 (Fig. 1B). In 2011, STB and STC were observed to have Taxa\_S (4) similar to 1999 (Fig. 2A). Dominance was highest across the sample stations in 1999 with STA having the highest (Fig. 1C) as compared to the values recorded at STA, STB and STC in 2011 (Fig. 2C).

Chlorophyta showed a Shannon\_H diversity index (0) and Simpson\_1-D evenness (0) at STB and STC in 2011 (Fig. 2D and E). The highest number of cells/ml (27) was recorded at STC in 1999 (Fig. 1B) while Taxa\_S (13) was highest at STA in 2011 (Fig. 2A). The highest dominance (1) was recorded at STB and STC in 2011 (Fig. 2C). Lowest Taxa\_S (1) was recorded at STB while the highest number of cells/ml (20) was recorded at STA in 1999 (Fig. 1A and B).

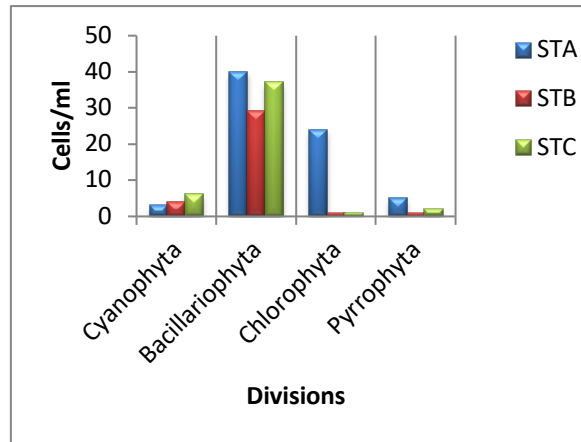
Pyrophyta showed a Taxa\_S of (4) at STA while STB and STC showed Taxa\_S of (2) at each station in the year 1999 (Fig. 1A). Similarly, STA was shown to have recorded the highest number of cells/ml (20) (Fig. 1B). In terms of dominance, STB had the highest (0.51) while STA recorded the least dominance (0.34) (Fig. 1C). Shannon\_H diversity index and Simpson\_1-D evenness were highest (1.19) and (0.66) at STA respectively (Fig. 1D and E). In 2011, STA and STC were observed to have the highest Taxa\_S (2) while STB recorded the least Taxa\_S (1) (Fig. 2A). Similar to the year 1999, STA recorded the highest number of cells/ml (5) as seen in Fig. 2B, while dominance was highest (1) at STB (Fig. 2C). Shannon\_H diversity index and Simpson\_1-D evenness were (0) at STB (Fig. 2D and E) in both cases. But STC was observed to have Shannon\_H diversity index (0.69) and Simpson\_1-D evenness (0.5) (Fig. 2D and E).

## Discussion

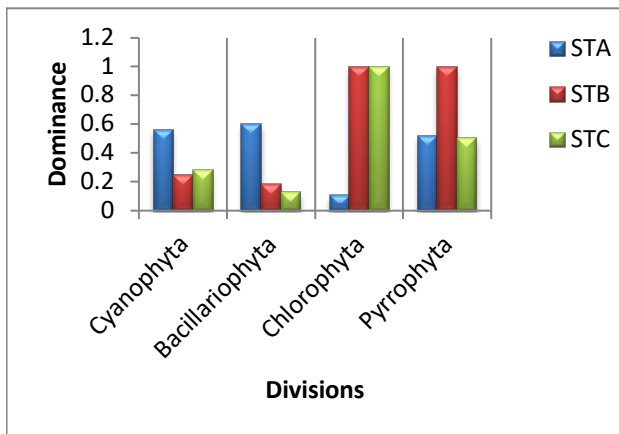
Benthic algal communities are diverse and rich in species composition, hence are regarded as rich in information that are ideal for monitoring and impacted environmental due to their relative short life cycle, enabling them to respond rapidly to environmental changes, and revealing cumulative effects resulting from consecutive environmental happenings over a long period of time (Kaiblinger and Dokulil, 2006). The decline in phytoplankton abundance noted between the years from 1999 to 2011 is remarkable to have occurred in a lotic system within a period of 12 years. This variation in phytoplankton diversity, abundance and species composition may be due to changes in the physical and chemical properties of the water between the years at the various sampling stations. Phytoplankton abundance, diversity and species composition are documented in literatures to have been influenced by the physical and chemical properties of water (Jun *et al.*, 2019; Zakariya *et al.*, 2013; Akanta *et al.*, 2011; Rodriguez *et al.*, 2011; Tanimu *et al.*, 2012).



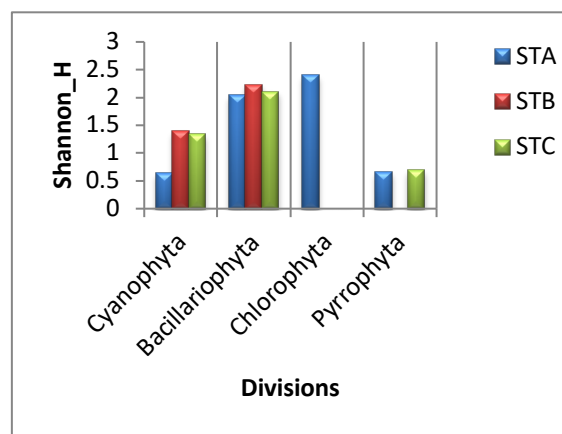
A



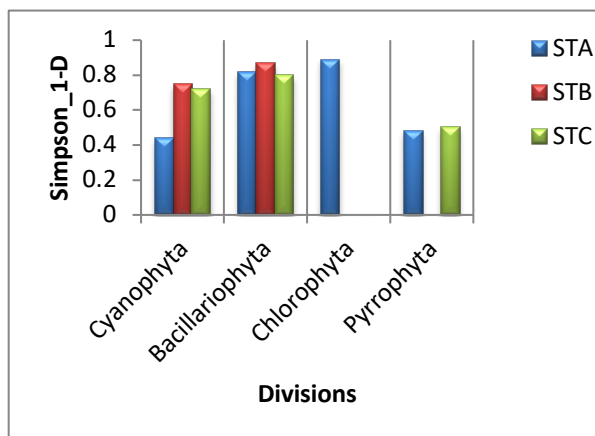
B



C



D



E

Figure 2: Diversity indices of phytoplankton in the year 2011

Division Bacillariophyta have been documented by many authors (Antoine and A-Saadi, 1982; Hadi *et al.*, 1984; Polat and Sarihan, 2000; Fikrat *et al.*, 2008; Zakariya *et al.*, 2013; Gong *et al.*, 2019) as the most dominant division of phytoplankton as observed in this study. In 2011, Chlorophyta was the second division of phytoplankton recorded in terms of number of species after Bacillariophyta. This finding corresponds to the work on ground water in Oklahoma (Pfiesta *et al.*, 1980, Fikrat *et al.*, 2008) and Hongmen reservoir (Gong *et al.*, 2019). Cyanophyta were present by 597 individuals in 1999 making it the second largest division after Bacillariophyta. Cyanophyta was recorded throughout the study period by 610 individuals, most of which were recorded in the wet season. This finding is in line with report of Cronberg *et al.*, (1999) and Fikrat *et al.*, (2008). Pyrophyta did not contribute significantly to the numerical composition of phytoplankton all through the study period. Generally, the number of phytoplankton recorded in 1999 was much greater than those recorded in 2011 with the maximum occurrence being recorded in the wet season of the year 1999 (Table 1). These changes are most likely associated with increased human population as result of urbanization, thereby leading to increased discharge of sewage, domestic waste, agricultural effluents from run-offs and other human activities such as washing near the river, irrigation farming, defecating in the water etc. around the study area. These activities may have likely altered the water physical and chemical properties that in turn did not support phytoplankton species survival leading to a loss in their diversity over time.

In water quality characterization using algal Shannon-Wiener diversity index, an index of  $>3$  = heavy pollution,  $1-3$  = moderate pollution and  $<1$  = clean (Wilm and Dorris, 1966). Based on this classification, it is fair to say that the catchment of the Niger River where this study was carried out is heavily polluted for Cyanophyta in 1999 (Fig. 1) but showed moderate pollution in 2011 (Fig. 2). The river was moderately polluted with Bacillariophyta across all the sample stations in both years except at STC in 1999 that showed heavy pollution (Fig. 1). Chlorophyta and Pyrophyta showed heavy pollution for all the sites except at STC (1999), STA (2011) and STA (1999) which were moderately polluted. Evenness in species distribution was shown by the Simpson index for Bacillariophyta and Cyanophyta in 2011, Chlorophyta and Pyrophyta in 1999 to be high, indicating that, the quality of water at those times was best to have the growth and development of most of the species recorded in these divisions. Tanimu *et al.* (2011) and Zakariya *et al.*, (2013) applied similar classification in their study.

The lower diversity and abundance of phytoplankton in 2011 may be attributed to the relatively high or increase in human activities observed across the sample sites, thus, leading to poor water quality.

## Conclusion

The result of this study showed remarkable changes in the phytoplankton abundance and species composition of the catchment under study over a period of 12 years. The catchment under study is polluted with Cyanophyta in the year 1999 and Pyrophyta in 2011. There was a loss in the species size-class abundance and changes in species composition in 2011 when compared to the data obtained in 1999, hence, the need to regulate human activities around the river and reduce the flow of nutrient into the water body.

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