Available online at http://ajol.info/index.php/ijbcs

Int. J. Biol. Chem. Sci. 9(3): 1181-1193, June 2015

ISSN 1997-342X (Online), ISSN 1991-8631 (Print)

International Journal of Biological and Chemical Sciences

Original Paper http://indexmedicus.afro.who.int

Investigation of phytoplankton distributions in the westernmost part of Barrier-lagoon-complex, Western Nigeria

Ademola Semiu YAKUB *, Joshua ADEDIPE and Juliet Kelechi IGBO

Department of Biological Oceanography, Nigerian Institute for Oceanography and Marine Research, Victoria Island, Lagos, Negeria.

* *Corresponding author; E-mail: demolaniomr@yahoo.com*

ABSTRACT

Distributions of phytoplankton were studied in two contiguous water bodies (Badagry Creek and Ologe Lagoon) within westernmost part of the Barrier-lagoon complex in Nigeria. Phytoplankton samples were collected and analysed using standard methods at five stations in each of the water bodies in September 2011, February and May 2012. Phytoplankton recorded from the two water bodies belonged to Classes Bacillariophyta, Chlorophtya, Cyanophyta and Euglenophyta. Total phytoplankton species of 92 and 94 were recorded in Badagry Creek and Ologe Lagoon respectively indicating relatively high diversity and productivity of the two water bodies. Bacillariophytes dominated the phytoplankton communities in the two water bodies constituting about 88% and 58% in Badagry Creek and Ologe Lagoon respectively. In terms of abundance, Badagry Creek was dominated by species only from the Class Bacillariophyta whereas each of the Classes Bacillariophyta, Chlorophyta and Cyanophyta had species with very high abundance in Ologe Lagoon. In Ologe Lagoon, two stations close to discharge points of municipal and abattoir wastes had low phytoplankton species number and diversity but high abundance of pollution indicator and harmful species of such genera as *Volvox*, *Microcystis* and *Oscillatoria*. The undesirable effects of the anthropogenic activities and the need to regulate them for sustainable management of the water bodies and the resources therein are discussed.

Keywords: Coastal waters, phytoplankton distribution, phytoplankton abundance, productivity, anthropogenic activities, harmful algae.

INTRODUCTION

Phytoplankton being the major group of primary producer organisms, are the bedrock of energy available for entire biological communities especially in coastal water bodies (Ama-Abasi and Akpan, 2006; Abowei et al., 2008; Yakub et al., 2011). Levels of abundance of various populations of phytoplankton in an aquatic ecosystem therefore indicate its level of productivity. Abundance, composition and distribution of phytoplankton of a coastal water body are often influenced by its physico-chemical conditions such as salinity gradients as well as concentrations of organic and inorganic ions (especially the nutrients). Indeed, excessive loading of natural water bodies with nutrients (nitrate and phosphate in particular) is a major cause of eutrophication which often results in phytoplankton or algal blooms (Abowei and Sikoki, 2005; Abowei et al., 2008; Onyema and Nwankwo, 2009).

DOI : http://dx.doi.org/10.4314/ijbcs.v9i3.4

In several cases, the bloom phytoplankton species include harmful ones which produce substances that are toxic either to finfish, shellfish, other aquatic higher animals or man, therefore posing significant socio-economic, health and ecological problems (Lefebvre et al., 2002; Abowei and Sikoki, 2005; Kadiri, 2011). According to the authors, production of the toxins by the harmful species is enhanced by high level of nutrients in the water body especially due to anthropogenic inputs. Thus, study of phytoplankton community, apart from providing information on productivity status, also serves as a good bio-monitoring approach for detecting and evaluating alterations in the physico-chemical conditions especially as a result of anthropogenic activities in the natural water bodies (Yakub, 2004; Abowei et al., 2008; Onyema and Nwankwo, 2009).

The Barrier-lagoon Complex which is constituted by a network of contiguous creeks and lagoons in the western part of Nigerian coastal zone, offers immense socio-economic benefits especially by supporting tremendous artisanal fishing activities. It also provides great opportunities and potentials for aquaculture. The barrier lagoon complex has however continued to experience environmental stress particularly from anthropogenic activities. This has resulted in significant undesirable ecological impacts in some parts of the complex such as the Lagos Lagoon (Ajao and Fagade, 2002; Ogunwemimo and Osuala, 2004; Nkwoji et al., 2010; Yakub et al., 2011).

Perhaps, although Yakub et al. (2013) reported on the physico-chemical parameters of the Badagry Creek and Ologe Lagoon, previous works on assessment of ecological status in the Barrier-Lagoon Complex have been concentrated mostly on the central part particularly the Lagos Lagoon. Considering the high level of human population growth rate with the concomitant increase in anthropogenic influences on coastal ecosystems especially in the western part of Nigeria. It is imperative to broaden the scope of ecological studies in the coastal waters. In order to bridge the gap of dearth of recent information on ecological conditions of this axis of Nigerian coastal zone, the present study investigated compositions and distributions of phytoplankton in Badagry creek and Ologe lagoon. The findings will be of immense benefit for effective and sustainable management of the coastal waters as well as provide basis for regulating various anthropogenic activities in the water bodies.

MATERIALS AND METHODS

Study area

The study was carried out in Badagry Creek and Ologe Lagoon within the western axis of the Barrier-Lagoon Complex in Nigeria (Figure 1).The Badagry Creek is the main body of the barrier lagoon complex that enters Nigeria (Figure 1). It has connections to the sea via Lake Nokoue in Cotonu and Lagos Lagoon and Harbor in Lagos. Ologe Lagoon on the other hand is a backwater into which some rivers and streams in the western part of Nigeria drain, and it in turn empties through some tributaries into the Badagry Creek and Lagos Lagoon (Figure 1).

Five stations were selected in each of Badagry Creek (stations A1 to A5) and Ologe Lagoon (B1 to B5) for sample collections. The sampling stations in Badagry Creek lie between Longitude 2^0 52.51”E and 3^0 06.3”E and Latitude 6^0 24.48” and 6^0 24.78”N while those in Ologe Lagoon are between Longitude 3^0 5.64”E and 3^0 6.57”E and Latitude 6^0 27.31”N and 6^0 29.98”N (Figure 1). Littoral mangroves and coconut are the major vegetation of the study area in the Badagry Creek while Ologe Lagoon was characterized mostly by rooted and floating macrophytes as well as dense rainforest especially in areas with low anthropogenic activities

Apart from sand mining and motorized boat operations which are major activities observed in the two water bodies, wastes from a major market in Badagry are discharged into Badagry creek at a location close to station A5. Ologe Lagoon receives municipal effluents through drainage canals at Agbara (station B1) and wastes from an abattoir at Ijanikin (station B2).

Collection and analysis of phytoplankton samples

On each sampling occasion, standard plankton net of 52 µm mesh size, was suspended and towed steadily at low speed (<4knots) in the water at every station for 5 minutes. After towing, phytoplankton samples were concentrated and fixed under 4% unbuffered formalin. Fixed samples were allowed to settle in the laboratory for at least 24 h and the supernatant carefully decanted until a concentration of about 40 ml was obtained.With the aid of a Sedgwick Rafter counting chamber, 1 ml of water sample was analyzed using the drop count method. Phytoplankton species were examined, identified and counted using a Microstar IV Carl Zeiss binocular microscope calibrated at different magnifications (x10, x40 and x100 objectives). Identification was done using relevant and standard guides and text books of authors such as Wimpenny (1966), Compère (1976; 1977). Community structures of phytoplankton both in Badagry Creek and Ologe Lagoon were determined using diversity indices such as Margalef species richness (d) diversity and Shannon Wiener (H). The diversity indices values were computed as described by Ogbeibu (2005) using a computer software package, 'Past' by Hammer and Harper (2005).

Phytoplankton samples were collected from the two water bodies and analysed in the months of September 2011 as well as February and May 2012.

RESULTS

Badagry Creek

The phytoplankton recorded from Badagry Creek belonged to three classes: Bacillariophyta (Diatoms), Chlorophyta (green algae) and Cyanophyta (blue-green algae). A total of 92 species belonging to 43 genera and 10 orders were recorded. Distribution, abundance and diversity indices values of the phytoplankton at various sampling stations during the sampling periods as well as percentage compositions of various orders are presented in Table 1. The phytoplankton community was dominated by diatoms (Bacillariophytes) making up a total of 50 species from 24 genera with the two orders, Centrales and Pennales constituting 47.61% and 39.51% of the entire community respectively (Table 1). *Actinoptychus*, *Aulacoseira*, *Coscinodiscus*, *Gyrosigma* and *Surirella* spp had relatively high abundance across all stations especially in the months of February and May (Table 1). Other taxa of relatively high abundance during the period were *Amphiprora* and *Closterium* spp of the class Chlorophyta (Table 1). Among the blue-green algae, *Microcystis aeruginosa* was the most dominant in the wet season month of September; *Anabaena* was recorded only in the dry season while *Oscillatoria* had its distribution in the two seasons across the five stations (Table 1). Higher total species number and abundance levels were recorded across various stations in the dry season months of February and May than wet season month of September which however had relatively high diversity indices (Shannon-Wiener and Margalef) levels (Table 1).

Ologe Lagoon

The phytoplankton collected from Ologe Lagoon belonged to four classes (Bacillariophyta, Chlorophyta, Cyanophyta and Euglenophyta), 10 orders, 47 genera and 94 species. Table 2 presents distribution, abundance and diversity indices values of the phytoplankton at various sampling stations during the sampling periods as well as percentage compositions of various orders in Ologe Lagoon. Diatoms dominated the phytoplankton community both in terms of abundance and species composition (Table 2). Order Centrales of the diatoms constituted 49.96% of the total phytoplankton abundance (Table 2). *Aulacoseira* sp had the highest abundance with distributions cutting across all the stations and sampling periods (Table 2). Other phytoplankton taxa of relatively high abundance and wide distributions belonged to Cholorophyta (*Pediastrum*, *Eudorina* and *Closterium* spps.) and Cyanophyta (*Anacystis* and *Microcystis* spps.). *Microcystis*, however as well *Oscillatoria*, also a cyanophyte had relatively high abundance distributions at stations B1 and B2 through the sampling periods (Table 2). Highest phytoplankton species number, total abundance and diversity indices (Shanon-Wiener and Margalef) levels were recorded across the five stations in the month of May, followed by February while September had the lowest values for these parameters (Table 2).

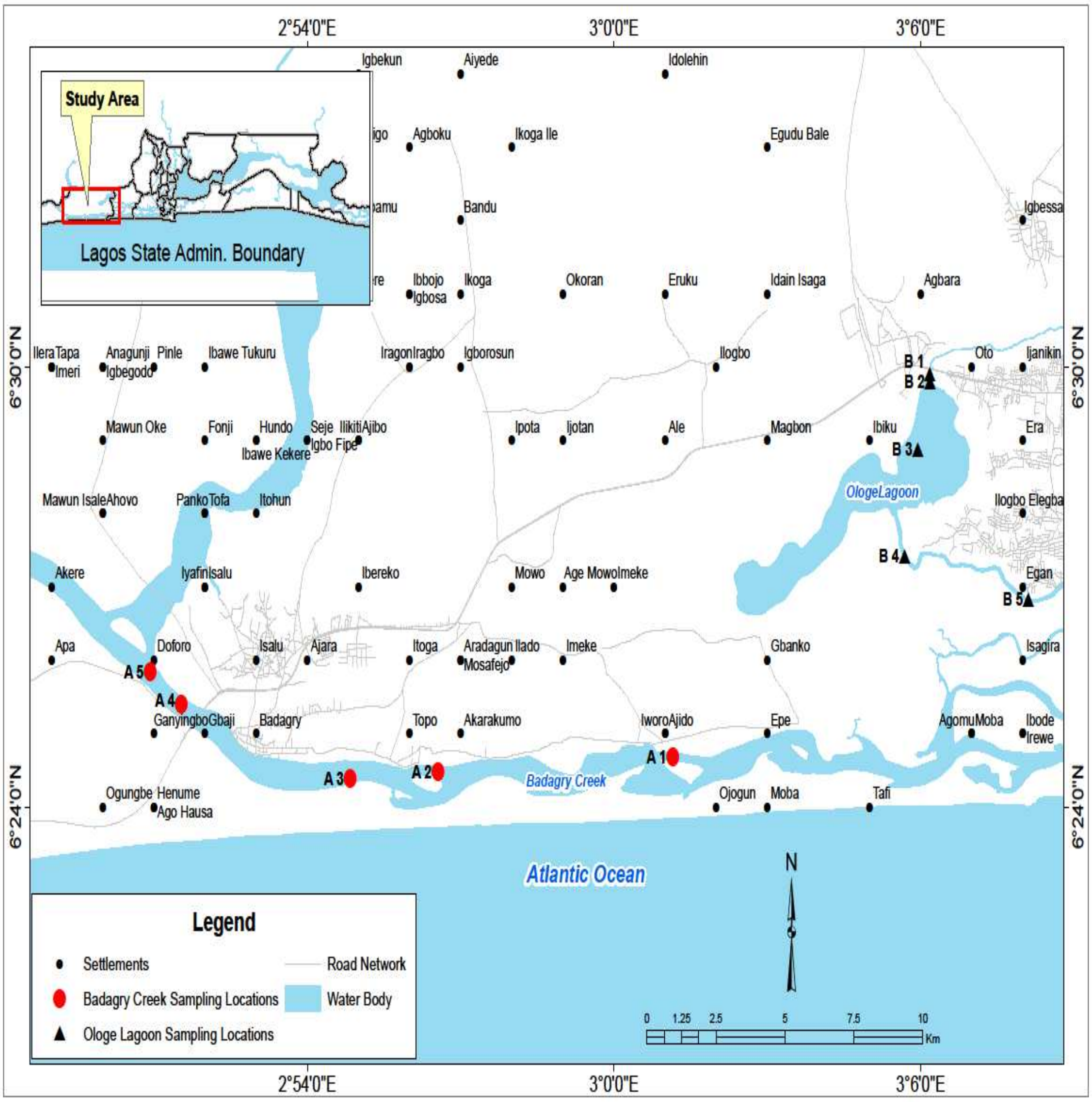

Figure 1: Sampling stations in Badagry Creek and Ologe Lagoon.

Table 1: Abundance, distribution and diversity of phytoplankton in Badagry Creek (September 2011-May 2012).

	SEPTEMBER, 2011					**FEBRUARY, 2012**					**MAY, 2012**					**% Composition**
	Badagry Creek					**Badagry Creek**					**Badagry Creek**					
	A1	**A2**	**A3**	**A4**	**A5**	**A1**	**A2**	**A3**	**A4**	**A5**	**A1**	**A2**	**A3**	**A4**	**A5**	
Division: Bacillariophyta (Diatomaceae)																
Order I: Centrales																
Actinoptychus undulatus (Bail.)	4	5	5	-	-	30,004	13,506	22,501	450	8,250	5,000	3,500	4,000	1,350	13,500	
Aulacoseira spp.	1	3	36	16	6	2,000	1875	1618	16	2033	1	2	-	1	84	
Coscinodiscus spp.	5	3	7	-	5	54	29	70	57	4	7529	8	19	7	7	
Cyclotella meneghiniana	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	**47.606**
Odontella spp.	3	7	-	-	3	-	-	-	-	-	-	-	-	-	-	
Skeletonema spp.	1	6	-	9	-	-	1	1	-	-	-	-	4	-	850	
Terpsinoe musica (Ehr.) Hustedt	-	-	2	-	-	3	3	4	4	24	4	-	5	1	5	
Gossleriella tropica Shütt	6	7	5	1	2	-	-	-	-	-	-	-	-	-	-	
Rhizosolenia spp.	-	-	-	-	-	-	2	-	-	-	-	1	-	-	-	
Order II: Pennales																
Fragilaria spp.	1	-	3	-	4	1	5	1	-	-	-	-	-	-	1	
Synedra spp.	1	3	3	1	3	6	15	8	8	8	4	3	5	3	6	
Tabellaria flocculosa	-	1	-	-	-	1	-	1	-	-	-	1	5	-	-	
Thalassiothrix longissima	-	-	-	-	-	3	6	8	2	3	3	-	-	3	-	**39.5143**
Gyrosigma spenceri	-	-	-	-	-	-	-	1	1	2	7,000	1	3,000	1,500	1,200	
Navicula spp.	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Parabelius delognei (V.H.) E.J. Cox	-	2	4	-	-	2	6	-	1	-	-	-	-	-	-	
Pinnularia spp.	-	-	-	-	-	1	-	-	-	-	3	-	-	-	1	

Pleurosigma angulatum	-	-	1	-	-	1	-	-	-	-	-	-	1	-	1	
Stenopterobia rautenbachiae	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	
Bacillaria paradoxa Gmel.	1	2	-	7	2	-	9	6	1	-	-	-	-	-	150	
Hantzschia sigma	-	-	-	-	-	-	-	-	-	1	9	-	1	-	-	
Nitzschia spp.	-	-	-	-	-	2	4	1	3	8	29	-	2	7	3	
Campylodiscus clypeus var. *bicostatus* (Ehr.) Kutzing	-	1	1	-	-	-	2	-	-	-	1	-	7	-	1	
Surirella spp.	-	2	-	-	1	7,600	4,200	12,000	26,000	29,500	1000	950	1250	2,300	460	
Division: Chlorophyta																
Order I: Chlorococcales																
Hydrodictyon sp.	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	**0.0072**
Pediastrum spp.	1	2	1	-	1	1	-	1	-	2	-	-	1	-	3	
Scenedesmus spp.	-	-	1	-	1	-	-	-	-	-	-	-	-	-	2	
Order II: Volvocales																**0.0008**
Volvox globator	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	
Order III: Zygnematales (Conjugales)																
Amphiprora costata	-	-	-	-	-	-	-	-	-	-	856	-	800	-	-	**0.7072**
Closterium spp.	-	1	1	-	2	6	11	19	15	5	8	-	3	2	2	
Staurastrum anatinum	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	
Gonatozygon kinahanii	3	-	1	-	-	1	1	-	2	-	-	-	-	-	-	
Spirogyra africana Fritsch Cruda	-	2	-	-	-	2	7	-	3	2	-	-	-	-	3	
Division: Cyanophyta																
Order I: Chroococcales																
Anacystis sp.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	**12.113**
Eucapsis alpine	-	-	-	-	-	-	-	-	-	-	-	-	1	1	5	
Microcystis aeruginosa Kutzing	21	69	30,000	20	42	-	-	-	-	-	-	-	-	-	-	

Order II: Nostocales																
Anabaena spp.	-	-	-	-	-	-	-	-	-	1	1	16	1	-	1	**0.0096**
Nodularia spumigena Mertens	-	-	-	-	-	-	-	-	-	1	-	-	-	-	3	
Order III: Oscillatoriales																
Cylindrospermum sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Dactyliosolen antarcticus	-	-	-	-	-	-	-	-	-	1	5	-	-	-	-	**0.0418**
Lyngbya martesiana Meneghiniana	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	
Oscillatoria spp.	1	3	8	-	2	3	5	5	1	2	38	3	7	11	3	
Spirulina spp.	-	1	-	-	-	-	-	-	-	-	-	-	1	-	1	
Total species diversity (S)	19	23	26	9	18	25	31	26	24	23	27	14	27	18	32	
Total abundance (N)	52	120	30083	57	74	39691	19687	36245	26564	39847	21494	4486	9114	5186	16296	
Shannon-Wiener Index (Hs)	0.98	0.82	0.01	0.72	0.80	0.37	0.46	0.46	0.35	0.53	0.62	0.31	3.96	3.71	4.21	
Margalef Index (d)	4.56	4.60	2.42	1.98	3.95	2.27	3.03	2.38	2.26	2.08	2.61	1.55	2.85	1.99	3.20	

- : Total Absence

Table 2: Abundance, distribution and diversity of phytoplankton in Ologe Lagoon (September 2011-May 2012).

	September, 2011					February, 2012					May, 2012					% Composition
	Ologe Lagoon					Ologe Lagoon					Ologe Lagoon					
	B1	B2	B3	B4	B5	B1	B2	B3	B4	B5	B1	B2	B3	B4	B5	
Division: Bacillariophyta																
Order I: Centrales																
Actinoptychus undulatus (Bail.)	3	5	-	3	-	2	-	1	1	3	-	-	5	-	1	
Aulacoseira spp.	3	19	48,5	40,0	162	5060	29,5	38,005	32,501	14,5	-	57,002	42,034	69,501	46950	
Coscinodiscus spp.	-	3	1	-	6	-	-	1	2	12	-	-	8	8	9	
Cyclotella meneghiniana	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	**49.9645**
Hyalodiscus sp.	-	-	-	2	-	-	2	-	-	-	-	-	-	-	-	
Melosira moniliformis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Terpsinoe musica (Ehr.) Hustedt	-	-	-	-	-	-	1	-	-	-	-	-	1	2	-	
Gossleriella tropica Shütt	-	1	1	-	8	-	-	-	-	-	-	-	-	-	-	
Rhizosolenia spp.	-	-	-	-	-	2	-	1	-	-	-	-	-	-	-	
Order II: Pennales																
Eunotia sp.	-	-	-	-	-	7	-	-	-	-	-	-	-	10	7	
Asterionella spp.	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	
Fragilaria spp.	1	3	-	1	-	-	1	-	-	-	-	-	1	-	-	
Synedra spp.	1	1	1	3	1	2	2	-	-	1	-	-	1	3	7	
Tabellaria flocculosa	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	
Thalassiothrix longissima	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	
Gomphonema parvulum	-	-	-	-	-	1	1	-	-	-	-	-	-	1	1	**8.266**
Navicula spp.	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-	
Parabelius delognei	-	3	-	2	-	-	-	-	-	-	-	-	-	-	-	
Pinnularia spp.	2	3	-	-	-	8	1	-	-	2	-	5	-	-	2	
Stenopterobia rautenbachiae	-	-	-	-	-			-	-		-		-	-		
Bacillaria paradoxa Gmel.	1	-	-	-	2	-	-	-	-	-	-	-	-	45,000	25,000	
Nitzschia intermedia	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	
Campylodiscus clypeus var. bicostatus (Ehr.) Kutzing	-	1	-	-	-	-	-	-	1	1	-	-	2	1	5	

Surirella spp.	-	-	-	-	-	-	-	1	1	4	-	-	-	1	1	
Order: mischococcales																
Goniochloris smithii	-	-	-	-	-	1	-	-	2	-	-	1	2	1	-	**0.0008**
Division: Chlorophyta																
Order I: Chlorococcales																
Tetraëdron cruciatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Pediastrum spp.	-	13	11	6	1	15	15,616	5,304	2,359	2,254	-	15	29	850	900	**3.2292**
Scenedesmus spp.	-	-	-	-	-	1	1	3	1	2	-	2	8	-	-	
Order II: VOLVOCALES																
Eudorina cylindrical	-	-	-	-	-	2,1	1,4	4	3	4	-	1,000	26	1,500	300	**0.747**
Order III: ZYGNEMATALES																
Closterium spp.	-	2	-	-	-	1	1	2	11252	34000	-	200	15	1	-	
Cosmarium subtumidum var. *oriculare*	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	**5.3646**
Staurastrum spp.	-	-	-	-	-	-	-	8	6	7	-	1	1	2	1	
Gonatozygon kinahanii	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	
Spirogyra africana Fritsch Cruda	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Division: CYANOPHYTA																
Order I: CHROOCOCCALES																
Anacystis sp.	-	-	-	55,000	-	9	10,250	12,600	8,750	1,750	-	1	7,250	12,500	13,500	
Chroococcus disperses	-	-	-	-	-	-	-	-	-	-	-	-	-	6	3	
Eucapsis alpine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	**27.3768**
Microcystis aeruginosa Kutzing	45	42, 5	-	3	47	13,00	19,000	5,250	5250	763	-	16,500	8,250	-	-	
Order II: NOSTOCALES																
Anabaena spp.	-	3	-	-	-	-	1	1	-	-	-	-	6	20000	-	**4.5108**
Nodularia spumigena Mertens	-	-	-	-	-	-	-	-	-	-	-	-	3	250	18,000	
Order III: Oscillatoriales																
Dactyliosolen antarcticus	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	
Lyngbya martesiana	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.4985**
Oscillatoria spp.	65	69	-	1	1	4002	49	1	-	-	-	3	16	11	-	
Plankothrix sp.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	
Division: Euglenophyta																

Order: Euglenales																
Phacus spp.	-	1	-	-	-	-	-	-	-	-	-	1	4	-	-	**0.0417**
Strombomonas fluviatilis	-	-	-	-	-	-	-	-	-	-	-	-	-	5	5	
Trachelomonas verrucosa	-	-	-	-	-	-	-	-	-	-	-	325	11	2	-	
Total species diversity (S)	9	27	8	13	13	29	21	19	22	22	0	17	33	29	26	
Total abundance (N)	122	42631	48514	95021	228	24231	75827	61182	60130	53303	0	75056	57674	149655	104698	
Shannon-Wiener Index (Hs)	0.48	0.01	0.46	0.49	0.74	0.58	0.79	0.63	0.69	0.54	0	0.60	4.76	5.18	5.02	
Margalef Index (d)	1.67	2.44	0.65	1.05	2.21	2.77	1.78	1.63	1.91	1.93	0	1.43	2.92	2.35	2.16	

- : Total Absence

DISCUSSION

The record of diatoms (Bacillariophytes) as the dominant phytoplankton class in the two water bodies both during rainy and dry seasons is typical of tropical aquatic ecosystems. Similar findings have been made in Nigerian coastal water bodies by previous workers such as Ama-Abasi and Akpan (2006), Abowei et al. (2008), Onyema (2008) and Yakub et al. (2011). The total abundance and number of species of phytoplankton recorded in each of the water bodies are relatively high compared with the findings in some other Nigerian coastal waters by earlier workers mentioned above.

The dominant diatom species recorded from the two water bodies were not listed by Kadiri (2011) among harmful algae of Nigerian coastal waters although the author's study was carried out in highly saline onshore areas of the coastal zone. However, *Coscinodiscus* which was recorded from various stations in Badagry Creek during various sampling regimes although not in very high abundance had been reported as potential harmful algae by Kadiri (2011). The high total abundance and diversity generally recorded for the phytoplankton from both Badagry Creek and Ologe Lagoon during the two seasons is an indication of relatively high productivity and healthy ecological conditions in the water bodies.

The record of only diatoms as the dominant phytoplankton species in Badagry Creek while Ologe Lagoon had dominant species from three different classes of phytoplankton is an indication of variability in phytoplankton distributions in the two water bodies. The variability could be as a result of differences in salinity levels and profiles earlier reported from the same study areas of the two water bodies by Yakub et al. (2013). The authors recorded estuarine salinity in the entire study area of the Badagry Creek but a spatial salinity gradient from freshwater at stations B1 and B2 to brackish condition at station B5 in Ologe Lagoon. The occurrence of *Bacillaria paradoxa* at the entire five stations in Badagry Creek but only at stations B4 and B5 in Ologe lagoon is due to the fact that the two water bodies are linked at a place close to these stations.

The relatively high phytoplankton abundance recorded at most stations in the two water bodies during dry season month of February which conforms the finding of Yakub et al. (2011) in the Lagos Lagoon could be as a result of increased level of photosynthetic activity due to high level of photoperiod that characterizes the season. It is noteworthy that in each of the two water bodies relatively similar phytoplankton abundance and taxa distributions were recorded in the dry season month of February and early rainy month of May. Perhaps, this is attributable to the time lag between commencement of rains (usually in March/April) and onset of flooding which could have prolonged dry season environmental conditions in the water bodies till the month of May.

The relatively high levels of abundance distributions of pollution indicator species of green algae (Chlorophytes) such as *Volvox globator* and blue-greens (Cyanophytes) such as *Microcystis* and *Oscillatoria* at stations B1 and B2 in Ologe Lagoon are attributable to the drainage of municipal effluents and abattoir wastes into the water body close to these stations. These anthropogenic activities could have also resulted in the low phytoplankton abundance and species number obtained at station B1 compared to other stations in Ologe lagoon. *Microcystis* which occurred in high abundance at the two stations had earlier been recorded as one of the dominant harmful blue-green algae in the entire Nigerian marine coastal ecosystems by Kadiri (2011).

The stations B1 and B2 had earlier been reported to have relatively high biochemical oxygen demand and nutrients (nitrate and phosphate) but low dissolved oxygen by Yakub et al. (2013). The authors attributed these to degradation of organic rich wastes being discharged into the water body close to these stations. Similar earlier reports of low phytoplankton abundance and diversity in organically polluted areas of Nigerian waters include those of Yakub (2004), Ama-Abasi and Akpan (2006), Abowei et al. (2008), Onyema (2008) and Yakub et al. (2011).

Conclusion

Badagry Creek and Ologe Lagoon in Nigerian westernmost part of the Barrier Lagoon Complex generally had relatively high diversity of phytoplankton with diatoms as dominant taxa. Phytoplankton compositions and distributions of the two water bodies varied somehow probably due to differences in their salinity profiles. Anthropogenically impacted areas of Ologe Lagoon (Stations B1 and B2) had relatively low phytoplankton species diversity as well as high abundance of pollution indicator and harmful phytoplankton species. In order to prevent further ecological deterioration and to ensure sustainable management of these water bodies, it is very imperative to control the level of anthropogenic activities such as the discharge of untreated municipal wastes especially into Ologe Lagoon.

REFERENCES

Abowei, JF, Sikoki FD. 2005. *Water Pollution: Management and Control.* Double Trust Publishers; Port Harcourt, Nigeria; 254p.

Abowei JFN, Davis OA, Tawari CC. 2008. Phytoplankton in the Lower Sombreiro River, Niger Delta, Nigeria. *Research Journal of Biological Sciences*, **3**(12): 1430-1436.

Ajao EA, Fagade SO. 2002. The benthic macro-infauna of Lagos Lagoon. *The Zoologist*, **1**(2):1-15.

Ama-Abasi D, Akpan FR. 2006. Possible Bioindicators of salinity change in Cross River Estuary, Southeast Nigeria. In: Proceedings of the 20th Annual Conference of the Fisheries Society of Nigeria, Ansa EJ, Anyanwu PE, Ayonadu BW, Erondu ES, Deekae SN (eds). Port Harcourt, Nigeria, 14th –18th November 2005, 254-260.

Compère P. 1975. Algues de la Région du Lac Tchad: Diatomophycées. *Cah. O.R.S.T.R.O.M., sér. Hydrobiol.*, **9**(4): 203 – 290.

Compère P. 1977. Algues de la Région du Lac Tchad: Chlorophycophytes. *Cah. O.R.S.T.R.O.M., sér. Hydrobiol.*, **11**(2): 77 – 117.

Hammer O, Harper DAT, Ryan PD. 2001. PAST: Palaeontogical Statistics Software packages for education and data analysis. *Palaeontologia Electronica*, **4**(1): 9.

Kadiri MO. 2011. Notes on Harmful Algae from Nigerian Coastal Waters. *Acta. Botanica, Hungarica*, **53**(1-2): 137-143.

Lefebver K, Silver M, Coale S, Tjeedma R. 2002. Demoic Acid in planktivorous fish in relation to toxic *Pseudo-Nitchia* cell densities. *Spriger (Marine Biology)*, **140**(3): 625-631.

Nkwoji JA, Yakub A, Ajani GE, Balogun KJ, Renner KO, Igbo JK, Ariyo AA, Bello BO. 2010. Seasonal variations in the water chemistry and benthic macro-invertebrates of a South Western lagoon, Lagos. Nigeria. *Journal of American Science*, **6**(3): 85-92.

Ogbeibu AE. 2005. *Biostatics: A Practical Approach to Research Data Handling*. Mindex Publishing Company Ltd.: Benin City.

Ogunwenmo CA, Osuala IA. 2004. Physico-chemical Parameters and Macrobenthos of an Estuarine Creek and Artificial Pond in Lagos, Southwestern Nigeria. *Acta SATECH*, **1**(2): 128-132.

Onyema IC. 2008. A checklist of Phytoplankton species of Iyagbe Lagoon, Lagos. *Journal of Fisheries and Aquatic Sciences*, **3**(3): 167 - 175.

Onyema IC, Nwankwo DI**.** 2009. Chlorophyll a dynamics and `environmental factors in a tropical estuarine lagoon. *Academia Arena*., **1**(1): 18 – 30.

Wimpenny RS. 1966. *The Plankton of the Sea*. Faber and Faber Limited: London; 426.

Yakub AS. 2004. Assessment of water quality and plankton of effluents receiving Awba Stream and Reservoir in Ibadan, Nigeria. *African Journal of Applied Zoology and Environmental Biology*, **6**: 107-110.

Yakub AS, Balogun KJ, Ajani GE, Renner KO, Ariyo AA, Bello BO, Nkwoji JA, Igbo JK. 2011. Distribution of Phytoplankton in some parts of Lagos Lagoon, Southwest Nigeria. *International Journal of Biological and Chemical Sciences*, **5**(1): 150 - 163.

Yakub AS, Igbo JK, Balogun KJ, Agwu AO, Bello BO, Appia J. 2013. Study of Physico-chemical Characteristics in the Westernmost Part of the Barrier Lagoon Complex, Western Nigeria. *International Journal of Biological and Chemical* Sciences, **7**(4): 1745-1751.