

The Physico-Chemical Characteristics And Phytoplankton Of The Onijedi Lagoon, Lagos.

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Abstract: The physico-chemical characteristics and phytoplankton of the Onijedi Lagoon, Lagos were investigated (September, 2009 to April, 2010). The physical and chemical factors showed monthly variations linked with seawater beach overflow especially at high tide and rainfall dynamics in the area. The result showed prevalent low nutrients, high salinity and alkaline pH among others. Physico-chemical conditions varied mainly between high brackish and sea conditions. The phytoplankton recorded 14 species from three groups. The dominant group was the Blue-green algae followed by Diatoms and Chlorophytes. Whereas the Blue-green algae recorded 57.3%, Diatoms, reported 46.6% (Centric - 13.9% and Pennate diatoms - 22.7%) and the Chlorophytes recorded 5.5% in terms of diversity. Total number of species recorded were between 6 and 11 through out the months and station. In terms of distribution and diversity, the dry season (Dec. 2009 – Apr. 2010) recorded a relatively higher phytoplankton diversity (S), and abundance of species (N) than the wet season. In terms of distribution, whereas the blue-green algae were more notable in the wet season, the diatoms were more diverse and relatively increased in terms of number in the dry season. In terms of abundance, the month of September (after the August break) recorded higher outcomes, while diversity (S) was relatively higher in the dry season for both stations. The biological indices such as Shannon-Wiener (Hs), Menhinicks (D), Margalef (d) and Equitability (j) reflected a similar trend of occurrence. Notable species for the study were *Microcystis aeruginosa* and *Microcystis flos-aquae*. *Scopulonema minus* a synonym of *Pleurocapsa minor* recorded in this study is a first report for Lagos, Nigeria.

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1. Introduction

According to Onyema (2009a) there are 10 lagoons in Lagos, Nigeria. These lagoons have been reported in literature and are the Yewa, Ologe and Badagry lagoons (FAO, 1969; Nwankwo, 2004a), Iyagbe lagoon (Webb, 1958; Onyema, 2008; Onyema and Nwankwo, 2009a), Lagos, Kuramo, Epe, Lekki and Mahin lagoons (Webb, 1958; Hill and Webb, 1958; FAO, 1969; Ikusemiju, 1975, 1991; Nwankwo 1998a, 1998b, 2004a) and the most exotic and controversial, the Onijedi lagoon (Afinowi, 1972; Yoloye, 1974, 1976; Onyema, 2009a,b). It is important to note that the Apese lagoon as reported on by Onyema (2009a,b) is a closed lagoon and has been previously investigated and reported as the Onijedi lagoon by Afinowi (1972) and Yoloye (1974, 1976). Whereas the Onijedi lagoon can be classified as a closed water lagoon, the Kuramo lagoon is now only seasonally closed especially in the dry season (Nwankwo *et al.*, 2008). All other lagoons in South-western Nigeria are open to the sea via the Lagos harbour. Unlike all other lagoons and estuarine water systems in the region, the Onijedi lagoon gets seawater inputs chiefly from beach overflows especially at high tide from the Atlantic ocean (Onyema, 2009 a, b). A similar situation presently occurs for the Kuramo lagoon. Additionally, water flows out of the Kuramo lagoon when floodwater fills it up in the wet season via the

Kuramo creek.

Lagoon biota is usually composed of the plankton, nekton and benthos. The plankton provide a crucial source of food to a diverse range of larger and more familiar aquatic organisms such as invertebrates, fin and shell fish, whales etc. A number of studies have examined the plankton of some of the lagoons and surrounding creeks in Lagos, Nigeria (Onyema *et al.*, 2003, 2007; Nwankwo *et al.*, 2008; Onyema and Ojo, 2008, Emmanuel and Onyema 2007, Onyema *et al.*, 2009). In these reports seasonal changing hydro-environmental characteristics are the determinants of the phytoplankton and zooplankton standing crop at anytime. The negative effect of increasing pollution pressure has also been documented by these authors. According to the aforementioned reports and more, diatoms, blue-green algae, green algae and dinoflagellates are recorded key members of the phytoplankton crop, whereas calanoid and cyclopoid copepods, cladocerans, rotifers and juvenile stages among others represent the zooplankton crop. For instance, according to Onyema *et al.*, (2003), diatoms (phytoplankton) and calanoid copepods (zooplankton) are the dominant groups of plankton in the Lagos lagoon.

The phytoplankton is the foundation of the aquatic food chain and its diversity and distribution varies from one aquatic ecosystem to the other. Long-

term plankton data are key to documenting ecosystem variability and helping to understand the responses of planktonic communities to natural and man induced changes. There is presently no record of the phytoplankton elements of the Onijedi lagoon. Afinowi (1972) and Yoloye (1974, 1976) concentrated on the bloody cockle (*Anadara senilis*) and some physico-chemical characteristics of the lagoon. On the other hand Onyema (2009a,b) gave attention to its possible mode of formation, geo-physical, water chemistry and attached algae community of the Onijedi lagoon. Therefore the aim of this study was to investigate the phytoplankton of the Onijedi lagoon in relation to seasonal fluctuation in physico-chemical characteristics.

2. Material and Methods

Description of study site

The Onijedi lagoon has been previously described by Onyema (2009 a,b) (as the Apese lagoon). It is part of the series of coastal lagoons found along the West African coast. It is the smallest of the ten lagoons in Lagos Nigeria in terms of size / coverage area (Fig. 1). It lies between Latitude 6° 25' 20.8N, Longitude 3° 27' 15.5E and Latitude 6° 25' 20.29N, Longitude 3° 27' 57.1E. The lagoon is situated in Victoria Island, Lagos state. It is lanceolate in shape and stretches for about 1.3km. It is 0.16km across at its widest breadth. It is located directly eastward of the Kuramo lagoon and southward of the Lagos lagoon just before the Atlantic ocean. It is presently separated from the Atlantic ocean by less than 30meters of beach.

The Onijedi lagoon is brackish throughout the year with considerable salinity variation. The coastal profile of Onijedi lagoon is endowed with coarse sand deposit; shells of bivalve molluscs and litters of non biodegradable materials (marine debris/ship solid wastes) dumped overboard in the sea from ocean going vessels in our coastal waters. These debris are eventually transported to the shore by prevailing ocean currents, winds and eventually waves and tidal action. They are emptied into the Onijedi lagoon as sea water spills over the separating sand bar.

The region is exposed to the wet (May to November) and dry season (December to April) with the wet season having a bimodal distribution. In the wet season the water volume of the lagoon increases as a result of run-off from the adjoining landmass. Part of the littoral zone is also usually submerged at this time. The vegetation type of the Onijedi lagoon shore is a strand of scrubby vegetation similar to that described by Akinsoji *et al.*, (2002) for the Light house beach. Some species occurring at the Onijedi lagoon include *Ipomoea pes-caprae*, *Philoxerus* sp., *Paspalum vaginatum*, *Schizachyrium pulchellum* and

Remirea maritima. Artisanal fishing and the collection and bagging of molluscan shells are the main occupation of the few inhabitants of the immediate area. Organisms associated with the shore includes marine birds and some macroinvertebrates. The bloody cockle (*Anadara senilis*) is also harvested and eaten by the locals as food. At the time of this study there were three shipwrecks at the Onijedi beach/coastline. These wrecks were already compromising the ocean current dynamics, sediment movement and shore profile.

Two stations were selected for this study. Whereas Station 1 has a G.P.S. co-ordinate of 6° 42' 24.79", 3° 46' 08.22", Station 2 was located at 6° 42' 26.92", 3° 45' 76.46". There was rainfall during January sample collection and in some other months, a day or night prior to sample collection.

Collection of water and Plankton samples

The collection of water samples was carried out once a month for a period of eight months (September, 2009 to April, 2010) at two stations (St. 1 and St. 2). Sample collection took place between 9am and 12noon. Water samples were collected from the lagoon in plastic bottle containers (75cl) with screw cap. The sample bottles were screwed tight and kept upright before transfer to the laboratory for further analysis. Plankton samples were collected by filtering 50 litres of the lagoon water with a plankton net (mesh size, 55µm). Plankton samples were kept in well labeled plastic bottles with formalin of about 5% concentration and transferred to the laboratory for further analysis.

Analysis of Water and Chlorophyll *a* Samples

Analysis of water samples and Chlorophyll *a* levels were as described in APHA (1998).

Phytoplankton Biomass

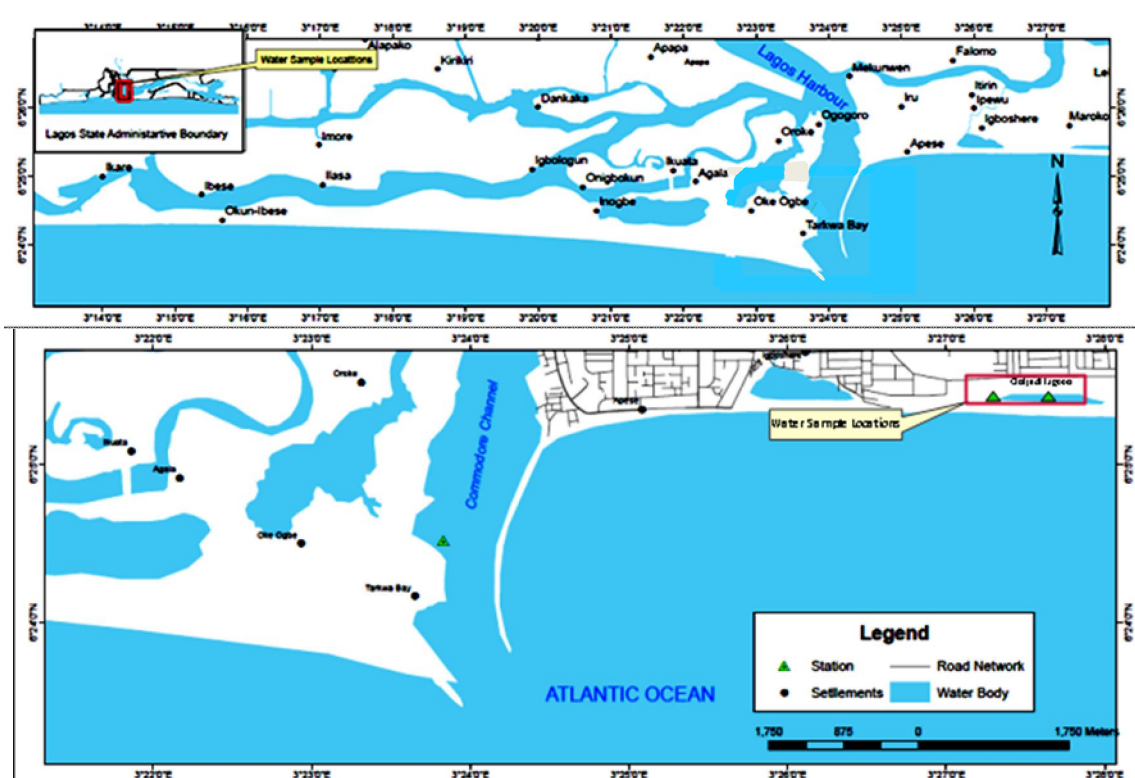
This was determined by counting cell numbers, colonies and individual of phytoplankton organisms, separately. Fixed plankton samples were allowed to settle in the laboratory for at least 48hrs and the supernatant decanted until a concentration of about 40ml was obtained. Two drops (0.2ml) of each sample with the aid of a dropper placed on a glass slide with cover slip over the mount were analyzed using the drop count method. This was done at least five times for each month's sample. Each drop was thoroughly investigated under a light binocular microscope (Olympus CH). Phytoplankton species were examined, identified and counted through the calibrated eyepiece of the microscope at different magnification (×50, ×100, and ×400) and the abundance average recorded. Total organism were then recorded and equated per ml.

The number of each taxon occurring in each field and total number of taxa per group were noted and number of species per sample. Confirmation of species identification and classification was done via relevant texts (Hendey 1958, 1964; Wimpenny, 1966; Patrick and Reimer, 1966, 1975; Whitford and Schmacher, 1973; Vanlandingham, 1982; Nwankwo, 1990, 1995, 2004a; Bettrons and Castrejon, 1999; Lange-Bertalot, 2001; Witkowski *et al.*, 2000; Siver, 2003; Rosowski,

2003).

Biological indices.

Indices used in the analysis of phytoplankton data were Total number of species (S), abundance of species (N), Log of Species diversity (Log S) and Log of species abundance (Log N) others used were Shannon-Wiener Index (Hs), Menhinick Index (D), Margalef Index (d), Equitability (j) and Simpson's Dominance Index (C) (Ogbeibu, 2005).



3. Results

The data obtained from the monthly variation of the physico-chemical parameters at the Onijedi lagoon in Victoria Island from September, 2009 to April, 2010 are represented in Table 1.

Physico-Chemical Characteristics

Air temperature values were observed to be higher in the dry than wet season. The highest air temperature was observed in the month of March, Station 1 (31.0°C) while December Station 1 and January Station 1 recorded the lowest air temperature (26°C). The highest water temperature was 27.0°C (September station 1, September station 2, November station 1, November Station 2, February Station 1 and April Station 2). The Total Suspended Solid was lowest in February, Station 1 (9mg/L) while the highest value was recorded in March Station 1 (25mg/L). The mean value for Total Suspended Solid

was 14 mg/L while that of Total Dissolved Solid was 50mg/L. Salinity showed monthly variation. The highest salinity was estimated in March Station 1 (30.8‰) and the lowest, in January Station 1 (8.6‰). The average salinity recorded was 20.26‰. The mean value of the Chloride ions for the months was 15365.25mg/L. Conductivity during the study ranged widely from 15300 $\mu\text{S}/\text{cm}$ (March, Station 2) to 53400 $\mu\text{S}/\text{cm}$ (January, Station 1). The Total hardness was between 2164.3 mg/L (December, Station 1) and 4880 mg/L (March, Station 2). pH value was between 7.62 and 8.52. The highest pH value at 25 °C was in October Station 2 (8.52), while the lowest was in March, Station 1 (7.62). A range of 8.0mg/L (December Station 1) to 18 mg/L (October Station 1) was reported for Acidity, while Alkalinity was between 98.2 (November, Station 1) and 130.3mg/L (April, Station 2).

Dissolved oxygen varied from 4.5 mg/L in

January Station 1 to 5.2 mg/L in November Station 2. The Biochemical Oxygen Demand ranged from 1 (April Station 1) to 5mg/L (February Station 2). Chemical Oxygen

Demand recorded a mean value of 4.38 ranged between 3 (September Station 1, October Station 2, April Station 1 and 2) and 5 (November Station 1, February Station 1 December Station 1 and Station 2). With regard to the cations, Calcium was between 96.2 (January Station 1) and 440.9 mg/L (October, Station 1). Magnesium levels were between 399.5 (January, Station 2) and 922.6mg/L (March, Station 2). With respect to the nutrients, nitrate ranged between 0.9 (January, Station 1) - 2.2mg/L (November, Station 2) Phosphate ranged between 0.10 (January, Station1) - 0.42mg/L (September, Station 2), Sulphate ranged between 500.6 (January, Station 2) and 1400.0mg/L (March, Station 2) and Silica ranged between 2.2 (November, Station1) and 3.6mg/L (March, Station 2) showed monthly variations. With regards to ranges for heavy metal levels were Copper 0.002 (April, Station 1 and Station 2) - 0.0038 (February, Station1), Iron ranged between 0.16 (January Station 1) and 0.31 (September, Station 2) and Zinc values ranged between 0.0016 (October, Station 2) and 0.004 (February, Station 1). For Chlorophyll a the lowest value (4.3µg/L) was recorded in October, Station 2, while 12.1µg/L was recorded for February, Station 2 and represented the highest value. The mean was 10.2µg/L.

Phytoplankton Spectrum.

Composition and distribution of phytoplankton in the Onijedi lagoon between September, 2009 and April, 2010 are presented in Table 2. 14 species were recorded at the two stations studied. Total number of species recorded per station and month ranged between 6 and 11. Station 2 for Dec., Sept., Mar., and April recorded the highest number of species (11 species), while Station 1 Nov. recorded 6 species only. Furthermore, Station 2 Sept. recorded the highest number of individuals (205 individuals per ml) while, Station 2 Oct. recorded 50 individuals per ml. The phytoplankton assemblage recorded 3 groups of species. They were the Blue-green algae (Division – Cyanophyta), Diatoms (Division – Bacillariophyta), and the Chlorophytes (Division – Chlorophyta). The dominant group of phytoplankton was the Blue-green algae followed by Diatoms and Chlorophytes. Whereas the Blue-green algae recorded 57.3%, Diatoms, reported 46.6% (Centrales - 13.9% and Pennales - 22.7%) and the Chlorophytes recorded 5.5% in terms of diversity (Fig. 2).

A checklist of the phytoplankton spectrum (first column) is presented within Table 2 alongside the distribution of the phytoplankton species at the

stations and months investigated. Table 3 on the other hand tabulates the phytoplankton community's eco-mathematical indices (biological indices). Log of Species diversity (Log S) ranged from 0.78 to 1.04. Log of phytoplankton abundance (Log N) values were between 1.70 and 2.30, Shannon-Wiener Index (Hs) were between 0.75 and 1.19, Menhinick Index (D) were between 0.64 and 1.13, Margalef Index (d)

Values were from 1.25 to 1.88, Equitability (j) values were between 0.87 and 0.97 and Simpson's Dominance Index ranged between 0.11 and 0.20. The key species occurring for the study were *Microcystis aeruginosa* and *Microcystis flos-aquae* in terms of occurrence and abundance. In terms of distribution, whereas the blue-green algae were more notable in the wet season, the diatoms were more diverse and relatively increased in terms of number in the dry season. In terms of abundance, the month of September (after the August break) recorded the higher outcome while diversity (S) was relatively higher in the dry season for both stations.

4. Discussions

The Onijedi lagoon is a closed brackish water lagoon throughout the year. Salinity and its tendencies towards sea water conditions were more prominent in the dry than wet season. Accordingly, increased rainfall distribution was directly implicated in the reduction in salinity of the lagoon. Recorded observation showed that sea water beach overflows which

was more frequent at high tides and during rough seas conditions was the chief route of salt water into the lagoon. The effect of evaporative concentration especially during the dry season (associated with reduced cloud cover and increased solar insolation) could additionally account for increasing salinity at this period.

Hence hydro-meteorological forcings are implicated in the control of hydro-climatic conditions of the Onijedi lagoon, namely fresh water associated with rainfall and seawater overflow from the Atlantic ocean.

Noticeably, water in the Onijedi lagoon fills up during the rains submerging littoral vegetation and increasing its volume and coverage area. The situation reverses in the dry season. The water is clear deep sea blue in colour for the dry season and light green for the wet season. In comparison to the Kuramo lagoon (oligohaline) (Nwankwo et al., 2008), the Onijedi lagoon is predominantly mid to high brackish (mesohaline) for most of the year. Sea salinities were also recorded. The high salinity values during the dry months may be attributed to low rainfall, high evaporation rate coupled, with low humidity, seawater overflows from the sea and reduce rain flood from land run-off. For instance, Nwankwo and Gaya (1996),

reported that rainfall distribution determines salinity gradient in the Lagos lagoon. The least salinity (8.6%) recorded in St. 1 for January was probably a reflection of dilution from rainfall. It rained just before samples were collected for the month of January. Salinity over the years has been single out as a key factor in coastal waters of Nigeria in determining the absence, presence and abundance of endemic species (Sandison and Hill, 1966; Oyekan, 1988; Brown and Oyekan, 1998; Onyema, 2008; Nwankwo, 2004b).

Additionally and comparative to the Onijedi lagoon, the Kuramo lagoon has recorded higher levels of nutrients (phosphates, nitrates and sulphates), heavy metals, biological and chemical oxygen demand and diversity in species of phytoplankton and zooplankton (Edokpayi et al., 2004; Nwankwo et al., 2008). The low biological oxygen demand value recorded throughout the sampling period showed that the site was less polluted comparatively. This could be explained by the high inputs of organic waste from hotels, high recreational activities poor sewerage systems from shanties and other anthropogenic related concerns in the immediate environment (of the Kuramo lagoon). These gross quantities of biodegradable waste and more, find their way unabated

into the Kuramo lagoon. The pH values recorded during the study were alkaline in the dry months. Alkaline pH values recorded for the Onijedi lagoon were an indication of high amount of CO₂ stored as forms of Carbonates in seawater producing a buffering effect (Olaniyan, 1975). A similar inference was reported by Onyema et al., (2003, 2007) for the Lagos lagoon and Iyagbe lagoon (Onyema and Nwankwo, 2009a).

On the other hand, the Onijedi lagoon area is presently sparsely populated. Additionally, there is no key point source of pollution or drain pipes from facilities or hotels entering it. This may additionally account for the probable near pristine conditions observable. However, marine debris which comprise mostly of non-degradable, used plastic bottles and other items are commonly found on the (east) shore at most times. These debris have been thrown overboard ship into our coastal waters while waiting to enter the Lagos harbour. The wind and wave especially at high tide continually move and transfer these debris over the beach berm and into the Onijedi lagoon. Land and sea breezes eventually concentrate them to the east extreme of the lagoon.

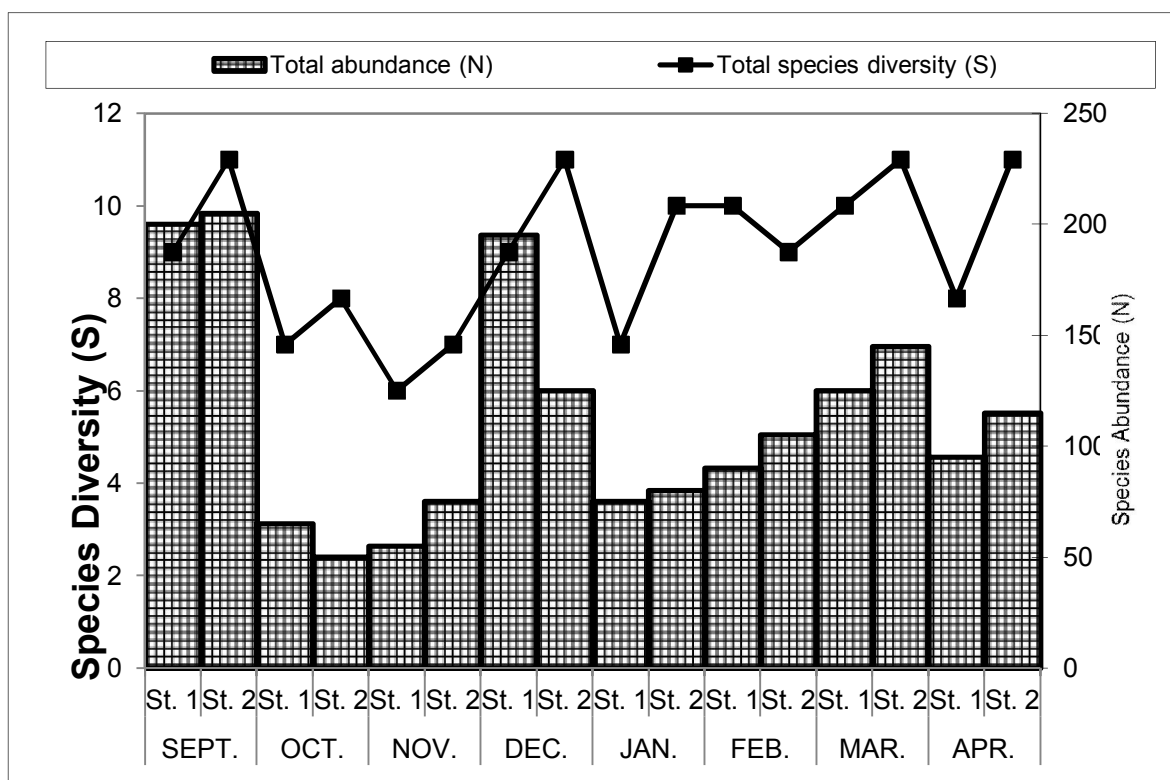


Fig. 2: Phytoplankton species diversity (S) and abundance (N) at the Onijedi lagoon, Lagos (Sept. 2009 – April 2010).

Table 1: Monthly Variation In Physico-chemical Characteristics at Onijedi Lagoon, Lagos (September, 2009 – April, 2010).

ARAMETERS	SEPT.		OCT.		NOV.		DEC.		JAN.		FEB.		MAR.		APR.		MEAN	
	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2
Air temperature (°C)	28.2	28.0	27.5	27.2	27.0	32.0	26.0	25.0	26.0	25.0	28.0	30.0	31.0	30.0	30.0	31.0	27.96	28.53
Water temperature (°C)	27.0	27.0	26.2	26.0	27.0	27.0	25.5	25.2	24.0	24.0	27.0	29.0	26.0	28.0	27.0	26.0	26.21	26.53
Rainfall (mm)	174.3		257.7		4.8		38.3		50.8		40.8		45.6		171.6		97.99	
pH at 25°C	8.43	8.49	8.45	8.54	8.29	8.30	8.05	8.12	7.69	8.00	8.33	8.10	7.62	7.85	7.94	7.99	8.10	8.17
Conductivity (µS/cm)	397	3420	322	3120	333	3340	263	322	153	243	336	3330	518	5430	434	4340	3445	3578
Total Suspended Solids (mg/L)	15	16	12	12	11	11	12	13	10	14	9	10	25	22	18	16	14.00	14.25
Total Dissolved Solids (mg/L)	250	2154	202	1966	242	2500	167	249	920	168	246	2480	336	3475	277	2777	2269	2440
Salinity (‰)	23.5	19.9	18.7	18.1	19.9	19.8	15.4	19.3	8.6	14.4	19.9	19.9	30.8	32.5	25.3	25.3	20.26	21.15
Acidity (mg/L)	15.1	12.2	18.0	11.3	11.1	11.6	8.0	10.2	16.3	8.2	12.2	9.6	18.1	10.2	10.4	11.8	13.65	10.64
Alkalinity (mg/L)	112.	114.	130.	122.	98.2	103.	102.	140.	112.	112.	122.	100.	122.	100.	112.	130.	114.0	115.4
Total hardness (mg/L)	450	4408	410	4008	300	3121	216	300	356	216	301	3609	462	4880	429	4080	3660.	3659.
Calcium (mg/L)	400.	360.	440.	320.	160.	190.	199.	170.	96.2	190.	172.	200.	380.	402.	360.	324.	276.3	269.8
Magnesium (mg/L)	835.	838.	716.	763.	623.	619.	404.	605.	795.	399.	650.	770.	873.	922.	808.	778.	713.4	712.2
Zinc (mg/L)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.002
Iron (mg/L)	0.28	0.31	0.26	0.30	0.22	0.27	0.28	0.20	0.16	0.18	0.29	0.24	0.22	0.28	0.25	0.26	0.25	0.26
Copper (mg/L)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.002
Chloride (mg/L)	133	1320	131	1318	190	1869	152	192	646	821	200	1900	186	1915	171	1910	1536	3038
Nitrate (mg/L)	1.10	1.45	1.00	1.12	1.20	2.40	1.60	1.60	0.90	1.10	2.20	1.30	1.40	1.68	1.44	1.50	1.36	1.52
Sulphate (mg/L)	121	1300	122	1200	105	1121	968.	120	520.	500.	121	1213	132	1400	129	1300	1101.	1154.
Phosphate (mg/L)	0.14	0.42	0.19	0.30	0.14	0.20	0.18	0.11	0.10	0.14	0.16	0.13	0.26	0.50	0.21	0.30	0.17	0.26
Silica (mg/L)	2.8	2.6	2.5	2.6	2.2	2.6	2.6	2.3	3.1	2.8	3.4	3.0	3.1	3.6	2.8	3.0	2.81	2.81
Biochemical Oxygen Demand (mg/L)	2	2	2	3	3	4	2	3	3	4	2	5	2	3	1	2	2.13	3.25
Chemical Oxygen Demand (mg/L)	3	4	4	3	5	6	5	5	6	8	5	9	4	4	3	3	4.38	5.25
Dissolved Oxygen (mg/L)	4.6	4.7	5.1	5.0	4.9	5.2	4.6	4.9	4.5	4.9	5.0	4.8	4.8	4.8	4.9	5.0	4.80	4.91
Chlorophyll a (µg/l)	7.9	8.0	6.2	4.3	10.2	8.8	11.9	11.2	7.3	7.3	12.1	9.0	10.2	10.8	8.6	8.4	9.30	8.48

Table 2: Species Composition and Abundance of Phytoplankton at the Onijedi Lagoon (September, 2009 – April, 2010).

TAXA	SEPT.		OCT.		NOV.		DEC.		JAN.		FEB.		MAR.		APR.	
	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2
DIVISION: CYANOPHYTA																
CLASS: CYANOPHYCEAE																
ORDER I: CHROCOCCALES																
<i>Microcystis aeruginosa</i> Kutzing	40	45	-	5	10	10	35	15	10	5	15	25	20	20	20	15
<i>Microcystis aeruginosa</i> var. <i>major</i> Wm.. Smith	35	30	-	-	15	5	50	10	-	-	10	15	10	10	15	5
<i>Microcystis flos-aquae</i> Kirchner	40	25	10	-	10	25	40	35	10	-	-	15	25	10	15	15
<i>Scopulonema minus</i> (Hansgirg) Geitler	45	40	-	-	-	5	10	5	-	10	-	-	-	5	-	5
ORDER II: HORMOGONALES																
<i>Lyngbya</i> sp.	15	5	10	5	-	15	20	5	-	5	15	10	20	15	-	10
DIVISION – BACILLARIOPHYTA																
CLASS-BACILLARIOPHYCEAE																
ORDER I – CENTRALES																
<i>Coscinodiscus centralis</i> Ehrenberg	5	10	-	10	5	-	5	-	15	10	5	10	15	10	10	15
<i>Coscinodiscus eccentricus</i> Ehrenberg			5						10	5	10	10	-	-	-	-
<i>Coscinodiscus radiatus</i> Ehrenberg	-	-	10	5	-	-	15	10	-	5	-	5	-	-	15	15
Order II – PENNALES																
<i>Amphora ovalis</i> Kutzing	-	5	-	-	-	10	-	-	5	10	5	10	10	15	5	10
<i>Cocconeis placentula</i>	10	10	-	5	5	-	5	15	-	5	-	5	-	5	-	10
<i>Cocconeis scutellum</i> Ehrenberg	5	15	10	-	-	5	-	-	5	-	-	-	-	15	5	
<i>Gyrosigma balticum</i> (Ehr.) Rabenhorst	-	15	-	5	10	-	-	10	15	-	10	5	5	5	-	10
<i>Pleurosigma angulatum</i> (Quekett) Wm Smith	5	-	10	10	-	-	10	15	-	5	5	10	15	10	-	5
DIVISION – CHLOROPHYTA																
CLASS – CHLOROPHYCEAE																
ORDER - CLADOPHORALES																
<i>Cladophora glomerata</i> (L) Kutzing	-	5	10	5	-	10	5	-	15	10	15	10	15	10	-	-
Species diversity (S)	9	11	7	8	6	7	9	11	7	10	10	9	10	11	8	11
Species abundance (N)	200	205	65	50	55	75	195	125	75	80	90	105	125	145	95	115

Table 3: Biological indices of phytoplankton species at the Onijedi lagoon

Index	SEPT.		OCT.		NOV.		DEC.		JAN.		FEB.		MAR.		APR.	
	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2	St. 1	St. 2
Total species diversity (S)	9	11	7	8	6	7	9	11	7	10	10	9	10	11	8	11
Total abundance (N)	200	205	65	50	55	75	195	125	75	80	90	105	125	145	95	115
Log of Species diversity (Log S)	0.95	1.04	0.85	0.90	0.78	0.85	0.95	1.04	0.85	1.00	1.00	0.95	1.00	1.04	0.90	1.04
Log of abundance (Log N)	2.30	2.31	1.81	1.70	1.74	1.88	2.29	2.10	1.88	1.90	1.95	2.02	2.10	2.16	1.98	2.06
Shannon-Wiener Index (Hs)	0.83	0.93	0.84	0.88	0.75	0.77	0.85	0.95	0.81	0.96	0.96	0.90	0.96	1.00	0.86	1.01
Menhinick Index (D)	0.64	0.77	0.87	1.13	0.81	0.81	0.64	0.98	0.81	1.12	1.05	0.88	0.89	0.91	0.82	1.03
Margalef Index (d)	1.51	1.88	1.44	1.79	1.25	1.39	1.52	2.07	1.39	2.05	2.00	1.72	1.86	2.01	1.54	2.11
Equitability Index (j)	0.87	0.89	0.99	0.97	0.96	0.91	0.89	0.91	0.96	0.96	0.96	0.95	0.96	0.96	0.96	0.97
Simpson's Dominance Index (C)	0.17	0.14	0.15	0.14	0.19	0.20	0.17	0.14	0.16	0.12	0.12	0.14	0.12	0.11	0.15	0.10

Salinity according to Nwankwo and Amuda (1993), was reported to be the most important hydrographic factor affecting plankton distribution for the Lagos lagoon. The phytoplankton spectrum were represented prominently by *Microcystis* spp. which was the dominant species in both the Onijedi and Kuramo lagoons throughout the year. However, the bloom proportions of this blue-green algae in the Kuramo lagoon gives it the prevalent blue-green colour throughout the year (Nwankwo et al., 2008) and its reflective of high levels of organic pollution.

Nwankwo, (2004b), Nwankwo et al. (2003) and Onyema, (2012) have already reported *Microcystis aureginosa* as an indicator of moderate to high levels of organic pollution in fresh or brackish water situations in South-western Nigeria lagoons. Additionally diatoms reported for the Kuramo lagoon including *Nitzschia palea*, were clear indicators of high levels of organic pollution in the lagoon.

Other notable phytoplankton species were *Coscinodiscus* spp. which were likely recruited from the sea and *Amphora ovalis*, *Cocconeis* spp. and *Pleurosigma angulatum* which confirms the shallow depth of the points of collection and the brackish and alkaline nature of the lagoon. The occurrence of *Scopulonema minus* a synonym of *Pleurocapsa minor* in the Onijedi lagoon is a first report in Lagos, Nigeria. *Chroococcus turgidus* a very related species have been recorded in the Lagos lagoon by Nwankwo (2004b) and Onyema (2008) within Iyagbe lagoon. The characteristics of Shannon-Wiener (Hs), Margalef (D), Equitability (j) and Menhinick indices (d) show that the distribution and occurrence of species changed from one point to another within the lagoon, but more from month to month. For instance, values for these indices were generally lower in September than in other subsequent months.

Among the lagoons and wetland of Lagos state, there has been an increased clamour for protected areas especially with regards to sustainability and conservation. Nwankwo (2004b) listed a few additions in the Lagos coastal area and categorized them as possible Marine Protected Areas. The Onijedi lagoon

qualifies to add to the list of Marine Protected Areas (MPA) in the region before it goes the way of the Kuramo lagoon.

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