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Spatio-Temporal variation in Phytoplankton Distribution and Abundance in a Tropical Freshwater Body in Niger Delta, Nigeria.

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Abstract: The spatio-temporal variation in phytoplankton abundance of Mbo River was investigated within a 10 months period beginning from November 2017 to August, 2018. Phytoplankton samples were collected from three stations and analyzed using standard methods. In this study, 3255 phytoplankton (individuals) belonging to four (4) classes, 36 genera and 44 species were encountered. They included Baccillariophyceae (29 species), Chlorophyceae (14), Dinophyceae (9) and Cyanobacteria (2). During the entire study period, the group Bacillariophyceae dominated and contributed about 65.4% to the total phytoplankton number. Chlorophyceae (20.4%) ranked second in terms of density part of the community, Dinophyceae recorded about 11.2% of the total phytoplankton number and Cyanobacteria was the least encountered species (3.0 %) to the total phytoplankton community. Percentage composition of phytoplankton revealed Baccillariophyceae > Chlorophyceae > Dinophyceae > Cynobacteria. The dominant species in the phytoplankton groups were: *Odontalla aurita*, *Cosmarium amoerum*, *Ceratium tripos* and *Microcystic aeruginosa*. All the phytoplankton groups showed significant differences across the sampling stations ($p< 0.05$) except Cyanobacteria. Phytoplankton abundance was higher in dry season while clear decline in abundance was recorded in the rainy season. There were significant differences ($p< 0.05$) in the abundance of phytoplankton groups in the dry and rainy seasons.

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1. Introduction

Plankton are a diverse group of organisms that live in the water column (Ekwe and Sikoki, 2006). They are regarded as the community of plants and animals adapted to suspension in the sea or fresh water, and are liable to passive movement by wind and currents (Reynolds, 1984; Onyeama, 2013). Plankton are conveniently segregated into the terms "phytoplankton and zooplankton" respectively, though there are differences in opinion where the dividing line is drawn (Cander-Lund and Lund, 1995).

Phytoplankton are microscopic plants drifting at the mercy of water currents and occur in different shapes and sizes. The different sizes include picophytoplankton (0.2-2µm), nanophytoplankton (2-20µm), micro-phytoplankton (20 - 200µm), meso-phytoplankton (200µm-2mm), and macro-phytoplankton (>2mm).

Phytoplankton is an important biotic component in an aquatic system and occupies the lowest trophic level (Chindah and Braide, 2001). They convert incident radiant energy of the sun to chemical energy in the presence of nutrients like phosphorus, iron, nitrogen, manganese, molybdenum and zinc and are restricted to the photic zone where there is enough sunlight for photosynthesis (Anene, 2003).

Phytoplankton are important source of food for larger animals. Phytoplankton are the first link in the food chain. They are known as primary producers because they produce the first forms of energy that is transfer in the food chain to other aquatic organisms (Chindah and Braide, 2001; Emmanuel and Onyeama, 2007). Summer is the most suitable season for the growth of phytoplankton in water because of long duration of sunshine. In late summer, the production of phytoplankton reduces because of heavy rainfall. During winter months in periods of low light, phytoplankton growth is inhibited (Williams and Lindley, 1980; Manisha *et al.,* 2013).

Ecologically, phytoplankton produces a lot of oxygen through the process of photosynthesis. Phytoplankton represent the primary oxygen source in low gradient rivers (Davies *et al.,* 2009) and serve as

basis for food chain and support commercial fisheries (Conde *et al.,* 2007).

Plankton respond rapidly to environmental changes and as such changing hydro environmental characteristics are determinants of the phytoplankton changing crop at any time (Onyeama, 2013). Their abundance, distribution and diversity are used as biological indicators of still water quality in rivers. Their density and species composition in tropical rivers demonstrate a particular animal biological characteristic (Ekpo, 2013).

Studies on spatial and seasonal distribution and abundance of phytoplankton has been reported by several authors (Ewa *et al*. (2013); Ekwu and Udo (2014); Abowei et al (2008); Ekpo *et al*. (2015); Dimowo (2013); Ebigwai *et al*. (2014); Zakariya *et al.* (2013); Olaniyan and Akinkuolie (2016); Antai and Joseph (2015).

This paper therefore provides information to complement the existing data in the distribution and abundance of phytoplankton in Mbo River, for effective monitoring to forestall any alteration due to increase human activities.

2. Material and Methods

2.1 Study Area

Mbo River (Fig. 1.0) is one of the major rivers in Akwa Ibom State, Nigeria, traversing across two local government areas; Mbo and Udung Uko Local Government Areas and lies within latitude 4°30° to 5° 30 North and longitude 7°30° to 8° 30 West on the south eastern Nigeria coastline. It is a near coastal river located within the Cross-River Basin and drains into the Cross-River Estuary at Ibaka in the Bight of Bonny, with which it maintains a permanent mouth thus exposing the river system to tidal ebb and flood. It forms part of the Atlantic Drainage system (Anukam, 1997) east of the Niger which comprises the Cross, Imo, Qua Iboe and Kwa Rivers. Mbo River which is within the Niger Delta Zone of Nigeria is located within tropical rain forest region characterized by tropical humid climate with distinct dry (November-March) and wet (April-October) seasons. The dry season is characterized by prevalence of dry tropical continental winds from the Sahara Desert while the wet season is typified by moist tropical wind from the Atlantic Ocean.

The vegetation cover of the drainage basin is invaded by nipa palm (*Nypa fruticans*) which seems to have displaced the mangrove trees (*Rhizophora* spp) (Orok *et. al.,* 2010). Mbo River is important to its adjourning communities since it supports important economic activities in the study area. These activities include: agriculture, fishery, eco-tourism and water supply for domestic use.

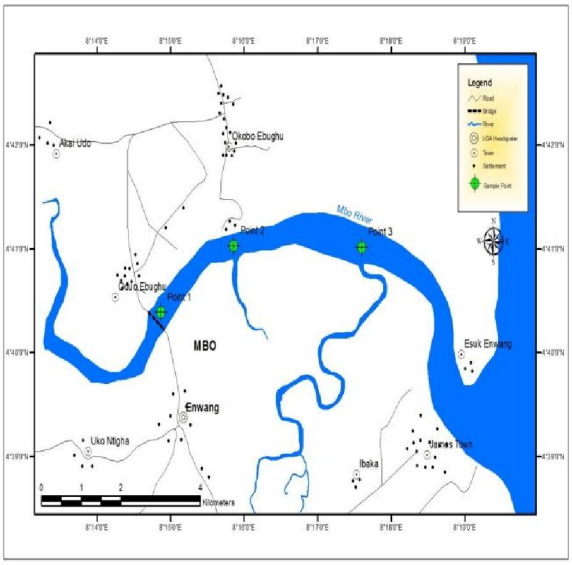

Figure 1: Map of the Study Area showing Sampling Stations.

2.2 Sampling Stations

Three sampling stations within the stretch of the river were identified (Fig. 1). The stations were chosen along the river gradient. Station 1 is located at Esuk Uloh. Station 2 is located between the bridge head and the defunct fishing terminal, at Esuk Egbughu where the virgin forest energy is located which is suspected to be highly contaminated (mid-stream). The average depth of this site is about 4.1m. The fringing vegetation is mainly *Nypa fruiticans* because mangrove species have been either replaced by the nypa palm or felled for construction and fire wood for smoking of fish and for domestic use. This station records intense human activities such as inflow of domestic sewage, intense fishing and faecal discharge which could impact negatively on this location along the river. Other endeavours here include the use of motorized boat for commercial services and a small landing port for medium sized sea faring boats, with lots of mechanical repairs going on here. Station 3 (Esuk Ukontenge Creek) is located upstream of Mbo River. The average depth for this station is about 3.5m. The fringing vegetation is mainly of red mangrove (Rhizophora spp).

2.3 Sample Collection and Sampling

Sampling was carried out fortnightly at the three sites from November 2017 to August 2018 inclusive, during the mid-morning hours (8:00am to 12 noon) on each sampling day. Plankton samples were collected using a plankton net of mesh size 25µm. The plankton net was immersed below the water surface, towed for 5 minutes at each sampling station, until a sufficient quantity of plankton was

collected. For qualitative estimation of plankton, 1 litre of surface water was filtered through the plankton net and preserved with 1 % Lugol's iodine solution to fix the phytoplankton.

2.4 Analysis of Sample

In the laboratory, quantitative sample from the three stations were concentrated to 10ml. 1ml from each sample was taken and all individual taxa present were counted. Specimens were sorted, counted using Zeiss binocular microscope at different magnifications (x40, x100 and x400). Lugol's solution was used for staining the samples to enhance proper discernment of the phytoplankton species based on morphological features, as individual species normally takes up the stain, thereby exposing the organelles for proper identification according to Akpan, (1994). Phytoplankton was identified using relevant literatures (Botes, 2003; John *et. al.* 2003).

2.5 Data Analysis

Statistical package for Social Sciences (SPSS) software was used in statistical analyses while the data were presented as mean and standard error. Analysis of variance (ANOVA) was used to compare abundance among the different species of phytoplankton and seasons. Duncan multiple range test (DMRT) was used to test for level of significant differences among the variables. Data obtained from phytoplankton group were empirically analyzed using the formula:

% Ra = n/N x 100 (Ali *et. al.* 2003).

Where:

%Ra = relative abundance

N = number of individuals

N = total number of all individuals.

Tables, and pie charts were used where necessary to present result.

3. Results

3.1 Spatial Distribution and Abundance of phytoplankton Across the Stations in Mbo River

Spatial distribution of phytoplankton in the study area is outlined in Table 1. The study recorded a total of 3255 phytoplankton (individuals) representing four (4) taxonomic groups, 36 genera and 44 species. They included Bacillariophyceae (29 species), Chlorophyceae (14), Dinophyceae (9) and Cyanobacteria (2). During the entire study period, the group Bacillariophyceae dominated and contributed about 65.4% to the total phytoplankton number. Chlorophyceae ranked second in terms of percentage share to the phytoplankton density and contributed about 20.4% part of the community. The group Dinophyceae share about 11.2% of the total phytoplankton number. The group Cyanobacteria shared least population of 3.0 % to the total phytoplankton standing crop (Figure 2). The dominant species in the phytoplankton groups were: *Odontalla aurita* (Baccillariophyceae) *Cosmarium amoerum* (Chlorophyceae), *Ceratium tripos* (Dinophyceae) and *Microcystic aeruginosa* (Cynobacteria). Percentage composition of phytoplankton revealed Baccillariophyceae > Chlorophyceae > Dinophyceae > Cynobacteria. All the phytoplankton groups showed significant differences across the sampling stations ($p< 0.05$) except Cyanobacteria (Table 2).

Table 1 Spatial Distribution of Phytoplankton in Mbo River

Taxa	Station 1	Station 2	Station 3	Total	% Freq.
CHLOROPHYCEAE					
Cosmarium amoerum	41	11	23	**75**	2.3
Cosmarium lachyderma	23	6	13	**42**	1.3
C. moniliforme	31	8	23	**62**	1.9
Desmidum swarici	20	2	9	**31**	0.9
Hyalothera mucosa	11	3	12	**26**	0.8
Spondylosium planum	27	5	18	**50**	1.5
Scenedesmus acuminatus	29	6	21	**56**	1.7
S. quadricauda	36	8	26	**70**	2.1
Staurastrum leptoclauda	5	1	3	**9**	0.3
Ankistrodemus fedcathas spp	36	4	21	**61**	1.9
Arthrodesmus incus	34	6	26	**66**	2.0
Clostridium hunulla	21	3	10	**34**	1.0
Selenxastrum bilraiarium spp	11	4	8	**23**	0.7
Spondylosium moruloforme	22	8	31	**61**	1.9
Sub-Total	**347**	**75**	**244**	**666**	20.4
BACCILLARIOPHYCEAE					
Chaetoceros decipiens	71	15	65	**151**	4.6
Cosscinodiscus centralis	15	6	15	**36**	1.1
Cosscinodiscus concinnus	20	6	13	**39**	1.2
C. eccentricus	82	22	68	**172**	5.3
C. jonesianus	14	3	16	**33**	1.0
C. marginalis	17	1	13	**31**	0.9
Odontella aurita	91	22	82	**195**	6.0
Odontella regia	87	19	77	**183**	5.6
O. sinensis	12	4	10	**26**	0.8
Eucampia ozodiacus	79	25	69	**173**	5.3
Melosira moniliforms	19	0	10	**29**	0.8
Odontella nummuloides	10	3	10	**23**	0.7
Gyrosigima distorium	23	5	12	**40**	1.2
Pleurosigna angulatum	72	18	75	**165**	5.1
P. elongatum	24	6	33	**63**	1.9
Cyclotella costatus	63	16	71	**150**	4.6
C. littoralis	25	2	7	**34**	1.0
C. stelligera	13	9	13	**35**	1.1
C. decipiens	56	15	59	**130**	3.9
Amphora ovalis	33	3	11	**47**	1.4
Biddulphia aurita	9	4	5	**18**	0.6
Baciliaria paradoxa	26	16	30	**72**	2.2
Fragillara crotonensis	17	4	12	**33**	1.0
Diatoma ancaps	19	8	16	**43**	1.3
Nitzschia closterium	33	4	16	**53**	1.6
Thalossiothrix nitzshiodes	18	2	10	**30**	0.9
Synedra utormohlil	13	7	12	**32**	1.0
Rhizosoleria spp	15	7	17	**39**	1.2
Asterionella spp	26	8	21	**55**	1.7
Sub-Total	**1002**	**260**	**868**	**2130**	65.4
DINOPHYCEAE					
Ceratium tripos	38	10	29	**77**	2.4

C. furca	20	6	13	**39**	1.8
C. trichoceros	30	9	13	**52**	1.7
Gonucular spp	26	9	16	**51**	1.6
Dinophysis spp	13	6	14	**33**	1.0
Peridinum excentricum	9	2	10	**21**	0.6
Ceratium fusus	15	6	7	**28**	0.8
Procentrum SP	20	8	8	**36**	1.1
Gymnodinum gracile	16	2	10	**28**	0.8
Sub-Total	**187**	**58**	**120**	**365**	11.2
CYANOBACTERIA					
Anabaena constricta	10	15	10	**35**	1.1
Microcystic aeroginosa	20	15	25	**60**	1.5
Sub-Total	**30**	**30**	**35**	**95**	3.0
Grand Total	1566	423	1267	**3255**	100
%composition	48.0	13.0	39.0	**100**	

Table 2 Frequency Distribution and Significant Difference of Phytoplankton Across Stations

Taxa	Station 1	Station 2	Station 3	Total	% Freq.	F	P	Decision Rule
CHLOROPHYCEAE	347	75	244	666	20.4	6.521	0.005**	p <0.05, ** significant
BACCILLARIOPHYCEAE	1002	260	868	2129	65.4	5.855	0.008**	p <0.05, ** significant
DINOPHYCEAE	187	58	120	365	11.2	6.557	0.005**	p <0.05 **significant
CYANOBACTERIA	30	30	35	95	3.0	0.048	0.954*	p > 0.05 * not significant
Grand Total	1566	423	1267	3255		6.225	0.006**	p <0.05, ** significant
%composition	48.1	12.9	39.0	100				

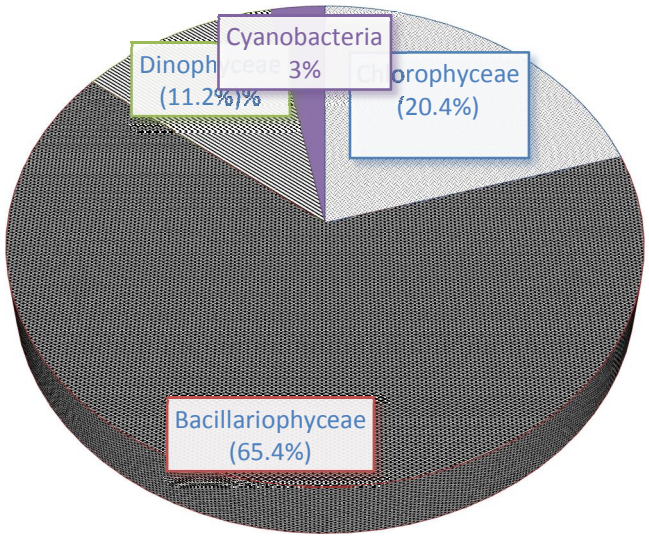

Figure 2: Percentage group Composition of Phytoplankton of Mbo River, Nigeria

Table 3: Seasonal Variation of Phytoplankton in Mbo River, Nigeria

		Dry season								Rainy season								
		NOV, 2017	DEC	JAN. 2018	FEB	MAR	Total	%Freq	APR	MAY	JUN	JUL	AUG	Total	% Freq	t	p	Level of significance
	CHLOROPHYCEAE	84	91	113	131	111	530	16.3	40	18	19	39	20	136	4.2	4.756	0.000	p <0.05, ** significant
	BACCILLARIOPHYCEAE	339	349	385	335	310	1718	52.8	104	63	83	80	79	409	12.6	5.861	0.000	p <0.05, ** significant
	DINOPHYCEAE	80	39	52	44	42	257	7.9	18	28	16	21	25	108	3.3	3.382	0.008	p < 0.05 **significant
	CYANOBACTERIA	15	20	10	20	5	70	2.2	5	5	5	5	5	25	0.7	2.156	0.006	p < 0.05 **significant
	GT	518	499	560	530	468	2575	79.2	167	114	123	145	129	678	20.8	5.705	0.000	p < 0.05 **significant
	% Composition	2575	= 79.2 %							678	=20.8%							
				D + R	=	3255												

Table 4: Monthly Distribution, Species Composition and Percentage Frequencies of Phytoplankton in Mbo River

	Dry Season						Rainy Season							
	NOV, 2017	DEC	JAN, 2018	FEB	MAR	TOTAL	APR	MAY	JUN	JUL	AUG	TOTAL	GT	GT % Freq
CHLOROPHYCEAE														
Cosmarium amoerum	17	8	19	10	10	64	0	5	0	5	1	11	**75**	2.3
Cosmarium lachyderma	12	7	0	15	0	34	3	0	0	2	3	8	**42**	1.3
C. moniliforme	0	14	12	15	12	53	3	0	5	0	1	9	**62**	1.9
Desmidum swarici	0	9	3	0	7	19	8	0	3	0	1	12	**31**	0.9
Hyalothera mucosa	4	5	0	0	3	12	3	4	0	7	0	14	**26**	0.8
Spondylosium planum	16	17	2	0	11	46	0	2	0	2	0	4	**50**	1.5
Scenedesmus acuminatus	2	0	18	16	17	53	0	0	0	3	0	3	**56**	1.7
S. quadrlcauda	7	3	3	26	21	60	2	0	1	0	7	10	**70**	2.1
Staurastrum leptoclauda	0	0	0	0	0	0	2	1	0	6	0	9	**9**	0.3
Ankistrodemus fedcathas	4	10	16	17	10	57	2	0	2	0	0	4	**61**	1.9
Arthrodesmus incus	6	0	14	17	15	52	5	6	1	0	2	14	**66**	2.0
Clostridium hunulla	16	3	0	0	5	24	4	0	1	0	5	10	**34**	1.0
Selenxastrum bilraiarium spp	0	0	14	0	0	14	5	0	1	3	0	9	**23**	0.7
Spondylosium moruloforms	0	15	12	15	0	42	3	0	5	11	0	19	**61**	1.9
Sub-Total	**84**	**91**	**113**	**131**	**111**		**40**	**18**	**19**	**39**	**20**		**666**	20.4
BACCILLARIOPHYCEAE														
Chaetoceros decipiens	36	25	34	17	28	140	3	6	0	0	2	11	151	4.6
Cosscinodiscus centralis	2	0	5	3	11	21	0	1	3	6	5	15	36	1.1
Cosscinodiscus concinnus	9	10	5	0	0	24	5	4	4	1	1	15	39	1.2
C. eccentricus	29	35	21	43	29	157	2	3	1	6	3	15	172	5.3
C. jonesianus	0	2	4	9	5	20	2	3	3	2	3	13	33	1.0
C. marginalis	0	8	5	5	2	20	4	2	2	1	2	11	31	0.9
Odontella aurita	38	43	34	28	41	184	3	0	5	1	2	11	195	6.0
Odontella regia	33	42	36	28	24	163	1	0	2	4	2	9	183	5.6
O. sinensis	0	1	12	5	0	18	2	0	3	0	3	8	26	0.8
Eucampia Ozodiacus	43	41	30	24	26	164	5	3	1	0	0	9	173	5.3
Melosira moniliformes	0	3	2	1	1	7	9	0	5	4	4	22	29	0.8
Odontella nummuloides	0	0	7	0	3	10	0	2	6	0	5	13	23	0.7
Gyrosigina distorium	0	8	0	7	7	22	6	0	4	3	5	18	40	1.2
Pleurosigna angulatum	30	27	21	24	42	144	0	1	7	5	8	21	165	5.1
P. elongatum	15	17	8	0	0	40	6	3	0	4	0	13	63	1.9
Cyclotella costatus	28	26	32	30	27	143	0	7	0	0	0	7	150	4.6
C. littoralis	0	0	5	8	7	20	4	0	6	0	4	14	34	1.0
C. stelligera	1	0	18	0	5	24	5	0	2	4	0	11	35	1.1
C. decipiens	22	26	29	26	21	124	0	0	3	3	3	9	130	3.9
Amphora ovalis	4	3	12	6	1	26	6	4	2	4	5	21	47	1.4
Biddulphia aurita	0	0	3	3	0	6	4	0	3	1	3	11	18	0.6
Baciliaria paradoxa	9	11	4	24	7	55	3	6	4	4	0	17	72	2.2
Fragillara crotonensis	3	0	11	0	8	22	2	0	3	4	2	11	33	1.0
Diatoma ancaps	8	0	3	8	0	19	8	0	3	7	6	24	43	1.3
Nitzschia closterium	16	1	5	6	8	36	5	4	0	2	6	17	53	1.6
Thalossiothrix nitzshiodes	7	1	1	5	0	14	4	5	1	6	0	16	30	0.9
Synedra utormohlil	0	10	3	0	0	13	4	5	4	3	3	19	32	1.0
Rhozosoleria spp	3	1	9	6	7	26	7	0	1	3	2	13	39	1.2
Asterionella spp	5	7	16	9	0	37	4	4	5	2	3	18	55	1.7
Sub-Total	339	349	385	335	310		104	63	83	80	79		2129	65.4
DIANOPHYCEAE														
Ceratium tripos	21	16	12	11	8	68	18	2	2	3	1	26	77	2.4
C. furca	16	0	10	6	0	32	1	0	2	1	3	7	59	1.8
C. trichoceros	16	1	13	4	5	39	1	3	1	7	2	14	52	1.7
Gonucular spp	7	8	3	8	10	36	0	9	3	1	1	14	51	1.6
Dinophysis spp	1	3	3	5	3	15	6	4	0	5	3	18	33	1.0
Peridinum excentricum	3	1	2	1	0	7	1	3	3	3	4	14	21	0.6
Ceratiuna fusus	0	4	3	5	9	21	2	0	0	1	4	7	28	0.8
Procentrum spp	9	4	3	4	0	20	3	3	4	0	6	16	36	1.1
Gymnodinum gracile	7	2	3	0	7	19	3	4	1	0	1	9	28	0.8
Sub-Total	**80**	**39**	**52**	**44**	**42**		**18**	**28**	**16**	**21**	**25**		**365**	11.2
CYANOBACTERIA														
Anabaena constricta	5	15	0	15	0	35	0	0	0	0	0	0	35	1.1
Microcystic aeroginosa	10	5	10	5	5	35	5	5	5	5	5	25	50	1.5
Sub-Total	**15**	**20**	**10**	**20**	**5**		**5**	**5**	**5**	**5**	**5**		**95**	3.0
Grand Total	**518**	**499**	**560**	**530**	**468**		**167**	**114**	**123**	**145**	**129**		**3255**	100

4.0 Discussion

During the entire study period, the group Bacillariophyceae contributed about 65.4%, Chlorophyceae 20.4%, Dinophyceae 11.2% and Cyanobacteria shared least population of 3.0 % to the total phytoplankton standing crop. Bacilliariophyceae played a unique and dominant role in the phytoplankton community contributing the highest density of about 65.4% in all stations. This study supports Taofikat (2012) report in the analysis of phytoplankton of a Tidal Creek, Lagos, Nigeria which recorded Bacillariophyta (78%) > Chlorophyta (11%) >Cyanophyta (10%) but contradicts the phytoplankton group Chlorophyceae (47%) > Bacillariophyceae (46%) > Cyanophyceae (7%)> Dianophyceae (<1%) to the total phytoplankton standing crop recorded by Anupama (2016) in Western Ramganga River Almora Uttarakhand, India.

The order of dominance of phytoplankton recorded in this study showed Baccillariophyceae > Chlorophyceae > Dinophyceae > Cynobacteria. Basically, Diatom (class- Bacillariophyceae), Chlorophyceae, Dinoflagellates (class- Dinophyceae) and blue-green algae (class- Cyanobacteria) are the principal phytoplankton taxa in Mbo River. This is different from the report of Dimowo (2013) who recorded the dominance of Cyanobacteria in Ogun River and also differ from the report of Ahmed *et al.* (2003) where Chlorophyceae was found to be dominating (95.0%) in all sampling stations in river Meghna, Bangladesh. However, the dominance of Baccillariophyceae in this study is similar with that of Essien-Ibok and Umoh, (2013) who found dominancy of Bacillariophyceae in the same river and George and Opeh (2016) who reported the dominance of bacillariophyceae during their studies in Calabar River. Palleyi, *et. al*. (2011) during their studies in Dhamra River Estuary of Odisha Coast, Bay of Bengal, India reported abundance of Bacillariophyceae representing majority of population (75 – 94%) at all the sampling stations, followed by Dinophyceae (3-14%), Cyanophyceae (3-8%) and Chlorophyceae (0-4%). The result of this study is similar to this report in the aspect of the identified groups with the highest contribution from Bacillariophyceae but differ in the order of group dominance.

Nassar, *et. al.* (2014) recorded a total of 145 species in north western part of the Red Sea, Egypt with clear dominance of Bacillariophyceae, which formed about 76.4% of the total phytoplankton counts. Also, Wokoma and Upadhi (2016) worked on phytoplankton species composition and abundance in Mini-Ndai Creek, Niger Delta, Nigeria and reported that Bacillariophyta (Diatoms) consisting about 97% dominated the phytoplankton community followed by Cyanobacteria (2.36%) and Chlorophyta (0.45%). This report is similar to the result of this study though slightly different in order of dominance of the phytoplankton groups. The low density of cyanobacteria observed in this study could be linked to low phosphate and nitrogen while the dominance of Bacillariophyta in terms of abundance indicates pollution. *Synedra spp* found in the study indicates high nutrient indicator while Dinoflagellates (*Dianophysis spp*) is an indication of organic pollution in the area. Also, the presence and abundance of *Coscinodiscus spp* revealed that the study area is a coastal environment.

The 44 species of phytoplankton recorded in this study is low when compared to Nassar, *et. al.* (2014) who recorded a total of 145 species; 117 species were recorded by Vajravelu, *et al.* (2018) and 71 species of phytoplankton recorded by Ramesh *et. al.* (2018) in Nachiketa Tal, Garhwal Himalaya. It is however higher than 41 and 39 species in Ogun River, Ogun State, reported by Dimowo (2013) and in Great Kwa River, Calabar, reported by Ebigwai *et al*. (2014) both in Nigeria respectively.

The 36 genera recorded in this study is higher than 31 genera recorded by Anupama (2016) in Western Ramganga River Almora Uttarakhand, India but lower that 45 genera recorded by Nassar, *et. al.* (2014) in north western part of the Red Sea, Egypt and quite lower than 57 genera recorded by Ramesh, *et. al* (2018) in Nachiketa Tal, Garhwal Himalaya.

Peaks in phytoplankton abundance occurred in January, following the long rains in June and July and the short rains in November–December. Phytoplankton furnished the aquatic food chain with the energy supply thus plays a vital role in the trophic pyramid. Quantity of phytoplankton increase chronologically from the upper to lower stretches of the river from January (dry season) to July (rainy season). During the investigation, the load of phytoplankton was recorded maximally in the dry season months.

5.0 Conclusion

The abundance of phytoplankton community influences the floral biodiversity of Mbo River. A change in the environmental factors leads to change in the tolerance, abundance, diversity and dominance of planktons. However, it was observed that Bacillariophyceae dominated and contributed about 65.4% to the total phytoplankton number. Chlorophyceae ranked second in terms of percentage share to the phytoplankton density and contributed about 20.4% part of the community. The group Dinophyceae share about 11.2% of the total phytoplankton number. The group Cyanobacteria shared least population of 3.0 % to the total

phytoplankton standing crop. All the phytoplankton groups showed significant differences across the sampling stations ($p< 0.05$) except Cyanobacteria. Phytoplankton abundance was higher in dry season while clear decline in abundance was recorded in the rainy season. There were significant differences ($p< 0.05$) in the abundance of phytoplankton groups in the dry and rainy seasons. The low abundance of phytoplankton taxa in station 2 is attributed to stress due to anthropogenic activities, thereby resulting in the low abundance has observed during the study. The low density of cyanobacteria observed in this study could be linked to low phosphate and nitrogen while the dominance of Bacillariophyta in terms of abundance indicates pollution. Synedra spp found in the study indicates high nutrient indicator while Dinoflagellates (*Dianophysis spp*) is an indication of organic pollution in the area. Also, the presence and abundance of *Coscinodiscus* spp revealed that the study area is a coastal environment.

6.0 References

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