academicJournals

Vol. 6(11), pp. 373-388, December, 2014
DOI: 10.5897/JENE2014. 0473
Article number:EEB403248860
ISSN 2006-9847

http://www.academicjournals.org/JENE

Journal of Ecology and the Natural Environment

Full Length Research Paper

Phytoplankton composition and water chemistry of a tidal creek (Ipa-Itako) part of Lagos Lagoon

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Received 10 September, 2014; Accepted 24 October, 2014

The composition and diversity of planktonic algae in a sluggish tidal freshwater/brackish mangrove dominated creek (Ipa Itako) part of the Lagos lagoon was investigated for twelve months (February 2010 - January 2011). The surface water pH varied between 6.5 (December 2010) and 8.6 (August 2010) indicating a slightly acidic to alkaline nature of the creek. The salinity was higher during the dry months (November- April) and phosphate - phosphorus and nitrate-nitrogen recorded highest values (3.50 and 16.70 mg/L) respectively in June, 2010. Ninety three species belonging to forty nine genera from five classes (Bacillariophyceae, Chlorophyceae, Euglenophyceae, Cyanophyceae and Xanthophyceae) were recorded. Bacillariophyceae constituted the most abundant group making up 72.85% of cells/ml followed by the Chlorophytes (18.02%) then the blue green (7.65%), euglenoids (1.40%) and xanthophytes (0.07%) with only *Vaucheria* sp. recorded as a representative of the group. Higher phytoplankton diversity and cell counts were recorded in the dry months than in the wet months. *Navicula*, *Pinnularia, Cymbella* (Diatoms) and *Closterium* (Chlorophyceae) were more frequently occurring species. Community structure analysis indices used indicated a diverse but stressed environment.

Key words: Diversity, phytoplankton, creek, eutrophication.

INTRODUCTION

The nine lagoons in south-western Nigeria (Lagos, Kuramo, Yewa, Ologe, Badagry, Iyagbe, Epe, Lekki and Mahin) receive several rivers and creeks that drain into them. Some, like the Ogun River, Majidun, Ogudu and Festac creeks receive maritime influence through the adjoining lagoons in the dry season. While others like Yewa, Owo, Oshun Rivers, Ogbe and Orile creeks remain fresh through the year. The Lagos Lagoon, Nigeria is an open, shallow and tidal lagoon with a surface area of 208 km^2. Olaniyan (1969) reported that the rainfall regime in Lagos lagoon system is seasonal, with a wet season from May-November (with a short dry spell in July and August) and a dry season from December-April while Nwankwo (1999) reported two peaks of rainfall linked with excessive flood, a major peak in June and a lesser peak in September, associated with this area. Various ecological studies at the Lagos Lagoon have investigated and highlighted the mixing induced by semi-diurnal tidal dynamics and river flow (Hill and Webb, 1958), the existence of environmental and biota gradients (Sandison, 1966; Nwankwo, 1996),

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Plate 1. Part of Ipa-Itako showing the dominant riparian vegetation.

an increase in biodiversity towards the harbour (Nwankwo, 1996) and the phytoplankton (Nwankwo, 1996; Adesalu and Nwankwo, 2005). According to Olaniyan (1957), Hill and Webb (1958) and Nwankwo (1998), two physiographic factors, rainfall and salinity determine the hydro-climatic conditions of the Lagos lagoon. Rainfall dilutes the lagoon water, breaks down any environmental gradient and enriches the environment (Nwankwo et al., 2003). The presence and dominance of diatoms in water bodies in Nigeria has been reported by Nwadiaro (1990) in the chanomi creek system of the Niger Delta, Chindah and Pudo (1991) in Bonny River, Erondu and Chindah (1991) in the new Calabar River, Niger Delta, Adesalu and Nwankwo (2005, 2008) in Olero and Abule Eledu creeks, respectively, Adesalu et al. (2008) in Ogbe creek and Nwankwo (1986, 1991) in the Lagoons of South western Nigeria. Due to seasonal distribution of rainfall, seasonal flooding is experienced within the lagoon system and adjourning creeks. The creeks and lagoons of south-western Nigeria apart from their more ecological and economic significance, serve as sink for the disposal of any increasing array of waste types. Refine oil, waste heat, sewage, wood waste, municipal and industrial effluents among others enter into immediate coastal waters through conduits such as rivers, creeks, storm water channel and lagoons (Akpata et al., 1993; Chukwu and Nwankwo, 2004). Hence, phycologists over the years have attempted to judge the degree and severity of pollution by analyzing changes in biological systems (Nwankwo, 2004). Egborge (1974) suggested that the seasonal variation of the phytoplankton population and abundance in many West African rivers could be related to the physico-chemical parameters of the water which in turn is determined by the distributive rainfall pattern. The interplay between the physical and chemical characteristics of any lagoon determines the spectrums of biota present at any time (Nwankwo, 2004).

After the light, the most important factor in phytoplankton productivity seems to be the concentration of inorganic salts, primarily nitrates and phosphates (Reynolds, 1984). The productivity of phytoplankton is strongly constrained by the need for light, which is only available in the upper layers and the need for mineral nutrients available only in the deeper layers. Nwankwo (1990) reported that the Lagos lagoon is primarily characterized by seasonal salinity variations. In wet season, there are obvious discontinuities in the salinity gradient which coincide with the periods of fresh water discharge (Nwankwo, 1990). The dry season however, imposes an increased tidal sea water incursion, which raises the salinity appreciably (Nwankwo, 1990). Olaniyan (1969) grouped the Lagos lagoon into three distinct environments with regards to salinity. They are: fresh, low brackish and high brackish. These features have impact on the lagoon floristic and faunanistic spectral changes in the temporal and seasonal terms (Nwankwo et al., 2003). Nwankwo and Amuda (1993) reported that information on the creeks of South-western Nigeria as well as their possible value in biological water quality assessment is either scanty or non-existent but more recently, Adesalu and Nwankwo (2006, 2008a), Adesalu and Olayokun (2011) and Adesalu et al. (2008b, 2010) worked on Olero, Ogbe, Agboyi, Ajegunle and Tomaro creeks, respectively. Since no study has been specifically carried out on this water body (Ipa-Itako), it is then necessary to investigate the phytoplankton composition interaction with the water chemistry.

MATERIALS AND METHODS

Description of the study site

Ipa-Itako creek (Figure 1) is one of the water bodies in Ikorodu area of Lagos State that empties into the Lagos lagoon. Three sampling stations were created, Station 1 (Latitude 06° 473′ 35N, Longitude 003° 570′ 26E), Station 2 (Latitude 06° 735′ 35N, Longitude 003° 324′ 26E) and Station 3 (Latitude 06° 804′ 35N, Longitude 003° 352′ 26E). Ipa-Itako creek is slow flowing and the shore is characterized by mangrove plants including *Rhizophora racemosa*, *Avicennia germinans* and very few *Eichorrnia crassipes* Solms on the surface of the water along the edges with *Rhizophora racemosa* being the dominant riparian vegetation (Plate 1). The creek is quite narrow as compared to some other creeks in the Lagos lagoon and this is probably due to the spread of mangrove plants in the area. The area experiences tidal influences from the sea via the Lagos Lagoon. Dredging often occurs at these stations which is probably the cause of the regular change in colour of the water body. The study area is quite far from human settlement and industries; the water has unpleasant odour and fishing is not common in this area.

Collection of samples

Samples were collected on every second saturday of the month for twelve months (February, 2010 – January, 2011) to spread across the dry months (December – April) and wet months (May-November). Phytoplankton samples were collected using 55 μm mesh size standard plankton net tied unto a motorized boat and towed horizontally at low speed (< 4 knots) for five minutes. The samples were transferred into 500 ml plastic containers and preserved with 4% unbuffered formalin. Water samples for the analysis of physico-chemical parameters were collected in 750 ml plastic containers with screw caps just below the water surface. All samples were transferred to the laboratory for further analysis.

Physical and chemical parameters analysis

Air and surface water temperatures were measured *in situ* with a

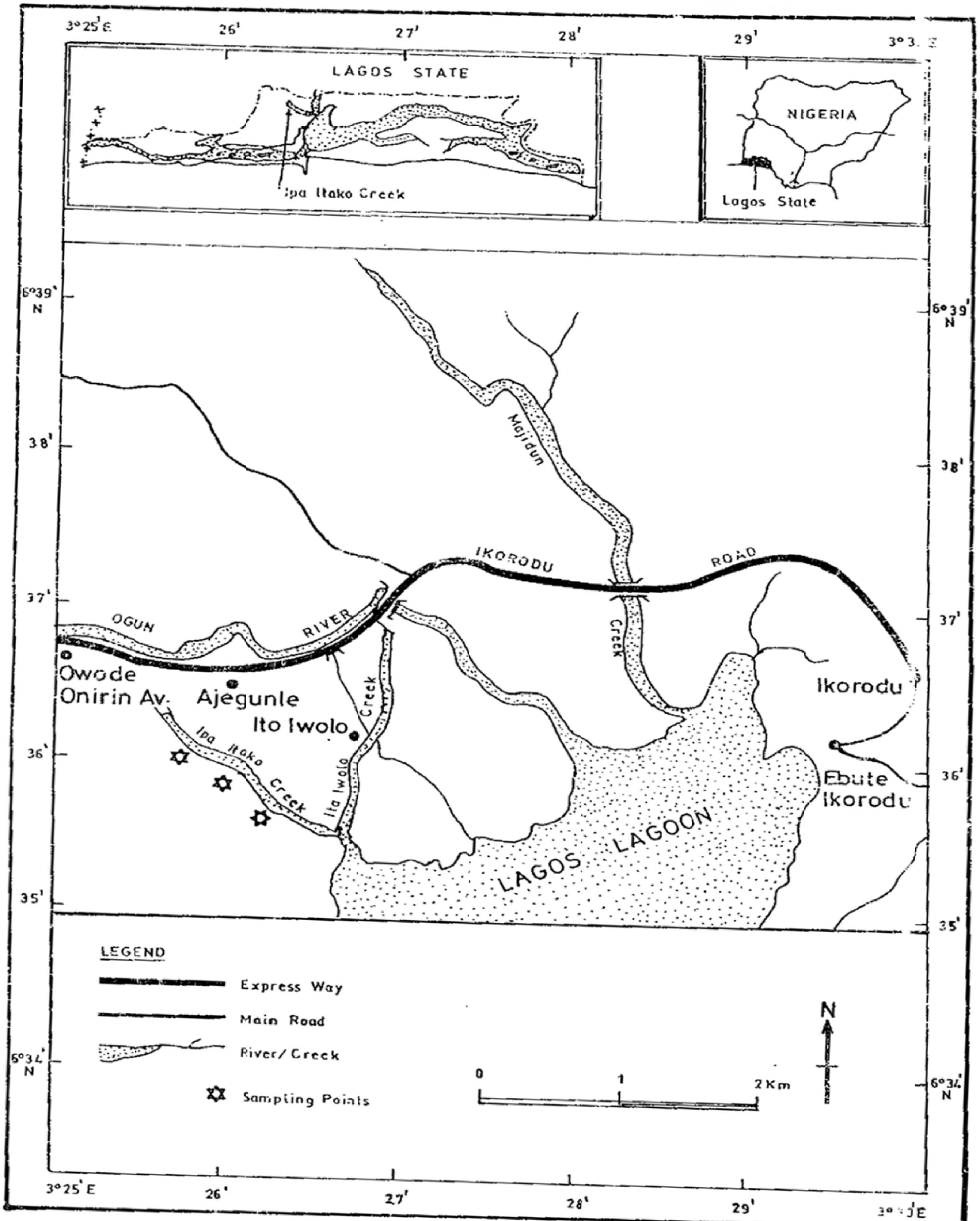

Figure 1. Map showing Ipa Itako creek part of Ikorodu area with sampling stations.

nitrate-nitrogen values were estimated using titrimetric method while phosphate-phosphorus and sulphate were determined by ascorbic acid and turbidimetric methods, respectively (APHA, 1998). Silica was determined at 600 nm using a pre-calibrated colorimeter (DR2010). Copper, lead and mercury values were measured using atomic absorption spectrophotometer (AAS) (APHA, 1998). Heavy metals, copper, lead and mercury were determined using Atomic Absorption Spectrophotometer (AAS). Rainfall data were kindly supplied by the Meteorological Services Department, Oshodi, Lagos State.

Phytoplankton analysis

Biological samples were analyzed using Olympus XSZ-N107 photo-microscope. In this study, filamentous blue green were counted using 10 μm of filament length representing one unit unicells and solitary cells were tallied as separate individuals, for *Microcystis* sp. the method used for filamentous algae was applied. For further analysis, one unit was equated as one cell. Chlorophyll 'a' was determined using a fluorometer equipped with filters for light emission and excitation. Relevant texts employed in the identification included Nwankwo (1984), Olaniyan (1969, 1975), Wimpenny (1996), Hustedt (1930, 1937, 1942, 1971), Patrick and Reimer (1966, 1975), Prescott (1964, 1973, 1982) and Whittford and Shumacher (1973).

Community structure analysis

To obtain the estimate of species diversity, three community structure indices were used: Margalef's diversity index (d) (Margalef, 1970), Shannon-Weaner Index (H^1) (Shannon and Weaver, 1963) and Species equitability (J) or evenness (Pielou, 1975).

RESULTS

Physico-chemical parameters

Some of the parameters analysed with the results are presented on Table 1. For this study, the highest (31.7°C) and lowest (26.2°C) surface water temperature values were recorded during dry (February 2010) and wet (July 2010) months at station 2, respectively. The pH was essentially neutral (7.0) for the first four months and varied from slightly acidic (6.5) to being alkaline with the highest value (8.6) recorded in August 2010 (wet month) at station 3. Highest transparency (225.6 cm) and conductivity (20.0 μs/cm) values were recorded in dry month (March 2010). Salinity decreased steadily as the rainfall increased, the highest value, 20.0‰ recorded in March 2010 (dry month) at station 1. Nitrate-nitrogen and phosphate-phosphous values varied between 2.0 – 16.7 and 1.58 - 3.50mg/L, respectively while sulphate highest value (23.4 mg/L) was recorded in April 2010 (dry month) at station 2 (Figure 2). Silica content of the water recorded its highest value (0.44 mg/L) in October 2010 (wet month) at station 2. Dissolved oxygen content highest value (5.7mg/L) was recorded during the dry month (April 2010) at station 2.

Phytoplankton results

93 taxa belonging to 49 genera were recorded for this study, spread across five classes, Bacillariophyceae, Chlorophyceae, Cyanophyceae, Euglenophyceae and Xanthophyceae (Table 2). Diatoms recorded highest percentage composition cells/ml value of 72.85% followed by the green algae (Table 3). *Navicula mutica, Navicula muralis*, *Pinnularia substomatophora, Nitzschia palea* and *Cymbella obtusa* were observed as frequently encountered species. Variations in chlorophyll 'a' value, total phytoplankton and rainfall are depicted on Figure 3.

Community structure analysis followed same trend as highest species divesity (d) value (6.46) corresponded with highest Shannon-Weaner index value (3.16) (Figure 5). Highest species evenness (j) value (0.99) was recorded in February at station 1 (Figure 4). Chlorophyll-a content varied between 0.01 and 0.04 mg/L throughout the sampling period (Figure 4). Numerically, the diatoms outnumbered other algae species, with *Navicula* appearing most throughout the study period. Other diatom species recorded were *Fragilaria construens, Coscinodiscus centralis, Cyclotella meneghiniana, Ulnaria ulna, Bacillaria paradoxa, Perlibellus berkeleya* and *Melosira moniliformis.*

DISCUSSION

Information on variation in physico-chemical factors of the Ipa Itako creek confirms earlier observations in the Lagos lagoon that two dominant factors, fresh water discharge and tidal sea water incursions governs the physical, chemical and biological characteristics of the areas (Hill and Webb, 1958; Sandison and Hill, 1966; Nwankwo, 1988, 1998b; Brown, 1991). According to Webb (Hill and Webb, 1958), rainfall other than temperature is more important in determining environments in the tropics. Rainfall pattern has been linked to the different ecological factors influencing the abundance and composition of phytoplankton in coastal waters of southwestern Nigeria (Olaniyan, 1969; Nwankwo and Akinsoji, 1992). The highest amount of rainfall recorded at Ipa Itako creek in June and July 2010, probably accounts for decrease in salinity values which is in accordance with observation made by Adesalu and Nwankwo (2008). Increased total suspended solids and lower transparency values recorded at the peak of wet season with high volume of rainfall confirmed the work of Adesalu et al. (2010) who stated that increased total suspended solids and reduced transparency values lower photosynthetic rate of phyto-plankton. According to Nwankwo and Akinsoji (1988), phos-phate-phosphorus alone or in combination with nitrate-nitrogen favoured the growth of *Navicula* and *Nitzschia* which were observed in this study and probably suggests high concentration of organic nitrogenous materials. Similarly, The presence and dominance of diatoms in the sampling areas conform with observation made by Nwadiaro (1990) in the Chanomi creek system of the Niger Delta, Chindah and Pudo (1991) in Bonny

Table 1. Physico-chemical analysis results of the surface water at Ipa-Itako through out sampling period (Wet months: May-October Dry month:November-April).

Parameter	February 2010			March 2010			April 2010			May 2010			June 2010			July 2010		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Surface Water temperature (°C)	31.5	31.7	31.2	29.8	30.1	29.9	29.0	29.4	28.5	31.5	31.4	31.5	28.3	29.0	28.7	26.5	26.2	26.4
Transparency (cm)	118.9	128.1	137.2	214.3	225.6	146.3	29.0	36.0	31.0	182.9	134.6	152.4	50.8	48.3	38.1	26.0	29.0	34.0
pH	7.0	7.0	7.0	7.6	7.3	7.0	7.4	7.5	7.2	7.6	7.5	7.5	8.0	7.7	7.5	7.0	8.4	8.3
Conductivity (us cm)	20.0	20.0	20.0	13.10	20.0	20.0	15.06	20.0	20.0	19.14	19.29	17.5	2.56	2.27	1.09	0.05	0.29	0.24
Total Suspend Solids (mg/L)	3.0	2.20	2.0	1.20	1.50	2.70	2.20	3.70	2.0	2.70	3.50	1.50	1.10	1.30	1.50	1.00	2.20	2.40
Total Dissolved Solids (Mg L)	10.0	10.0	10.0	10.0	10.0	10.0	7.62	10.0	10.0	9.55	9.61	8.78	0.79	1.12	0.55	0.02	0.140.12	0.12
Lead (mg L)	0.06	0.04	0.05	0.06	0.05	0.07	0.03	0.02	0.05	0.29	0.31	0.03	0.01	0.10	0.02	0	0	0
Copper (mg/L)	2.90	3.27	3.10	2.92	3.36	3.29	5.60	4.70	4.20	4.60	4.44	3.70	4.50	5.50	4.60	3.60	4.21	3.60
Mercury (mg/L)	ND	ND	ND	ND	ND	ND	nd	nd	nd	ND	ND	ND	nd	nd	nd	ND	ND	ND
Silica (mg/L)	0.20	0.34	0.22	0.23	0.35	0.24	0.30	0.44	0.29	0.04	0.30	0.009	0.22	0.14	0.17	0.05	0.04	0.019
Dissolved Oxygen (mg/L)	5.40	5.00	5.50	5.10	5.20	5.20	5.50	5.70	5.00	5.00	5.20	5.40	5.20	5.00	5.10	5.00	5.10	5.00
Biological Oxygen Demand (mg/L)	9.0	10.0	9.0	8.0	9.0	6.0	11.0	9.0	8.0	10.0	7.0	6.0	9.0	8.0	9.0	10.0	9.0	11.0
Chemical Oxygen Demand (mg/L)	12.0	10.0	9.0	10.0	12.0	8.0	14.0	12.0	10.0	13.0	11.0	13.0	14.0	11.0	15.0	14.0	12.0	15.0

Parameter	August 2010			September 2010			October 2010			November 2010			December 2010			January 2011		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Surface Water temperature (°C)	26.7	26.6	26.6	27.1	27.1	27.2	27.5	27.6	27.9	28.0	27.6	27.5	28.6	28.3	28.2	27.3	26.9	26.7
Transparency (cm)	54.0	80.0	79.0	70.0	54.0	59.0	41.0	55.0	44.0	48.0	41.0	42.0	74.0	82.0	67.0	140.0	141.0	102.0
pH	8.4	8.4	8.6	6.8	7.2	7.2	7.2	7.2	7.1	6.8	7.2	7.2	6.5	6.5	6.5	6.7	6.6	6.8
Conductivity (us cm)	0.62	0.58	0.14	0.04	0.05	0.18	0.07	0.08	0.08	0.00	0.08	0.09	1.26	2.19	1.20	8.43	14.06	10.46
Total Suspend Solids (mg/L)	1.10	1.00	1.00	1.40	1.10	1.20	1.10	1.20	1.10	1.40	1.10	1.20	1.00	1.10	2.10	1.20	1.10	1.OO
Total Dissolved Solids (Mg L)	0.31	0.30	0.21	0.02	0.02	0.09	0.04	0.04	0.04	0.00	0.04	0.04	0.63	1.16	0.59	4.16	7.05	5.25
Lead (mg L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.02	0.03	0.001	ND	ND	ND
Copper (mg/L	1.20	0.70	1.50	1.40	1.20	1.30	1.10	1.30	1.12	1.40	1.20	1.30	1.23	1.10	1.04	2.00	2.10	1.60
Mercury (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silica (mg/L)	0.20	0.34	0.22	0.23	0.35	0.24	0.30	0.44	0.29	0.40	0.30	0.009	0.22	0.14	0.17	0.05	0.04	0.019
Dissolved Oxygen (mg/L)	0.02	0.04	0.03	0.02	0.04	0.02	0.01	0.11	0.03	0.02	0.04	0.01	0.21	0.14	0.02	0.01	0.01	0.02
Biological Oxygen Demand (mg/L)	7.0	8.0	9.0	9.0	8.0	9.0	11.0	13.0	11.0	9.0	8.0	9.0	10.0	11.0	10.0	12.0	10.0	11.0
Chemical Oxygen Demand (mg/L)	10.0	12.0	11.0	15.0	13.0	12.0	14.0	16.0	13.0	15.0	13.0	12.0	12.0	13.0	12.0	15.0	14.0	13.0

mercury-in-glass thermometer and recorded in degree Celsius (°C). *In situ* measurement of transparency and salinity were determined using 20 cm diameter Secchi disc and handheld refractometer respectively. Total suspended solids (TSS) and total dissolved solids were estimated using gravimetric method (APHA, 1998). The pH was determined using a Cole Parmer Testr3 while conductivity values were measured using Philip PW9505 conductivity meter. Dissolved oxygen, chemical oxygen demand and

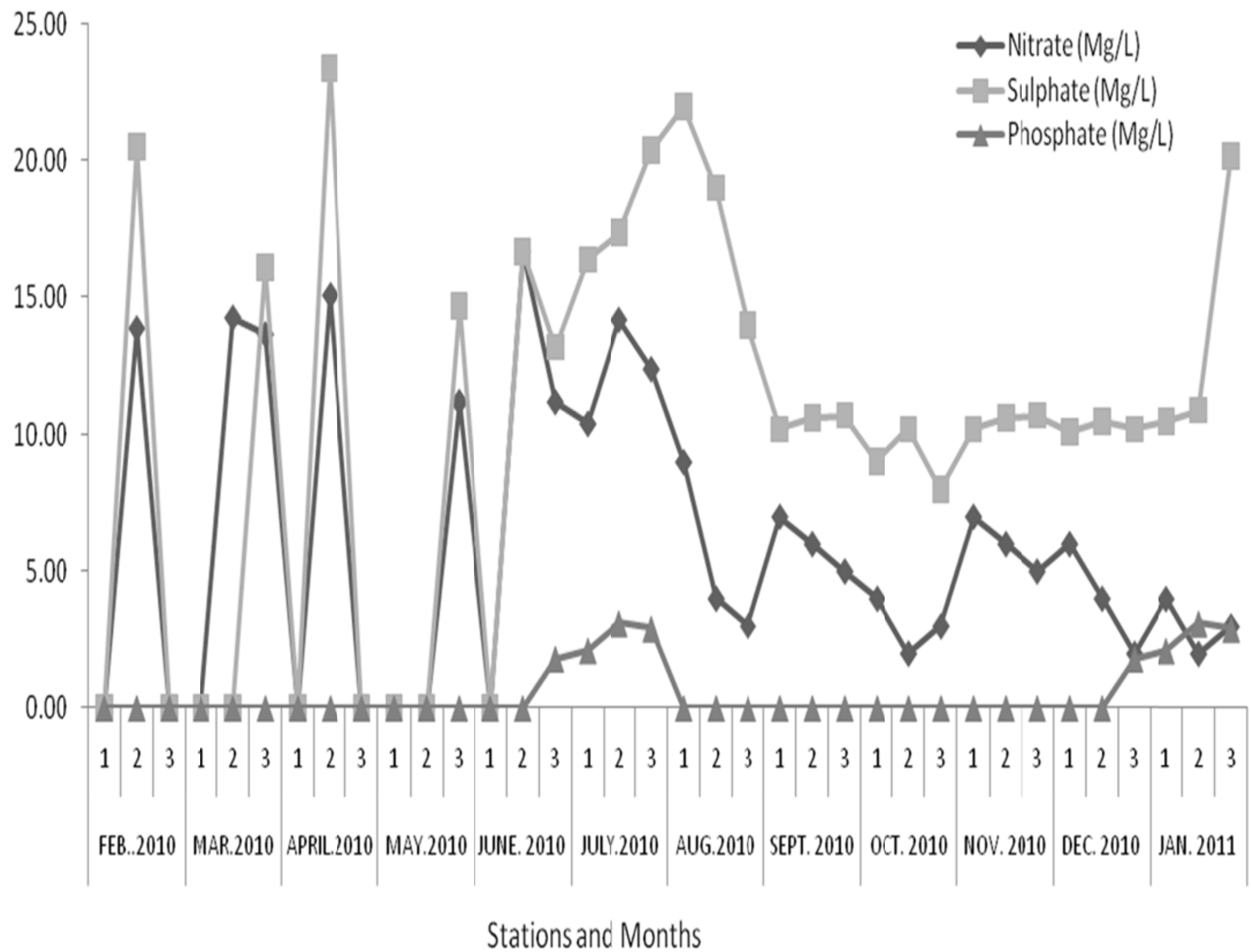

Figure 2. Temporal distribution of dissolved inorganic nutrients at Ipa-Itako.

River, Erondu and Chindah (1991) in the new Calabar River, Niger Delta, Adesalu and Nwankwo (2005, 2008) in Olero and Abule Eledu creek respectively, Adesalu et al. (2008) in Ogbe creek and Nwankwo (1986, 1991) in the Lagoons of South western Nigeria. The presence and abundance of *Oscillatoria* sp. among the blue-green supported Nwankwo (2004) who stated that the blue green algal forms found in the creek were mostly filamentous forms and could be opportunistic forms which by biomodification of physical processes usually proliferate to advantages of other species. Akpata et al. (1993), Chukwu and Nwankwo (2004) reported that the creeks and lagoons of South-western Nigeria, apart from their more ecological and economic significance, serve as sink for the disposal of an increasing array of waste types. Sewage, wood waste, refine oil, waste heat, municipal and industrial effluents among others find their way unabated into immediate coastal waters through conduits such as storm water channel, rivers, creeks and lagoons. The presence of *Coscinodiscus, Oscillatoria limosa* and *Euglena acus* were indications that probably Ipa Itako creek is organically polluted. This agrees with the finding of Palmer (1969) that some euglenoids can tolerate various levels of organically polluted waters therefore they can be used as biological indicators of pollution. Adesalu and Nwankwo (2008) also stated *Oscillatoria limosa* as biological indicator of organically polluted environment. Variations in the appearance of different species in relation to months and time of the year could be attributed to the observation of past characteristics, such that during the rainy season, an immerse volume of fresh water passes through the harbour and out into the sea whereas during the dry season, the flow of fresh water ceases and sea water enters the harbour giving rise to marine conditions near the harbour mouth and to brackish water extending to

Table 2. Phytoplankton composition at Ipa-Itako creek.

S/N	Classification	February 2010			March 2010			April 2010			May 2010			June 2010			July 2010		
	Division:Bacillariophyta	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
	Class: Bacillariophyceae																		
	Order: Achnanthales																		
	Family:Catenulaceae																		
1	*Achnanthes lanceolata* (Breb) Grun.																		
	Family: Catenulaceae																		
2	*Amphipleura pallucida* Kutzing																		
3	*Amphora custata* Hust.																		
4	*A. holsatica* Hustedt																		
5	*A. microcephala* Kutzing																		
6	*A. pediculus* var.minor Grun.																		
7	*Amphora* sp																		
	Order: Fragilariaceae																		
	Family: Fragilaraceae																		
8	*Asterionella ralfsii* W.Sm				1			2								1			
9	*Fragilaria construens* Her.			1	2	4			1	1			3	1	1			1	3
10	*F. virescenses* Ralf.																		
11	*Fragilaria* sp.																		
12	*Synedra delicatissima* W.Sm		2	2			2			1		3		1		4	2		
13	*Synedra* sp.		1	3			1												
14	*Ulnaria ulna* (*Nitzsch*) Ehrenberg																		1
	Order: Bacillariales																		
15	*Bacillaria paradoxa* Gmelin			2	4	9	5			3	1	4	5	2		1		4	3
16	*Nitzschia ignorata* Krasske																		
17	*N. obtusa* W.Sm.																		
18	*Nitzschia palae* (Kutzing) Wm Smith	2	2	6	12	6	4	2	1	3	2		2	1				1	4
	Family: Cocconeidaceae																		
19	*Cocconeis placentula* var. lineatus																		
20	*Cocconeis* sp																		
	Family: cymbellellaceae																		
21	*Cymbella affinis* Ehr																		
22	*C. aspersa* (Ehr) Cleve			1		1	4		2	1				3	2	2	2		
23	*C. ehrenbergii* Kutz																		
24	*C. gracilis* (Rabh) Cleve																		
25	*C. lanceolata* (Ehr) van																		
26	*C. obtuse* (Kutz) Grun			1	1		2	4	6	3	3	1	2	4	7	6			

Table 2. Contd.

27	*C. reinhardii* Krammer																		
28	*C. silesiaca* Bleisch.																		
29	*Cymbella* sp																		
	Family: Eunotiaceae																		
30	*Eunotia elegans* Øestrup																		
31	*E. pectinalis* var minor (Kutz)Rabh.																		
	Family: Gomphonemataceae																		
32	*Gomphonema* sp.																		
	Order: Naviculales																		
	Family: Naviculaceae																		
33	*Frustulia rhomboids* (Ehr.) de Toni				1		2				2		1				1		
34	*Gyrosigma acuminatum* (Kutzing) Rabh																		
35	*Luticola mutica* (Kutzing)	2	4	5	2	9	8	5	9	12	4	6	2	5	2	7	8	5	9
36	*Navicula cryptocephala* Kutz.																		
37	*N. exigua* (Greg) O. Mulla	2	4	10	1		4	2			3				2	2	3	1	1
38	*N. gracilis* Hautzsh																		
39	*N. muralis* Gum	2	5	7	3	7	10	5	6	6	8	11	9	9	3	5	8	6	8
40	*Navicula* sp.																		
41	*Neidium* sp																		
42	*Perlibellus berkeleya* (Kutz)E.. J Cox	2		3	1	4	4		5	2	2			1	3				1
43	*Pinnularia acrosphaeria* Breb.																		
44	*P. biceps* Gregory																		
45	*P. braunii* (Grun) Cleve																		
46	*P. substomatophora* Hust	1	2		2		4			3	5	5	9	6	2	4	6	2	2
47	*Pinnularia* sp.																		
48	*Plaurosigma strigosum* W. Sm.																		
49	*Pleurosigma* sp																		
	Family: Surirellaceae																		
50	*Surirella* sp.																		
	Order: Tabellariales																		
	Family: Tabellariaceae																		
51	*Tabellaria fenestrate* (Lyng) Kutzing																		
52	*T. flocculosa* (Roth) Kut	2		3		5	3		7	2	4		3	2		3	1		2
	Family: Stephanodiscaceae																		
53	*Coscinodiscus centralis* Ehrenberg	2	12	8	2	4	2			6	9	3	2						
54	*Cyclotella meneghiana* Kutzing	1	3	6	2	3	4	2											
55	*Diatomell* sp																		

Table 2. Contd.

	Family: Diplodaceae																	
56	*Diploneis puella* (Schum) Cleve																	
	Family: Melosiraceae																	
57	*Melosira moniliformis* (OFM) Agardh	2	6	4	9	6	10	2	4	8	2	5	7		2	5	3	4
	Class: Cyanophyceae																	
	Order I: Oscillatoriales																	
58	*Oscillatoria formosa* Bory		3			2						2		3				
59	*O. borneti*	2	3	9										2				
60	*O. limosa* (Roth). Ag		1	2	2									1				
61	*Spirulina laxa* G.m Smith	2	3	1	6	5				6		2		6	2		6	
62	*Spirulina* sp.																	
63	*Pseudophormidium* sp.																	
	Order II: Chroococcales																	
64	*Chroococcus turicensis* (Nag) Hansgirg		3	1	2									1				
65	*Gleocapsa granosa* (Berk.) Kutz..				2	2								3				
66	*Microcystis aeruginosa* Nag				2	1				2				2	1			
	Class: Chlorophyceae																	
	Order I Chlorococcales																	
67	*Ankistrodesmus falcatus* G.S West	1	2	4	2	1								2	2			2
68	*Chaetosphaeridium globosum* (Nordst) Kleb.																	
69	*Chaetosphaeridium* sp																	
70	*Chlorella vulgaris* Beyerinck			2	4	2				4				3				5
71	*Coelastrum* sp																	
72	*Hyalotheca* sp																	
73	*Pleurotanium* ovatum																	
74	*Pithophthora* sp.																	
75	*Scenedesmus bijuga* (Turp) Lagerheim			3		1								2				2
76	*S. obliquus* (Turp) Kutzing			3	6	5				5		4		4	6			7
77	*Treubaria* sp																	
	Order II: Desmidiales																	
78	*Closterium gracile* Breb.																	
79	*C. incurvum* Breb					1				3				4				2
80	*C. moniliferum* Her.																	
81	*C. setaceum* Ehrenb.				2	4				1		2		4				3
82	*C. venus* Kutz	2			2	3				1		1			3			5
83	*Closterium* sp.																	
84	*Cosmarium dentatum* Wolle		2	1	2	4								4	2			
85	*C. mobiliforme* (Turp) Ralfs		2	1	2	4				4					2			

Table 2. Contd.

86	*C. pseudobroomei* Wolle	1	1	3		2				4		2			4				
87	*Gonatozygon aculeatum* Hastings			2	2	1									1				
88	*Penium cylindrus* (Her.) Breb.					2								2					
	Order III: Ulothricales																		
89	*Ulothrix zonata* (Weber & Mohr) Kutz.		2	4		4								4	2				
	Class: Euglenophyceae																		
	Order: Euglenales																		
90	*Euglena proxima* Dang	2	2		3					3				1					
91	*E. acus* Ehrenberg	2	1		4	3									2			3	
92	*Phacus triqueter* Playfair		1	4	3							2		4	5			5	
	Class: Xanthophyceae																		
93	*Vaucheria* sp.																		
	Total Number of Species (s)	17	23	29	30	29	16	8	9	23	12	16	11	28	21	11	10	22	12
	Total Number of I ndividuals (N)	30	67	95	89	105	69	24	41	84	45	58	42	84	56	40	36	79	39
	Margalef Species Diversity (d)	4.70	5.23	6.15	6.46	6.02	3.54	2.20	2.15	4.97	2.89	3.69	2.68	6.09	4.97	2.71	2.51	4.81	3.00
	Shannon- Weaver (H)	2.80	2.90	3.15	3.16	3.18	2.60	1.99	2.01	2.92	2.30	2.52	2.21	3.71	1.55	2.25	2.06	2.95	2.21
	Species Evenness (j)	0.99	0.93	0.94	0.93	0.95	0.94	0.96	0.91	0.93	0.93	0.91	0.92	0.95	0.51	0.94	0.90	0.95	0.89
S/N	**Classification**	**August2010**			**September 2010**			**October 2010**			**November 2010**			**December 2010**			**January 2011**		
	Division: Bacillariophyta	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	Class: Bacillariophyceae																		
	Order: Achnanthales																		
	Family: Catenulaceae																		
1	*Achnanthes lanceolata* (Breb) Grun.										3		22						
	Family: Catenulaceae																		
2	*Amphipleura pallucida* Kutzing		3					2		5		5	19						
3	*Amphora custata* Hust.														1				
4	*A. holsatica* Hustedt											1							
5	*A. microcephala* Kutzing											1							
6	*A. pediculus* var.minor Grun.									1									
7	*Amphora* sp															3			
	Order: Fragilariaceae																		
	Family :Fragilaraceae																		
8	*Asterionella ralfsii* W.Sm																		
9	*Fragilaria construens* Her.																		
10	*F. virescenses* Ralf.							15		1									
11	*Fragilaria* sp.										218	1200	120	167	586	40			
12	*Synedra delicatissima* W. Sm																		

Table 2. Contd.

13	*Synedra* sp.				1		16			12	2	8	132	1			34	20	
14	*Ulnaria ulna* (Nitzsch) Ehrenberg																		
	Order: Bacillariales																		
15	*Bacillaria paradoxa* Gmelin																		
16	*Nitzschia ignorata* Krasske														5		2		
17	*N. obtusa* W.Sm.									10		1		1					
18	*Nitzschia palae* (Kutzing) Wm Smith					2													
	Family: Cocconeidaceae																		
19	*Cocconeis placentula* var. lineatus			131															
20	*Cocconeis* sp											2	21						
	Family: cymbellellaceae																		
21	*Cymbella affinis* Ehr											1							
22	*C. aspersa* (Ehr) Cheve																		
23	*C. ehrenbergii* Kutz													12		4			
24	*C. gracilis* (Rabh) Cleve									1									
25	*C. lanceolata* (Ehr) van									5									
26	*C. obtuse* (Kutz) Grun														5				
27	*C. reinhardii* Krammer												1						
28	*C. silesiaca* Bleisch.	4		12															
29	*Cymbella* sp									12					1				1
	Family: Eunotiaceae																		
30	*Eunotia elegans* 0estrup					3									1				1
31	*E. pectinalis* var minor (Kutz)Rabh.									2									
	Family: Gomphonemataceae																		
32	*Gomphonema* sp.							1		2						1			
	Order: Naviculales																		
	Family: Naviculaceae																		
33	*Frustulia rhomboids* (Ehr.) de Toni								2	1							6	38	6
34	*Gyrosigma acuminatum* (Kutzing) Rabh						1	5							1			10	10
35	*Luticola mutica* (Kutzing)									3									
36	*Navicula cryptocephala* Kutz.				1			1		1		1							
37	*N. exigua* (Greg) O. Mulla																		
38	*N. gracilis* Hautzsh									2					2				
39	*N. muralis* Gum									2					2				
40	*Navicula* sp.								2					2					
41	*Neidium* sp				3	3													
42	*Perlibellus berkeleya* (Kutz)E.. J Cox																		

Table 2. Contd.

43	*Pinnularia acrosphaeria* Breb.													1	8	31			
44	*P. biceps* Gregory									1						5			
45	*P. braunii* (Grun) Cleve									5	1							1	6
46	*p. substomatophora* Hust																		
47	*Pinnularia* sp.				1					1		1			15				1
48	*Plaurosigma strigosum* W. Sm.	1			1						2	5	7					25	25
49	*Pleurosigma* sp														38	5			
	Family: Surirellaceae																		
50	*Surirella* sp.	1			1										5				2
	Order: Tabellariales																		
	Family: Tabellariaceae																		
51	*Tabellaria fenestrate* (Lyng) Kutzing	2			1		9	17	4	15	4	1	3	1	10	10		47	
52	*T. flocculosa* (Roth) Kut												1		1				
	Family : Stephanodiscaceae																		
53	*Coscinodiscus centralis* Ehrenberg											5	43						
54	*Cyclotella meneghiana* Kutzing						1												
55	*Diatomell* sp		3																
	Family: Diplodaceae																		
56	*Diploneis puella* (Schum) Cleve									3									
	Family: Melosiraceae																		
57	*Melosira moniliformis* (OFM) Agardh							3			2	13	60	1		10			1
	Class: Cyanophyceae																		
	Order I: O scillatoriales																		
58	*Oscillatoria formosa* Bory																		
59	*O. borneti*																		
60	*O . limosa* (Roth). Ag																		
61	*Spirulina laxa* G.m Smith											6		8	60	15			
62	*Spirulina* sp.						150												
63	*Pseudophormidium* sp.																		
	Order II: Chroococcales																		
64	*Chroococcus turicensis* (Nag) Hansgirg																		
65	*Gleocapsa granosa* (Berk.) Kutz..																		
66	*Microcystis aeruginosa* Nag																		
	Class: Chlorophyceae																		
	Order I Chlorococcales																		

Table 2. Contd.

67	*Ankistrodesmus falcatus* G.S West																		
68	*Chaetosphaeridium globosum* (Nordst) Kleb.	1			300														
69	*Chaetosphaeridium* sp	39	5																
70	*Chlorella vulgaris* Beyerinck																		
71	*Coelastrum* sp	40																	
72	*Hyalotheca* sp	1																	
73	*Pleurotanium ovatum*		7		2			73	1	15									
74	*Pithophthora* sp.	83																	
75	*Scenedesmus bijuga* (Turp) Lagerheim																		
76	*S. obliquus* (Turp) Kutzing																		
77	*Treubaria* sp							2		2									
	Order II: Desmidiales																		
78	*Closterium gracile* Breb.														1	5			
79	*C. incurvum* Breb																		
80	*C . moniliferum* Her.				20			2	1										
81	*C. setaceum* Ehrenb.			3	3														
82	*C. venus* Kutz																		
83	*Closterium* sp.							29											
84	*Cosmarium dentatum* Wolle																		
85	*C. mobiliforme* (Turp) Ralfs																		
86	*C. pseudobroomei* Wolle																		
87	*Gonatozygon aculeatum* Hastings																		
88	*Penium cylindrus* (Her.) Breb.																		
	Order III: Ulothricales																		
89	*Ulothrix zonata* (Weber & Mohr) Kutz.																		
	Class: Euglenophyceae																		
	Order: Euglenales																		
90	*Euglena proxima* Dang																		
91	*E. acus* Ehrenberg																		
92	*Phacus triqueter* Playfair																		
	Class: Xanthophyceae																		
93	*Vaucheria* sp.	3	1																
	Total Number of Species (s)	10	5	3	13	2	5	10	5	22	7	16	10	9	17	11	3	6	9
	Total Number of I ndividuals (N)	175	19	146	338	8	178	145	10	100	232	1252	428	194	742	129	42	141	53
	Margalef Species Diversity (d)	1.74	1.36	0.40	2.06	0.48	0.77	1.81	1.74	4.56	1.10	2.10	1.49	1.52	2.42	2.06	0.54	1.01	2.01
	Shannon- Weaver (H)	1.35	1.46	0.38	0.55	0.66	0.59	1.48	1.47	2.64	0.33	0.27	1.78	0.62	0.91	1.96	0.59	1.53	1.59
	Species Evenness (j)	0.59	0.91	0.35	0.21	0.95	0.37	0.64	0.91	0.85	0.17	0.10	0.77	0.28	0.23	0.82	0.54	0.85	0.72

Table 3. Percentage composition of different classes of algae observed at the Ita-ipako stations.

Class:	Feb. 2010	Mar.2010	April 2010	May 2010	June 2010	July 2010	Aug. 2010	Sept. 2010	Oct. 2010	Nov. 2010	Dec. 2010	Jan. 2011	Total Phytoplankton/Class (Cells/ml)	Percentage composition
Bacillariophyceae	121	170	116	129	100	98	151	42	140	1910	946	236	4159	72.85
Cyanophyceae	23	35	38	37	21	44	0	0	150	6	83	0	437	7.65
Chlorophyceae	36	74	65	61	68	80	179	335	125	0	6	0	1029	18.02
Euglenophyceae	12	19	6	11	14	18	0	0	0	0	0	0	80	1.40
Xanthophyceae	0	0	0	0	0	0	4	0	0	0	0	0	4	0.07
Total Phytoplankton/month (cells/ml)	192	298	225	238	203	240	334	377	415	1916	1035	236		
Percentage Composition/month	3.36	5.22	3.94	4.17	3.56	4.20	5.85	6.60	7.27	33.56	18.13	4.13		

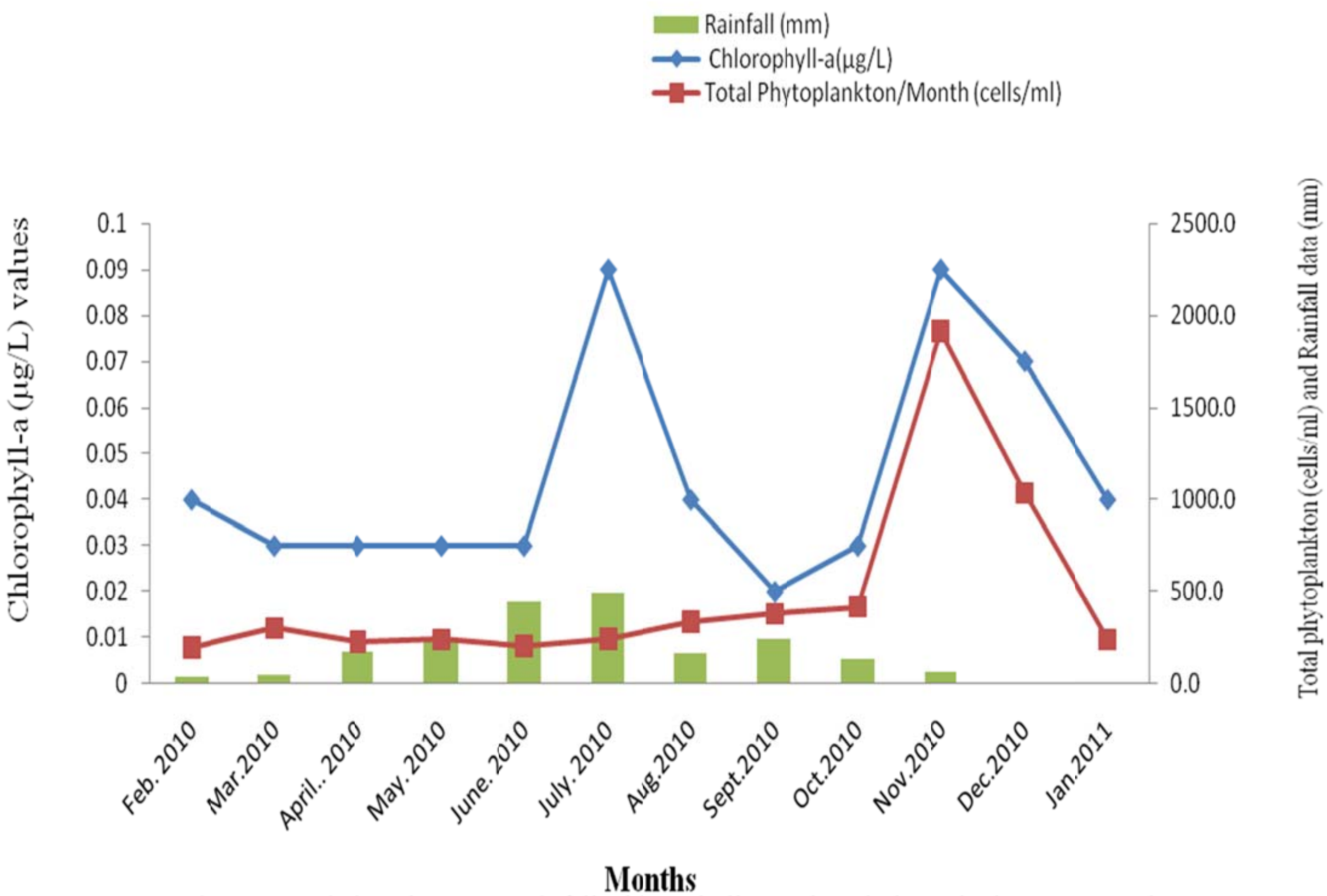

Figure 3. Variations between rainfall chlorophyll ‘a’ and total phytoplankton at Ipa-Itako.

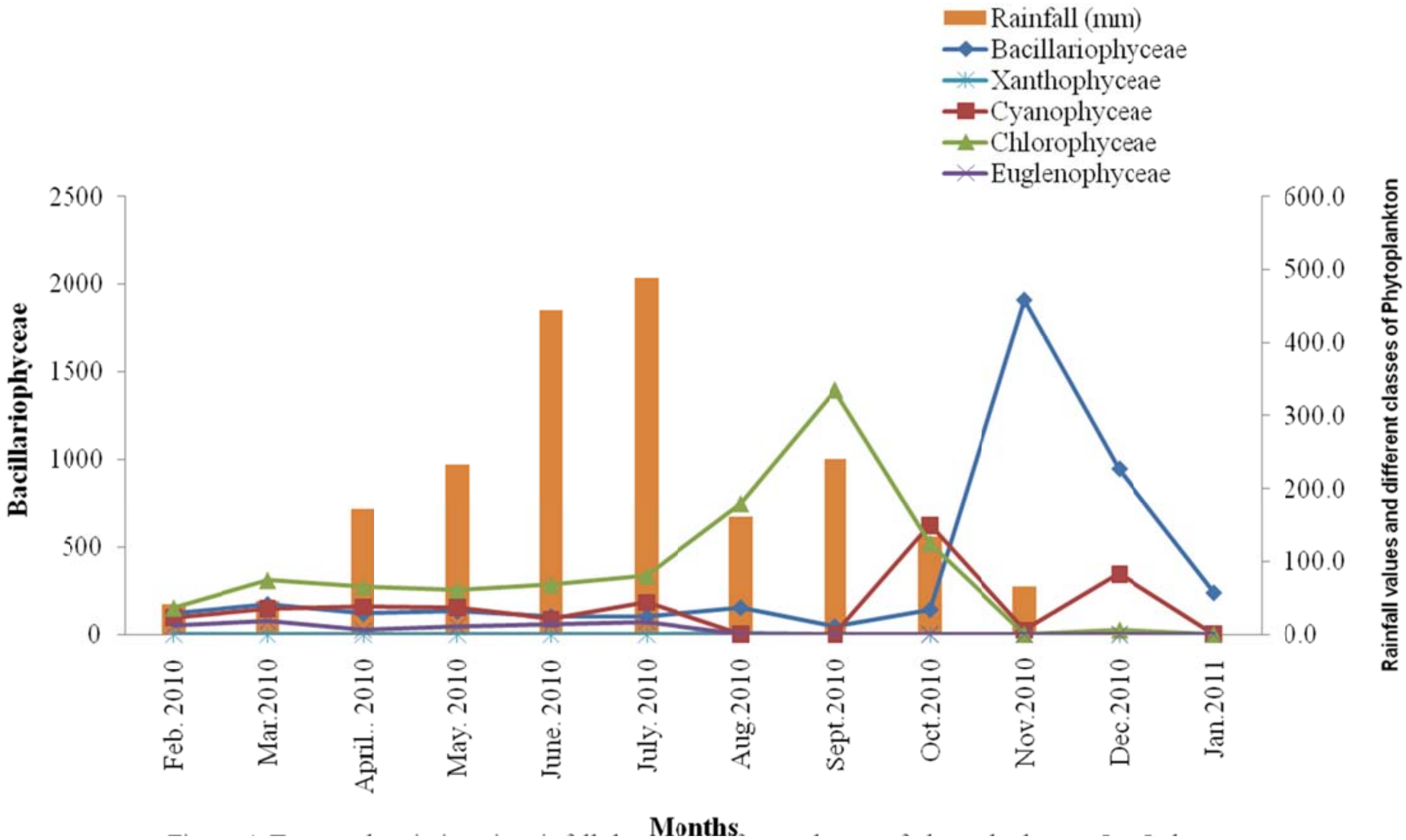

Figure 4. Temporal variations in rainfall data and different classes of phytoplankton at Ipa-Itako.

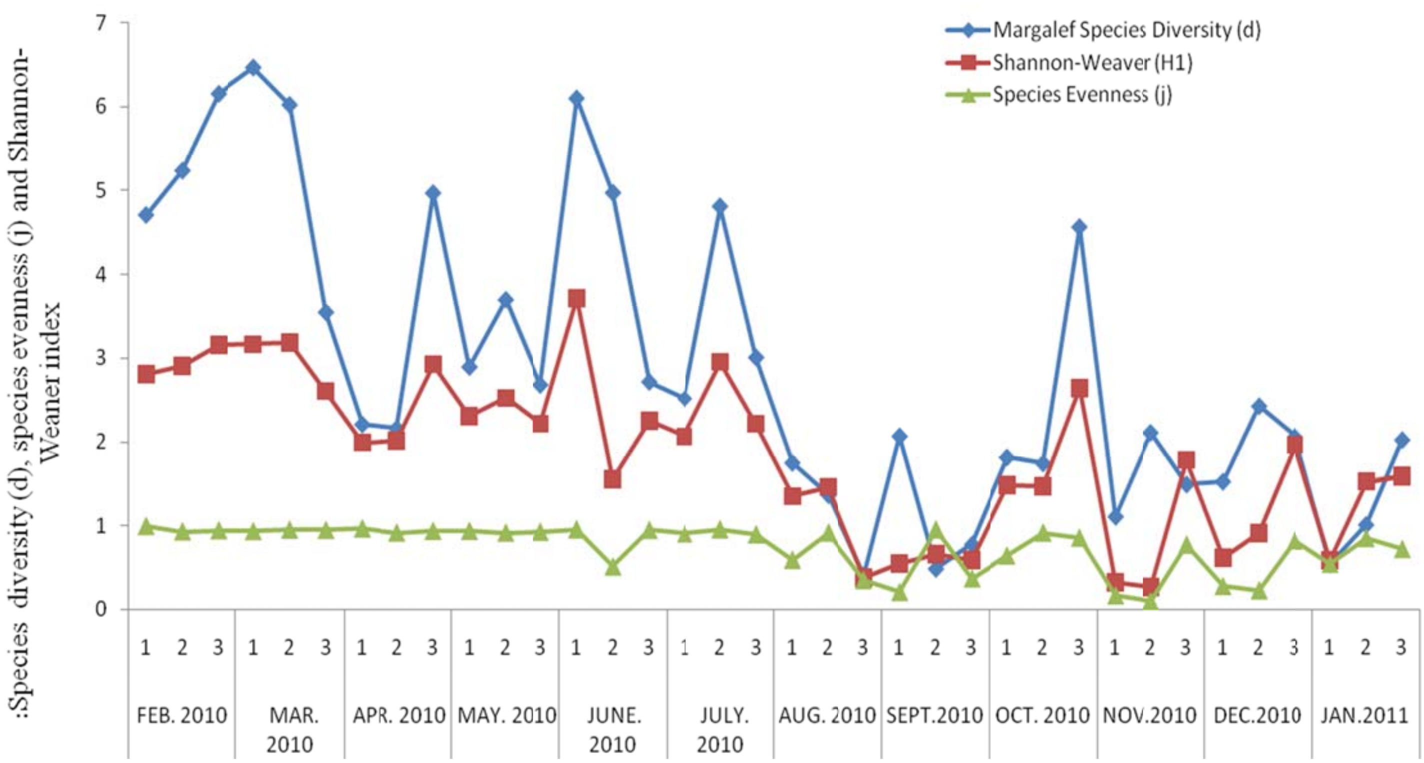

Figure 5. Relationship between community structure analysis at Ita-Ipako.

about 32 km up the lagoons and creeks. Thus, the organisms in this area are subjected to seasonal fluctuations from fresh water to brackish conditions. It is of note worthy that part of Ipa-Itako is undergoing construction now for expansion of Ikorodu road, hence this study served as baseline study and pre-construction data.

REFERENCES

Adesalu TA, Nwankwo DI (2005). Studies on the Phytoplankton of Olero creek and parts of Benin River, Nigeria. The Ecologia 3(2):21-30.

Adesalu TA, Nwankwo DI (2008a). Effect of water quality indices on phytoplankton of a sluggish tidal creek in Lagos, Nigeria. Pak. J. Biol. Sci. 11(6):836-844.

Adesalu,TA, Abiola TO, Bofia TO (2008b). Studies on the epiphytic algae associated with two floating aquatic macrophytes in a sluggish non-tidal polluted creek in Lagos, Nigeria. Asian J. Sci. Res. 1(4):363-373.

Adesalu TA, Bagbe M, Keyede D (2010). Hydrochemistry and phytoplankton composition of two tidal creeks in South-Western Nigeria. Rev. Biol. Trop. (Int.) J. Trop. Biol. 58(3):827-840.

Adesalu TA and Olayokun OM (2011). Water chemistry and phytoplankton composition of a polluted tidal creek, Lagos. J. Sci. Res. Dev. 13:171-183.

Akpata TV, Oyenekan JA and Nwankwo DI (1993). Impact of organic pollution on the Bacterial, Plankton and Benthic Population of Lagos lagoon, Nig. Inter. J. Ecol. Envir. Sci. 19:73-82.

APHA (1998). Standard method for the examination of water and waste-water, 20th edition. Washington D. C. 1213pp.

Brown CA (1991). Community structure and secondary production of benthic microfauna of the Lagos lagoon and harbour. M.Phil Thesis, University of Lagos. 359pp.

Chinda AC and Pudo J (1991). A preliminary checklist of algae found in plankton of Bonny River in Niger Delta, Nigeria. Fragm flor.Geobot. 36(1):112-126.

Chukwu LO and Nwankwo DI (2004). The impact of land based pollution on the hydrochemistry and macro community of a tropical West Africa creek. The Ecologia. 3(1-2):1-9.

Egborge AB (1974). The seasonal variation and distribution of phytoplankton of Osun river, Nigeria. Fresh water Biology. 4:177-191.

Erondu ES and Chindah AC (1991) Physico-chemical phytoplankton changes in a tidal freshwater station of the New Calabar River South Eastern Nigeria. Envir. Ecol. 9(3):561-570.

Hill MB and Webb JE (1958). The ecology of Lagos lagoon II. The topography and physical features of the Lagos lagoon. Philosophical Transaction of Royal Society, London. 241:307-417.

Hustedt F (1930–1937). Die. Kiselalgen 7. In Rabenhorst (ed.): Kryptogemen-flora von Deutshland Österreichs un der Schweiz. A Kademiscehe Vergasell Schaft M.L.H. Leipzing. 466pp.

Hustedt F (1942). Bacillariophyta In: Huber-Pestblozzi (ed.): Die Binnengewasser Stuttgardt. 206pp.

Hustedt F (1971). Kryptogamen-flora von Deutschland, Österreichs un der Schweiz. A Kademiscehe Vergasell Schaft M.L.H. Leipzing. 816pp.

Margalef R (1970). Perspective in Ecological Theory. University of Chicago press, Chicago. 111pp.

Nwadiaro CS (1990). A hydrobiological survey of the Chanomi creek system, lower Niger Delta, Nigeria. Limnologica. 21:263-274.

Nwankwo DI (1984). Seasonal changes of phytoplankton of Lagos lagoon and the adjacent sea in relation to environmental factors. Ph.D Thesis, University of Lagos. 447pp.

Nwankwo DI (1986). Phytoplankton of a sewage disposal site in Lagos lagoon, Nigeria. Nig. J. Biol. Sci. 1:89-91.

Nwankwo DI (1988). A preliminary checklist of planktonic algae in the Lagos lagoon, Nigeria. Nig. J. Bot. 3:53-70.

Nwankwo DI (1990). Contribution to the diatom flora of Nigeria. Diatoms of Lagos lagoon and the adjacent sea. Nig. J. Bot. 3:53-70.

Nwankwo DI (1991). A survey of the dinoflagellates of Nigeria I. Armoured dinoflagellates of Lagos lagoon and associated tidal creeks. Nig. J. Bot. 4:49-60

Nwankwo DI (1996). Phytoplankton diversity and succession in Lagos lagoon. Archiv Fur Hydrobiologie. 135(4):529-542.

Nwankwo DI (1998). Seasonal changes in phytoplankton population and diversity in Epe lagoon, Nigeria. Acta Hydrobiologia. 40(2):82-92.

Nwankwo DI (2004). Studies on the Environmental Reference of blue-green algae (cyanophyta) in Nigeria coastal waters. The Nig Envir Soc. J. 2(1):44-51.

Nwankwo DI and Akinsoji A (1988). Periphyton algae of Eutrophic creek and their possible use as indicator. Nig. J. Bot 1:47-54.

Nwankwo DI and Akinsoji A (1992). Epiphyte community on water hyacinth, Eichhornia crassipes (Mart.)Solms in coastal waters of South-Western Nigeria. Archiv Fur Hydrobiologie. 124(4):501-511.

Nwankwo DI and Amuda SA (1993). Periphyton diatoms on three floating macrophytes in a polluted South Western Nigeria creek. Inter. J. Eco Envir Sci. 19:1-10.

Nwankwo DI, Onyema IC and Adesalu TA (2003). A survey of harmful algae in coastal waters of South Western Nigeria. The Nig. Envir. Soc. J. 1(2):241-246.

Olaniyan CI (1957). The seasonal variation in plankton population in the Lagos harbour, Nigeria. Ph.D Thesis, University of London.158pp.

Olaniyan CI (1969). The seasonal variation in the hydrology and total plankton of the lagoons of South Western Nigeria. Nig. J. Sci. 3:101-119.

Olaniyan CI (1975). The seasonal variation in the hydrology and total plankton of the lagoons of South Western Nigeria. Nig. J. Mar. Res. 8:36-59.

Palmer MC (1969). A composite rating of algae tolerating organic pollution. Phycology 5:78-82

Patrick R and Reimer CW (1966). The diatoms of the United States exclusive of Alaska and Hawaii. Vol. 1–Monographs. Academy of Natural Sciences, Philadelphia. 688pp.

Patrick R and Reimer CW (1975). The diatoms of the united states exclusive of Alaska and Hawaii. Vol. 2, Part 1–Monographs. Academy of Natural Sciences, Philadelphia. 213pp.

Pielou EC (1975). The measurement of diversity to different types of biological collections J. Theor. Biol. 13:131-144.

Prescott GW (1961-1973) .Algae of the Western Great Lake Area. Wm. C Brown Co. IOWA. 977pp.

Prescott GW (1982). Algae of the Western Great Lakes area with an illustrated key to the genera of desmids and freshwater diatoms. Brown Co Publishers, Dubuque IOWA. 977pp.

Reynolds CS (1984). The ecology of freshwater phytoplankton. Cambridge University press. 114pp.

Sandison EE (1966). The effect of salinity fluctuation on the life of Balanus pallidus strusburi (Darwin) in Lagos Habour, Nig. J. Anim. Ecol. 35:365-378.

Sandison EE and Hill MB (1966). The distribution of Balanus pallidus strusburi (Darwin), Gryphaea gasar (Adarson) Danizenberg, Mercicerella enigmatica Farbel and Hydroides uncinata (Phillipi) in relation to salinity in Lagos harbour and adjacent creeks. J. Anim. Ecol. 38:235-258.

Shannon CE and Weiner W (1963). The mathematical theory of communication. University of Illinois press, Urbans. 125pp.

Wimpenny RS (1996). The plankton of the sea. Faber and Faber Limited, London.

Whitford LA and Schumacher GJ (1973).A manual of fresh water algae. Raleigh, North Carolina. 574pp.