Cyanobacteria of a Tropical Lagoon, Nigeria.

Adesalu, Taofikat Abosede [1], Nwankwo, Dike Ikegwu.[2]

[1]Department of Botany and Microbiology, University of Lagos, Nigeria.
[2]Department of Marine sciences, University of Lagos, Nigeria.
boseadesalu@yahoo.com.

Abstract: Investigations for the first time into the blue green algae of Lekki lagoon were carried out for 24 months (June 2003- May 2005) at monthly intervals using standard plankton net of mesh size 55µm. One hundred and seventy nine species belonging to thirty genera were observed. The filamentous blue green algae *Oscillatoria* formed the most abundant genus making up twenty three species followed by *Phormidium* eighteen species. *Anabaena* and *Chroococcus* recorded thirteen species each while the genera, *Gleocapsa, Merismopedia* and *Microcystis* recorded ten, eight and twelve species respectively. Only one genus each of *Cyanosarcina, Calothrix* and *Scytonema* were encountered. Bloom forming species identified were *Microcystis aeruginosa, M. flos-aquae, M. wesenbergii* and *Anabaena flos-aquae.* In this study, thirty-nine new species were recorded for Lagos lagoon complex in which Lekki lagoon is one of it while *Cyanosarcina hueberliorum* is new record for Nigeria. [Nature and Science 2010;8(7):77-82]. (ISSN: 1545-0740).

Key words: Cyanophytes, tropical, bloom, Lagos lagoon complex

Introduction

The coastline of South Western Nigeria is a meandering network of lagoons and creeks of which Lagos lagoon with an area of 208sqkm is the largest (Nwankwo 1989).The geography and hydrology of various parts of Lagos lagoon complex in which Lekki lagoon is one it have been described by several workers. These include Lekki lagoon (Ikusemiju 1973); Lagos lagoon (Hill and Webb 1958) and harbour (Olaniyan 1957). Checklists of planktonic algae in some parts of Nigeria have been documented by different workers. For instance in the North, Holden and Green (1960) studied the phytoplankton of River Sokoto while Khan and Agugo (1990) studied Kongiri dam, Jos mine lakes was studied by Anadu et al. (1990).

In Southern region, studies include Opute (1990,1991,1992) who studied Warri Forcados estuary phytoplankton, New Calabar river by Nwadiaro and Ezefili (1986). Biswas (1984, 1992) had report for eastern region while western region reports include that of Imevbore (1968) on Eleiyele reservoir, Egborge and Sagey (1979) on Ibadan freshwater ecosystem. Nwankwo (1988) studied the planktonic algae of Lagos lagoon, Nwankwo (1993) reported eight cyanobacteria bloom species of coastal waters in South Western Nigeria excluding Lekki lagoon, Nwankwo (1997) reported dinoflagellates list of Lagos lagoon. Adesalu and Nwankwo (2005, 2009) reported the diatoms of Olero creek and Lekki lagoon respectively, Wujek et al. (2003) studied the chrysophytes of Lekki lagoon while Kadiri (1989, 1993, 1999, 2000) reported the rich flora of *Micrasterias*, desmids, algae composition and euglenoids of Ikpoba reservoir respectively.

Of the entire aforementioned checklist, none specifically reported the cyanobacteria checklist in Nigeria coastal waters. The present study was undertaken to investigate the composition of cyanobacteria species of Lekki lagoon for possible biological monitoring since the lagoon is a source of fish supply for people of South Western states and beyond.

Description of study area

Lekki lagoon (Fig.1) a large expanse of shallow freshwater extends between Lagos and Ogun states. It covers an area of about 247km^2. A greater part of the lagoon is shallow (<3.0 m), while some areas are up to 6.4m deep. It lies between longitudes $4^0 00'$ E and $4^0 12'$ E and latitude $6^0 25'$ N and $6^0 37'$ N. The lagoon is fed by river Oni in the north eastern part, while rivers Osun and Saga flow into the north western part. Two peaks of rainfall are associated with this lagoon, a major peak in July and a lesser peak in September. There are two peaks of sunshine hours which approximately correspond to the equinoxes. The mainstay of communities that live around this environment is artisanal fishing.

Materials and methods

Collection of sample

Biological samples were collected monthly from twelve stations (Table 1) using Hydrobios plankton net of 55µm mesh size. For quantitative analysis 5litres of the water was concentrated. Biological samples were preserved in 4% unbuffered formalin. Identification was done using Olympus BX51 photomicroscope. Water samples were collected into clean plastic containers for chemical analysis while *in situ* measurements of temperature, transparency, pH and depth were made.

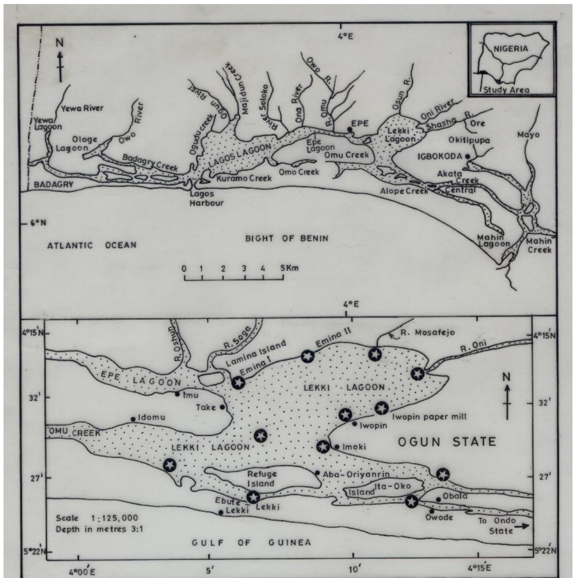

Fig.1 : Lekki Lagoon showing sampling stations

Table 1 : Average Depth (M) And Geographical Position Of Sampling Stations

STATIONS	Average depth	Longitudes	Latitudes
Emina 1	2.77	$4^0$5.080E	$6^0$32.754N
Emina II	1.61	$4^0$7.511E	$6^0$34.07N
Entrance of River Mosafejo	1.51	$4^0$10.239E	$6^0$35.344N
Entrance of River Oni	1.80	$4^0$12.153E	$6^0$35.090N
Iwopin 1	1.80	$4^0$13.153E	$6^0$32.309N
Iwopin 11	2.69	$4^0$9.651E	$6^0$32.137N
Imoki	2.17	$4^0$10.048E	$6^0$31.253N
Ise 1	1.81	$4^0$13.413E	$6^0$26.833N
Ise 11	2.41	$4^0$9.788E	$6^0$26.181N
Ebute lekki	1.29	$4^0$5.353E	$6^0$26.685N
Entrance of Omu creek	1.88	$4^0$7.604E	$6^0$28.867N
Lagoon centre	2.23	$4^0$3.348E	$6^0$28.577N

Physical and chemical analysis of water sample

The methods described by America Public Health Association (APHA 1998) were used for physical and chemical analysis. The air and surface water temperature were measured in situ with a simple mercury thermometer while the transparency was measured using a 20cm diameter Secchi disc. The depth was measured with a calibrated pole and the water pH determined using a Phillips pH meter (Model PW950). The chemical factors determined include Salinity, conductivity, dissolved oxygen (DO) and biological oxygen demand (BOD_5). Salinity was determined using the Silver Nitrate Chromate titration method as described by BARNES (1980) while Dissolved oxygen content was determined using a Griffin oxygen meter. Oxygen saturation was recorded in percentage. Biological Oxygen Demand is the measure of the amount of dissolved oxygen that could be depleted from the water body during natural biological assimilation or degradation of organic compounds by the organisms present especially bacteria. This was done after the dissolved oxygen had been measured using the standard method of biochemical consumption of oxygen in 5 days at 20^0C while conductivity was determined using the HANNA instrument (H18733), a wide range conductivity meter that has salinometer range in µS. Conductivity values were recorded as $mScm^{-1}$ at 25^oC (APHA 1998). The department The Federal Meteorological Department, Oshodi, Lagos kindly provided rainfall and sunshine hours data for the period of investigation (Table 2)

Nutrient determination

For nitrate determination, Hach Cadmium reduction method was used (APHA 1998). Phosphate-phosphorus is known to be important in a number of ways, one being that it facilitates the uptake of nitrogen. It was determined by ascorbic acid method. The values obtained were recorded in milligrams per litre (mgl^{-1}) (APHA 1998) (Table 2)

Results

Water chemistry

The physical and chemical characteristics of the study area are presented in Table 2.The mean pH of the water with a range of 7.41-7.46 indicated that the system is highly buffered. Conductivity which is the numerical expression of the ability of a solution to carry an electric current represents the total ions of water ranged between 0.47-0.56 μScm^{-1} the lowest value for phosphate-phosphorus, nitrate-nitrogen and sulphate were 2.42, 2.70 and 0.002 mgL^{-1}. Salinity recorded the least value of 0.40‰ while chloride ion had the highest value of 10.00 mgL^{-1}.

Table 2: Mean physico-chemical values for Lekki lagoon (concentrations in mg L^{-1})

STATIONS	A	B	C	D	E	F	G	H	I	J	K	L
Surface Water tempemperature (^{0}C)	30.54	30.73	30.55	30.61	30.40	30.31	30.35	30.23	30.38	30.63	30.70	30.55
Air tempemperature (^{0}C)	29.68	29.60	29.60	29.71	29.51	29.44	29.55	29.08	29.29	28.90	29.27	29.21
Transparency (cm)	5.74	7.38	11.33	9.25	11.67	10.29	11.08	10.42	14.42	7.30	10.04	12.33
Total suspended solids	9.07	8.56	9.16	8.45	9.28	9.78	11.76	12.71	8.39	11.50	8.87	8.87
pH	7.42	7.43	7.41	7.43	7.44	7.46	7.44	7.46	7.44	7.42	7.37	7.38
Salinity ‰	0.47	0.47	0.45	0.45	0.40	0.55	0.47	0.44	0.45	0.44	0.50	0.47
Phosphate-phosphorus	2.53	2.70	2.42	2.50	2.56	2.61	2.47	2.49	2.96	2.53	2.54	2.44
Nitrate-nitrogen	2.73	2.93	3.42	2.98	2.54	3.85	3.44	3.25	2.75	3.31	2.70	3.97
Chloride	9.23	9.67	9.59	10.00	9.88	9.52	9.40	9.17	9.31	9.31	9.54	9.99
Conductivity (μScm^{-1})	0.56	0.52	0.56	0.47	0.47	0.48	0.49	0.52	0.46	0.53	0.62	0.56
Dissolved Oxygen	4.15	3.46	4.21	4.10	4.16	4.25	4.25	4.19	4.17	4.16	4.18	4.17
Biological Oxygen demand	0.23	0.22	0.26	0.23	0.22	0.25	0.29	0.30	0.31	0.28	0.26	0.24
Chemical oxygen demand	0.36	0.30	0.26	0.25	0.24	0.29	0.34	0.32	0.30	0.31	0.31	0.25
Oil and grease	0.03	0.02	0.02	0.02	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Turbidity (FTU)	8.59	9.25	10.00	7.46	9.57	8.87	8.37	7.99	8.42	10.29	9.15	8.69
Total dissolved solids	9.48	10.29	10.65	8.51	11.29	11.50	9.87	9.95	10.31	10.58	10.81	10.29
Sulphate	0.03	0.02	0.03	0.04	0.03	0.03	0.02	0.02	0.05	0.04	0.06	0.03
Ca	10.46	11.11	11.92	12.07	11.57	10.71	11.04	10.96	10.70	10.21	11.40	11.52
Fe	0.30	0.23	0.24	0.26	0.22	0.25	0.21	0.23	0.25	0.28	0.30	0.55
Pb	0.01	0.08	0.25	0.08	0.08	0.01	0.02	0.01	0.00	0.00	0.04	0.02
Hg	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01
Cu	0.05	0.02	0.02	0.02	0.03	0.06	0.01	0.01	0.01	0.00	0.02	0.04
Ni	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Zn	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01

Cyanobacteria analysis

In this study, cyanobacteria genera are arranged alphabetically within families and the species in alphabetical order within genera (Table 3).

Table 3: Cyanobacteria checklist at Lekki lagoon, Nigeria

Division : Cyanophyta
Class : Cyanophyceae
Order: Chroococcales
Family 1: Chroococcaceae
Chroococcus decorticans
C. dispersus (V.Keiss) Lemm.
C. limnecticus Lemm.
**C. limnecticus var. subsalsus* Lemm.
C. minor
*C. minutus (*Kutz.) Rabenh.
C. palidus Nageli
C. prescottii Dr. & Daily
C. turgidus (Kutz.) Lemm.
C. turicensis (Nag.) Hangirg
C. varius A. Braun
Chroococcus sp 1
Chroococcus sp 11
**Cyanosarcina huebeliorum* Komarek & Anagnostids
Dactylococcopsis raphidiodes Hansg**.**
D. smithii Chodat & Chodat
Dactylococcopsis sp.
Family 2: Merismopediaceae
Agmenellum quadriplicatum
Agmenellum sp.
Aphanocapsa delicatissima West & West
A. elaschista West & West
A. elachista var conferta West & West
**A. nubilum* Nygaard
A.pulverea
A. rivularis
Aphanocapsa sp.
**Aphanothece bullosa var major* Geitler
Aphanothece sp.
Merismopedia angularis Geitler
M. convoluta Breb.

M. elegans A.Br.
M. glauca (Ehr.) Nag.
M. major G.M.Smith
M. marsonii Lemm.
M. punctata Meyen.
M. tennuisima Lemm.
Family 3: Chaemasiphonaceae
Clastidium setigerum
Clastidium sp.
Family 4: Microscystaceae
**Gleocapsa alpicola* (Lyng.) Bornet
**G. arenaria* (Hass.) Rabenh.
G. biformis Novacek
G. compacta Kutz.
G. conglomerata Kutz.
**G. decorticans* (A.Br.) P.Richter
G. delicatissima
G. magma (Breb.) Kutz.
G. quarternata (Breb.) Kutz
Gleocapsa sp.
Gleothece heufleri
Gleothece linearis Nag
Gleothece sp.
Microcystis aeruginosa Kutz.
M. aeruginosa var elongata Rao,C.B
**M. aeruginosa var major* (Wittr.) Smith
M. elongata sp.nov.
**M. firma* (Kutz.) Dr. & Daily
M. flos-aquae (Wittr.) Kirchner
M. paludosus
**M. pulverea* (Wood) Forti
**M. ramosa* Bharadwaja
**M. robusta* (Clack) Nygaard
M. viridis (A. Br.) Lemm.
M wesenbergii Kosinskaja
Order 2: Nostocales
Family: Nostocaceae
Anabaena azollae Strasburger
A. circinalis (Kutz.) Rabh.
**A. confervoides* Reinsch
A. constricta Lauter b.
A. cycadeae J.Reinsch
A. cylindrica Lemmermann
A. fircinalis
A. flos-aquae (Lyng.) Breb.
A. limnectica G.M.Smith
A. spiroides Lemm.
**A. torulosa* (Carm.) Lagerh.
Anabaena sp.1
Anabaena sp 11
Aphanabaena sp
Calothrix sp
Cylindrospermum catenatum Ralfs
Cylindrospermum majus Kutz.
Cylindrospermum sp 1
Nostoc carneum
Nostoc linkia
N. muscorum Agardh
N. peltigerae Letellier
N. sphaericum Vauch.
Nostoc sp.1
Nostoc sp 11
Order 3: Oscillatoriales
Family 1: Oscillatoriaceae
Lyngbya birgei G.M.Smith
L. contorta Lemm.
**L lagerheimia* (Mobius) Gom.
L limnectica Lemmermann
**L. martensiana* Menegh.
L versicolor (Wattman)Gomont
Lyngbya sp
Oscillatoria acuminata Gomont
O. acutissima Kufferath
O. agardii Gomont.
O. angustissima West & West
O. articulata
O. brevis Kutz.
O curviceps Agardh
O. formosa Bory.
**O formosa f. edaghica* Novickova
O. germinata Meneghini
O lacustris
**O. lemmermanni* Wolosz
O. limnectica Lemm.
O. limosa (Roth) Ag.
O. margaritifera Kutzing (Gomont)
O. minima
O. planctonica Wolosz
**O. rubescens* DC ex Gomont
O. sancta (Kutz.)Gom
**O simplissima* Gomont.
O. subrevis Schmidle
O. tenuis Ag.
Oscillatoria sp.
Family 2:Phormidiaceae
Arthrospira fusiformis Fott & Karim
Arthrospira sp.
Microcoleus codii Fremy
M. subtorulosus
M. willeana
Microcoleus sp.1
Microcoleus sp 11
Phormidium angustissimum West & West
**P. caerulescens* Geitler
**P. chlorinum* Komarek
P. cortianum
P. crouanii Gomont
P. foveolarum (Mont.) Gomont

**P. insigne* Skuja	
**P. laetevirens* Skuja	
P. luridum (Kutz.) Gomont	
**P luteum* Kosinskaja	
**P. molle* Palik	
P nigro-viride Gomont	
**P. papyraceum* (Ag.) Gom.	
P. retzii (Ag.) Gomont	
P. tenue (Menegh.)Gom.	
P. tinctorium Kutz.	
Phormidium sp 1	
Phormidium sp 11	
**Plantothrix clavarata* Skuja	
**P. cryptovaginata* Skacelova & Komarek	
**P. isothrix* Komarek	
P. minor	
P. planctonica	
Plantothrix sp1	
Plantothrix sp 11	
Trichodesmium laucustre Klebahn	
Trichodesmium sp.	
Family 3:Pseudanabaenaceae	
**Limnothrix planctonica* Geitler	
Limnothrix sp.	
**Pseudoanabaena curta* Hollerbach	
**P. moniliformis* Komarek & Kling	
**P thermalis* Anagnostidis	
Pseudoanabaena sp	
Spirulina filiformis	
S. princeps W.et G.S.West	
S. major Geitler	
S. meneghiniana Anagnostidis	
S. tennerima	
Spirulina sp 1	
Spirulina sp 11	
**Leptolyngbya hypolimnectica*	
**Leptolyngbya ocridana* Cardo *(Phormidium)*	
L. tenuis	
Leptolyngbya sp.	
**Plantolyngbya brevicellularis* Cronberg &Komarek	
**P. minor* Komarek&Cronberg	
**P. tallingii* Komarek & Kling	
**P. minor*	
Planktolyngbya sp.	
Family:Schizotrichaceae	
Schizothrix pulvinata	
S. friesii (Ag.) Gomont	
Schizothrix sp.	
Scytonema sp.	

Discussion

The cyanobacteria checklist reflects the influence of hydrological conditions of this area. The dominance of *Oscillatoria* throughout the season could be a pointer that the hydrology and salinity of the studied area favours its growth. The particular high diversity of blue-green observed in the lagoon could also be that the water chemistry favours growth of cyanophytes. Five bloom forming cyanophytes identified in this study include *Microcystis aeruginos, M. wesenbergii, , Anabaena flos-aquae, A. spiroides* and *Oscillatoria formosa.* The variation in physical and chemical parameters observed during the study period may be as a result of the influence of weather conditions. For instance, the rainy season occurring between June and October, characterized by low transparency and pH; increased total suspended solids, higher turbidity and increased flood water condition which might have initiated stressful environmental condition and these conform with Dart and Stretton (1980) who stated that variations in water temperature could cause alterations in the pH due to changes in ionization and increased solubility or precipitation of bottom deposits. Nwankwo and Onitiri (1992) also pointed out that it is possible that rainfall triggers off flood situations which usually increases total solids, reduces transparency and consequently light penetration and also dislodges attached algal forms. The phytoplankton community and the physio-chemical parameters exhibited seasonal changes closely related to the pattern of rainfall. The presence or absence of any blue-green species may be due to the changing physical environment other than pollution (Nwankwo 1994).

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Corresponding author:
Adesalu, T. A.Department of Botany and Microbiology
University of Lagos, Akoka, Nigeria
E-mail: boseadesalu@yahoo.com.

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