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Temporal variations in water chemistry and chlorophyll-*a* at the Tomaro creek Lagos, Nigeria

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Temporal variations of the water chemistry and chlorophyll-a dynamics at the Tomaro creek Lagos were investigated for six months (October, 2007 to March, 2008). Temperature remained high (>27°C) all through the sampled period while total suspended solids and transparency increased in the dry months. Total dissolved solids were high (≥8160 mg/L) between December and March while lower values (≤2529 mg/L) were recorded between October and November. Salinity, conductivity and pH values increased steadily during the sampled months. Chemical oxygen demand and biological oxygen demand values at the site remained low (<12.80 mg/L; ≤2.0 mg/L) between the period free of organic pollution and moderately (≤52.2 mg/L; 7.0 mg/L) organically polluted period. Heavy metals (Pb, Fe, Cu) especially Fe followed almost same pattern as chlorophyll-a recorded. Phytoplankton abundance dropped (80cells/ml) between November and December. Phytoplankton diversity was high while the species were evenly distributed.

Key words: Tidal creek, water chemistry, chlorophyll-a, phytoplankton.

INTRODUCTION

Tidal creeks provide major aquatic links between storm water runoffs from land and saline estuaries and lagoons. Tidal creeks may originate as storm water channels or creeklets drain into coastal rivers or directly into estuaries or lagoons. This ecosystem is characteristic due to frequent variations in the physical and chemical features of the creek water. Such water chemistry dynamics makes them unique habitats that provide home to a myriad of euryhaline biota. Tidal creeks and associated mangrove swamps are important habitats for juvenile fishes, shrimps and crabs however, devastated through erection on new settlement and roads. Habitat modification in Nigeria led to sand filling of the kuramo creek which created the kuramo lagoon (Nwankwo et al., 2008). There are also sand excavation at the Badagry, Majidun, Porto Novo creeks and the dredging of Ajegunle, Shomolu and Orile Stormwater channels. Such modifications alter environments to the advantage of opportunistic species (Nwankwo1995, 1996; Nwankwo and Akinsoji, 1988). Creeks, creeklets and storm water channels are prominent features of low lying coastal zones of south-west Nigeria.

Most of these experience semi-diurnal tidal regime that affects the water chemistry and determine the biota (Adesalu and Nwankwo, 2008, 2010; Nwankwo, 1997; Onyema, 2007). According to Nwankwo and Amuda (1993), the creeks, creeklets and storm water channels of south-west Nigeria serve as conduits that drain flood water and land based pollutants into the coastal lagoons. The fresh water parts of these conduits serve as refugiumes for aquatic weeds while the more saline parts are inundated with halophytes (Nwankwo and Amuda, 1993; Nwankwo and Gaya; 1996; Adesalu and Nwankwo, 2008). Egborge (1988) described the submerged roots of water hyacinth *Eichhornia crassipes* (Mart,Solms) that heavily infested part of the Badagry creek as a biological museum of aquatic biota. Nwankwo and Akinsoji (1992) reported the preponderance of water hyacinth in the Orile

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canal, storm water channel that drain part of Lagos main-land. In high brackish water zones of the Abule Agege and Five Cowries creek, Nwankwo (1991), Nwankwo and Gaya (1996) and Onyema and Nwankwo (2006) docu-mented estuarine dinoflagellates notably, *Ceratium spp*. The possible impact of land based pollutants on benthic macrofauna in the Port Novo creek was described by Chukwu and Nwankwo (2004) while the temporal succession of phytoplankton at the Abule-Eledu creek Lagos was documented by Adesalu and Nwankwo (2008). Furthermore, the fish resources and plankton of the Abule Agege creek were reported by Emmanuel and Onyema (2007) while Onyema and Ojo (2009) reported the temporal distribution of zooplankton of the Majidun creek, Lagos. Similarly, Onyema et al. (2010) provided an interim check list of the zooplankton at the Tomaro creek, Lagos that flows through a mangrove swamp. Nwankwo (1995) documented the euglenoids of some storm water channels in south-west Nigeria while Nwankwo et al. (in press) reported the composition and distribution of plank-ton in the FESTAC creek, a highly nitrified sluggish creek. Adesalu et al. (2010) compared the biota of the Ajegunle and the Tomaro creeks. Information on the estimation of primary productivity using other methods other than the drop count method is scanty. Karlman (1982) determined productivity at the Kainji lake, Nigeria using the dark and white bottle oxygen method in the abandoned Tin mines of Jos, Nigeria. Kemdirin (1990) used the chlorophyll-*a* method to determine the primary productivity. At the Ikpoba lake, Benin, Nigeria, Kadiri (1993) used chlorophyl-a method in determining productivity. Similarly in the brackish environment, Onyema and Nwankwo (2009) estimated primary productivity at the Iyagbe Lagoon, Lagos, Nigeria while Onuoha and Nwankwo (2010) used the chlorophyll-a method in determining the primary productivity in the Ologe lagoon. Published work on the creeks, creeklets and storm water channels of South-west Nigeria have been limited to abundance com-position, water chemistry and determination of phytoplan-kton dynamics. The aim of this study was to investigate the high plankton diversity, chlorophyll-*a* dynamics and water characteristics at the Tomaro creek, Lagos.

MATERIALS AND METHODS

Study site

Tomaro creek is one of the numerous creeks located in south-west, Nigeria (Figure 1). It drains into the Lagos lagoon through the Apapa wharf. It is tidal, deep and experiences the same climatic conditions as other part of south-west, Nigeria. The littoral part of the creek is surrounded by mangrove species particularly *Rhizophora racemosa.*

Collection of samples

Duplicate samples, one for the determination of water chemistry characteristics and the other for plankton investigation were collected at Tomaro creek between 9.00 and 12.00 h. Water sam-ples were collected 20 cm below the water surface in 1 L plastic containers with screw caps. Plankton samples were collected in 55 µm mesh size standard plankton net tied on a motorized boat and towed to low speed (<4 knots) for 5 min. Each concentrate was poured into a well labeled 250 ml plastic container. Water samples were preserved in an ice-chest while plankton samples were preserved in 4% unbuffered formalin.

Determination of water chemistry characteristics

On each occasion, air and water temperature were determined using an ordinary mercury in-glass thermometer to the nearest 1°C.Transparency was measured with a 20 cm diameter black and white painted Secchi disc while water depth was estimated with a calibrated pole. The pH and Dissolve Oxygen were measured *in-situ* using Griffin digital pH meter (model 80) and Graffin digital meter Dissolve Oxygen (model 40) respectively. Salinity was determined with a refractometer while conductivity was determined with a HANNA instrument. In the laboratory, total suspended solids (TSS) were determined by filtering 500 ml of the sample through pre-weighted filter papers that was subsequently dried in an oven at 105°C for 24 h, cooled and re-weighted while Total Dissolved Solids (TDS) were estimated by evaporating 100 ml of filtrate in a pre-weighted evaporating dish at 100°C. Phosphate-phosphorus content was estimated after treatment with Denige's reagent while nitrate-nitrogen content was estimated using the phenol disulphonic acid (APHA, 1993). The sulphate and reactive silicates were deter-mined using the standard method as described by Strickland and Parsons (1972). Biochemical Oxygen Demand (BOD) level was estimated after 5-days incubation period using the method described in APHA (1993). Heavy metal content (Cu, Pb, Fe) were determined with an Atomic Absorption Spectrophotometer (model 969). Rainfall data were kindly supplied by the Nigerian Institute for Oceanography and Marine research, Victoria Island, Lagos.

Determination of phytoplankton biomass

Each plankton sample was scanned using a wild MII binocular microscope with a calibrated eye piece. A total of 10 drops were thoroughly investigated for each sample. Each drop was scanned in five fields with the movement of the stage to various sides. In the study, the microtransect drop-count method was used as described by Lackey (1938). All organisms, unicells, filaments, coenobia were counted as one and recorded as organisms per ml after appropriate conversions. The phytoplanktons were identified using relevant texts (Deskachary, 1959; Barber and Harworth, 1981; Hendey, 1964; Patrick and Reimer 1966, 1975).

Chlorophyll-*a* determination in water sample

Chlorophyll-*a* was determined using the method described by Holm-Harsen (1970). This method involves filtering 250 ml water sample, extracting the chlorophyll-*a* with methanol, centrifuging at 3200 rpm for 10 min and measuring the extinction loads at 665 and 750 nm. Calculation was done using the formula:

$$\text{Chlorophyll-}a = \frac{(\text{Abs 665nm-Abs 750nm}) \times A \times Vm}{Vf \times L}$$

Where, A= Absorbance coefficient of chlorophyll-*a* in methanol; Vm= volume of methanol used for extinction; Vf= Volume filtered; L= Path length of cuvette.

RESULTS

Data on the physico-chemical and biological charac-teristics of Tomaro creek are presented in Tables 1 and

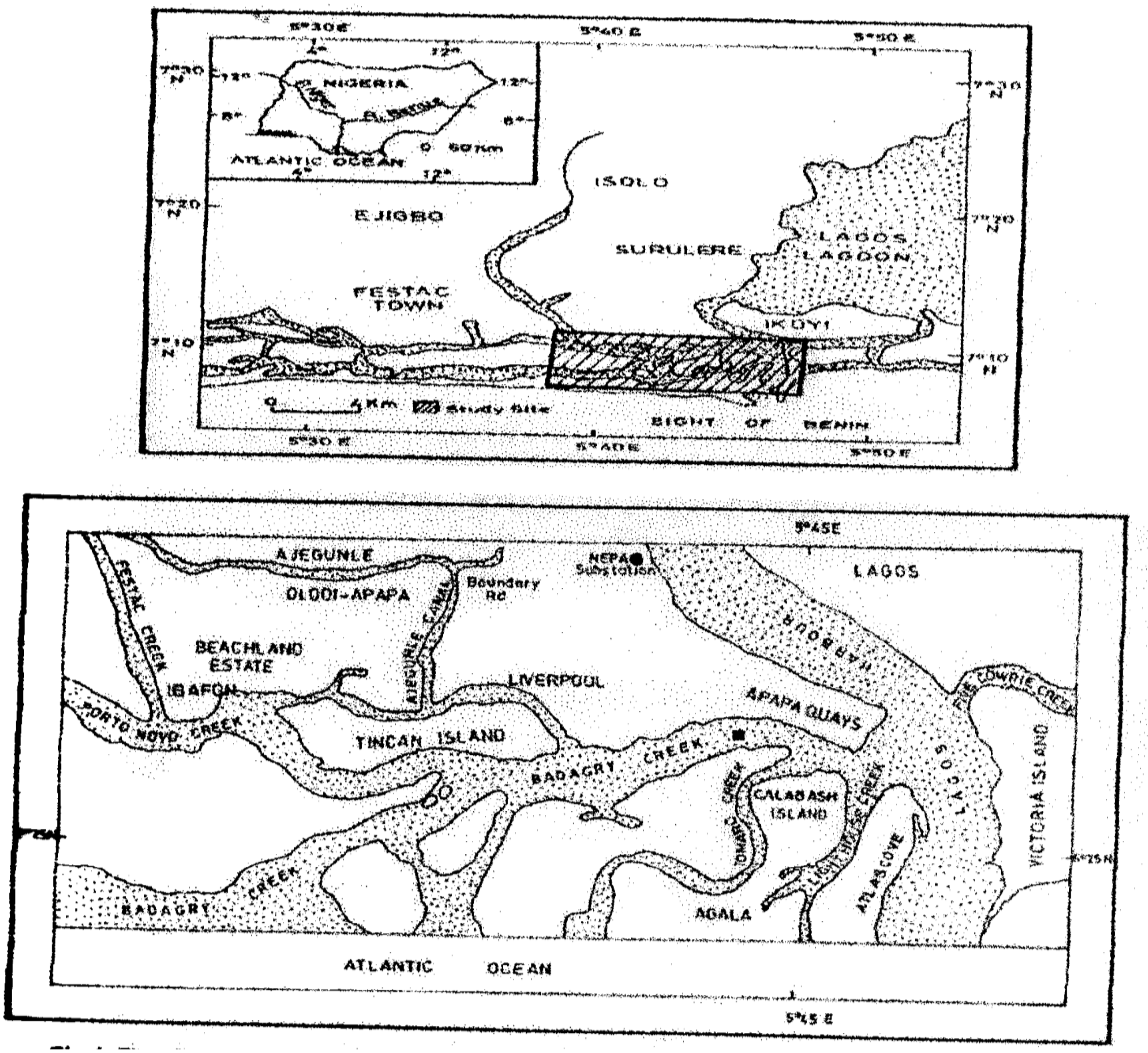

Figure 1. The Apapa area of lagos showing major creek and sampling site.

2. Air and water temperature were high (>27°C) all through the sampling months except in February when air and water temperatures were 23.8 and 25.1°C respectively. Total suspended solids were low in the site (<146 mg/L) while total dissolved solids were high (1780 mg/L) all through the sampled period (8160 mg/L). Similarly, transparency was high (7103 mg/L) in the dry months; the site remained slightly alkaline (pH<7.62) while salinity and conductivity values increased from October to March. Dissolved Oxygen values were above 4.1 mg/L all through the samples period except between November and December when dissolved oxygen values ranged between 3.6 and 3.8mg/L. Biochemical oxygen demand values (6.0 mg/L) was recorded in October and December. Nutrient levels were relatively high at the site whereas reactive nitrogen values ranged between 3.8 and 4.8 mg/L, reactive phosphorus level ranged from 1.0 to 2.5 mg/L.The lowest reactive silicate value was 1.8 mg/l while the highest was 3.60 m/L. Between October 2007 and March 2008, sulphate values varied from 32.0 mg/L in the wet months to 588mg/L in the dry months. Highest chlorophyll-a concentration (22) was recorded in March when lower rainfall pattern (17.6) was recorded and this corresponded to higher sulphate values (1200) (Figure 2). Heavy metal level was low (< 0.22 mg/L) throughout the sampled period and the highest Lead (Pb) value was recorded in March during the dry season when higher chlorophyll-a and Iron (Fe) values were recorded (Figure 3). Shannon and weaver index remained at above 0.71 while equitability (j) was above 0.86 in the dry months. Total suspended solids were low while total dissolved solids and transparency values were high at

Table 1. Monthly variation in physico-chemical parameters at the Tomaro creek (October, 2007-March, 2008).

Parameter	OCT. 2007	NOV. 2007	DEC. 2007	JAN. 2008	FEB. 2008	MAR. 2008
Air Temperature(ºC)	27.2	30	32	27.8	23.8	26
Water Temperature (°C)	27.5	28.1	29.5	27.2	25.1	29.7
Salinity($^{o}/_{oo}$)	2.20	3.00	10.50	16.8	21.9	20.90
pH	7.32	7.36	7.34	7.52	7.62	7.57
Conductivity(µs/cm)	4090	5730	19040	30500	36600	37000
Dissolved oxygen (mg/L)	4.2	3.8	3.6	4.1	5.4	4.8
Chemical oxygen demand (mg/L)	23.0	15.0	52.2	12.8	18.0	6.6
Biological oxygen demand (mg/L)	7.0	3.2	6.2	2.0	2.6	2.9
Dissolved oxygen (mg/L)	4.2	3.8	3.6	4.1	5.4	4.8
Chemical oxygen demand (mg/L)	23.0	15.0	52.2	12.8	18.0	6.6
Biological oxygen demand (mg/L)	7.0	3.2	6.2	2.0	2.6	2.9
Biological characteristics						
Chlorophyll-a estimates (µg/L)	10	20	16	18	19	22
Number of individual Phytoplankton	110	670	605	665	575	455

Table 2. Monthly variation in phytoplankton composition at Tomaro creek (OCT.2007-MAR. 2008)

Phytoplankton	OCT	NOV.	DEC.	JAN.	FEB.	MAR
Division: Bacillariophyta						
Class: Bacillariophyceae						
Order I: Centrales						
Actinotyphus splendens (Schadbolt) Ralfs	10	-	-	-	-	-
Aulacoseira granulata (Ehrenberg) Simonson	15	-	10	-	-	-
Cerataulina bergoni H.perag	-	-	-	-	30	-
Coscinodiscus centralis Ehrenberg	-	30	20	10	10	20
Coscinodiscus excentricus Ehrenberg	-	-	10	20	10	20
Coscinodiscus lineatus Ehrenberg	-	10	-	-	-	-
Coscinodiscus marginatus Ehrenberg	-	-	-	5	-	-
Guinardia flaccid (Castr.)	-	-	-	20	-	-
Hemidiscus sp	-	-	5		-	-
Skeletonema costatum (Greville)Cleve	-	-	-	-	5	-
Order II: Pennales						
Closterium sp	-	-	10	10	-	-
Fragillaria construens(Ehrenberg) Grun.						
Gyrosigma balticum (Ehrenberg) Rabenhorst	30	10	-	-	-	-
Navicula expansa Haglestcin	-	-	-	20	10	10
Navicula mutica Kutzing	-	20	10	-	-	10
Parlibellus delognei (V.H) Cox	-	-	-	40	90	10
Pleurosigma angulatum (Quekeh) Wm. Smith	-	-	-	5	-	-
Pleurosigma elongatum Wm. Smith	-	20	10	-	-	-
Pinnularia major Kutzing	-	20	-	-	40	-
Synedra crystalline Kutzing	-	-	5	10	-	-
Ulnaria ulna (Nitzsch) Ehrenberg	-	-	-	-	-	30
Thalasionema fraunfeldi (Grun.)	-	-	-	20	20	-
Division: Pyrrophyta						
Class: Dinophyceae						
Order: Dinophysiales						
Ceratium marcrocerus Ehrenberg	-	5	-	-	15	15

Table 2. Contd.

Division: Chlorophyta						
Class: Chlorophyceae						
Order: Cladophorales						
Cladophora glomerata (L.Kutzing)	-	-	15	-	-	-
Division: Cyanophyta						
Class: Cyanophyceae						
Order 1: Chrooccocales						
Merismopedia gluca (Ehrenberg) Nageli	-	-	-	-	45	-
Microcystis aeruginosa Kutzing	-	500	500	500	300	300
Order II: Hormogonales						
Lyngbya limnectica Lemm	-	-	-	-	-	20
Lyngbya martensiana Meneghini	10	20	20	10	-	10
Oscillatoria limosa C.A. Agorah	20	15	-	-	-	10
O.sancta Gomont	15	20	-	-	-	-
Number of species (s)	6	11	12	12	11	11
Total number of individuals (N)	110	670	605	665	575	455

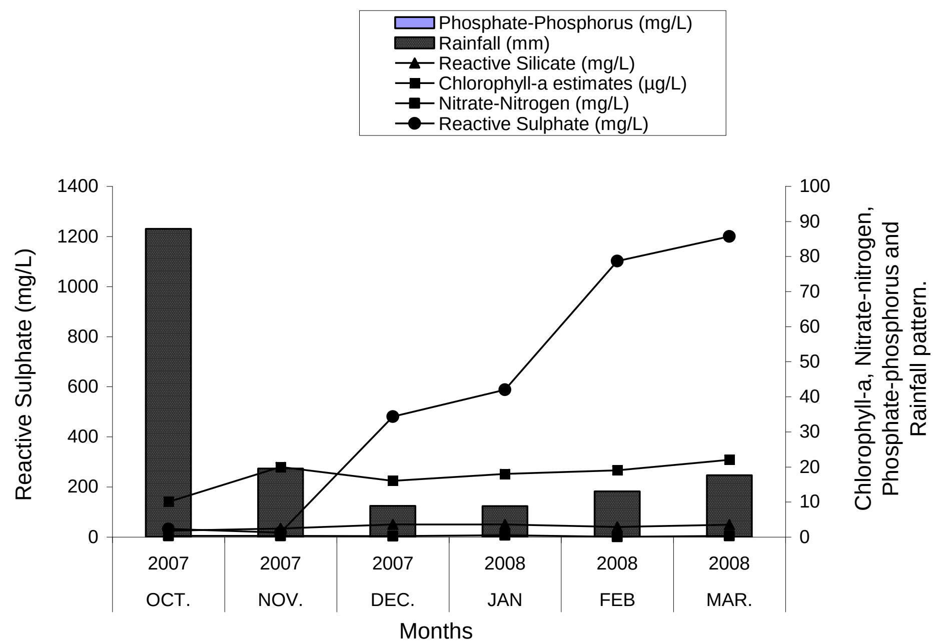

Figure 2. Relationship between Chlorophyll-a, nutrients and rainfall pattern at Tomaro creek.

the creek (Figure 4). Relationship between chlorophyll-a, number of individual phytoplankton and rainfall is represented in Figure 5.

DISCUSSION

The observed low air and water temperatures in February may be due to the harmattan haze prevalent at the period and possible increase in cloud cover that reduced isolation. Similar reports have been made in tidal creeks of south-west Nigeria (Nwankwo and Gaya, 1993; Adesalu and Nwankwo, 2005, 2008; Chukwu and Nwankwo, 2004). The reported low TSS, high TDS and high transparency in the dry months agrees with observations of Adesalu et al. (2010), Nwankwo (1996, 1997), and Onyema and Nwankwo (2006) in coastal waters of south-west Nigeria.

According to Nwankwo (1996), Nwankwo and Akinsoji (1992), humic and fluvic acid exudates enter creeklets, creeks, rivers and lagoons of south-west, Nigeria. The

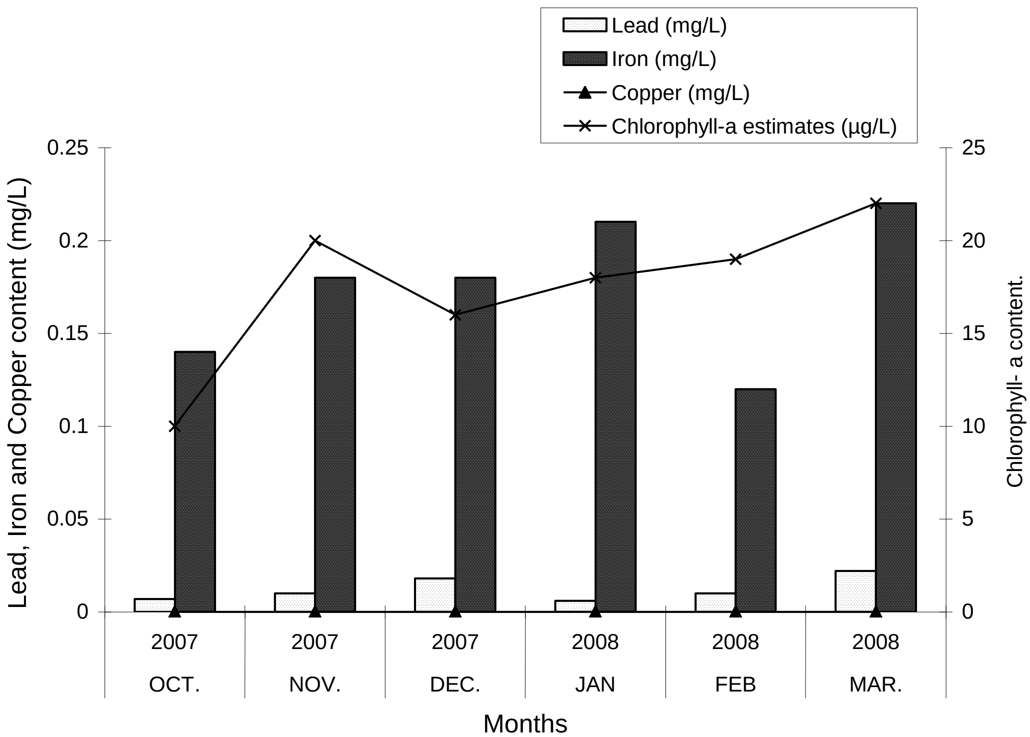

Figure 3. Comparison of chlorophyll-a content and some heavy metals at Tomaro creek.

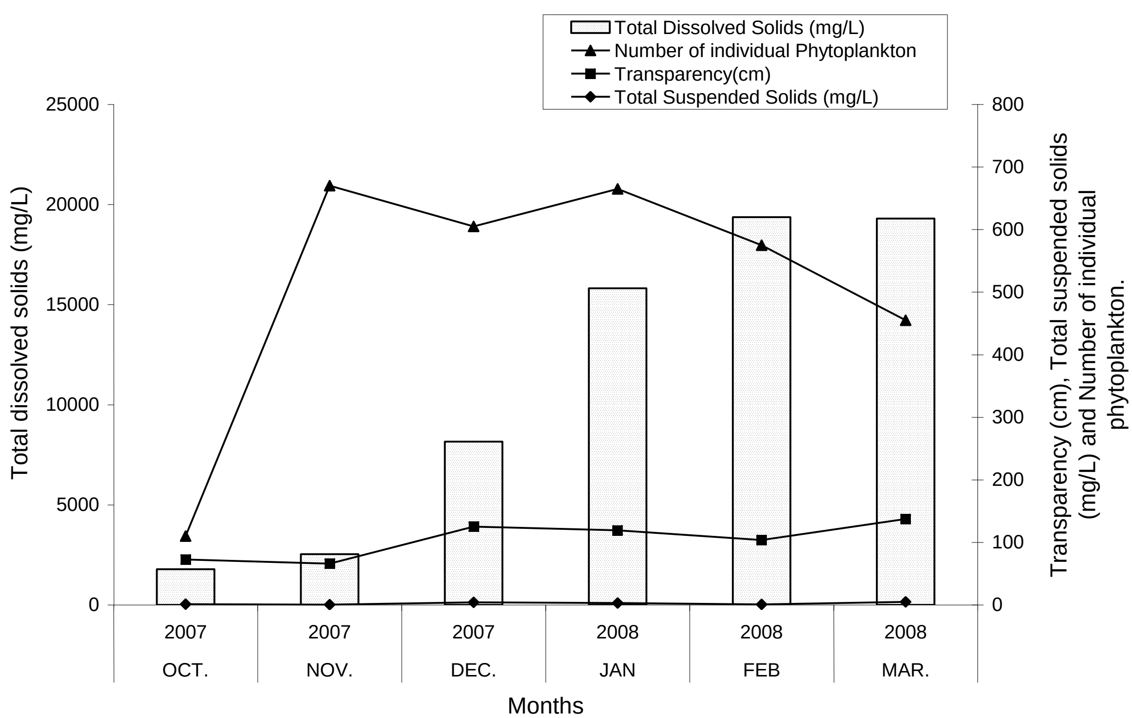

Figure 4. Total dissolved solids, total suspended, transparency and Number of individual phytoplankton values

observed increase in salinity (>10.50‰) and conductivity (>190.40 µS/cm) in the dry months agrees with what is obtain in tidal creeks of south-west Nigeria (Nwankwo and Gaya, 1996; Adesalu and Nwankwo, 2008; Emmanuel and Onyema, 2008; Adesalu et al., 2010). The low dissolved oxygen values between November and December (3.6 to 3.8 mg/L), low chemical oxygen demand values in December as well as February to April (6.6 to

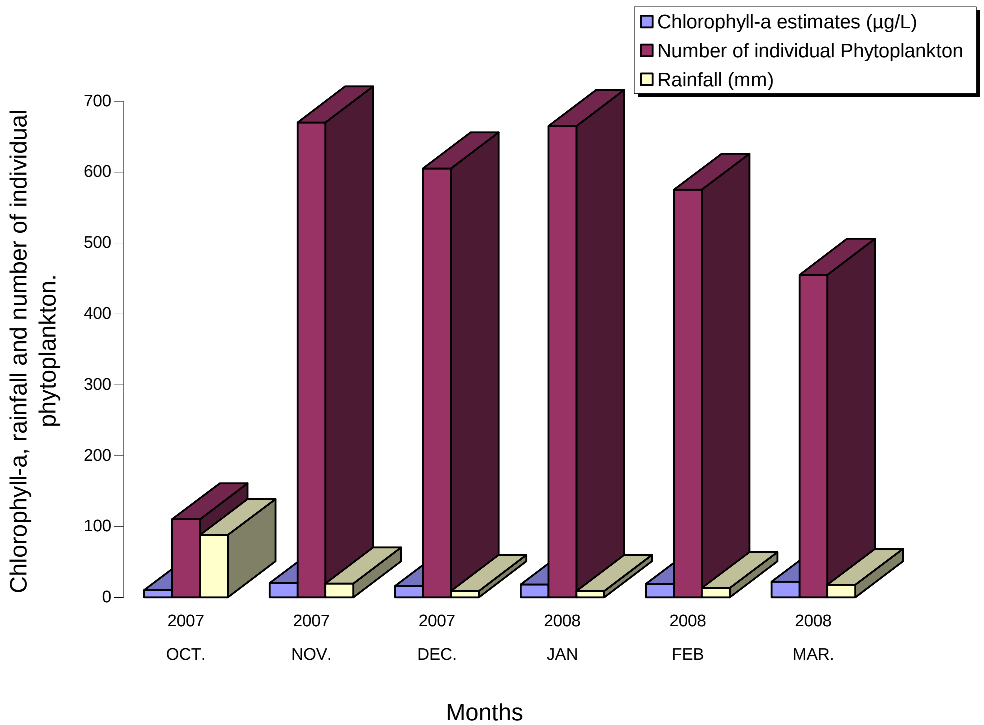

Figure 5. Relationship between chlorophyll-a, number of individual phytoplankton and rainfall.

18 mg/L) and low biological oxygen demand values in December, February-April could be an indication of the level of pollution. According to Hyres (1960), biological oxygen demand values less than 2.0 mg/L indicate clean water, 2.0 to 4.0 mg/L indicate moderate pollution while above 8.0 mg/L indicate severe stress. In this regard, Tomaro creek may be said to be moderately polluted. According to Nwankwo (1993, 1996), nitrate-nitrogen is limiting in coastal water of south-west Nigeria. The high values of nitrate-nitrogen recorded in this study may account for the relatively high phytoplankton abundance. The steady rise in chlorophyll-a value may be due to improved isolation, high transparency and deeper photosynthetic depth. Furthermore, the high values of reactive nitrogen may facilitate phytoplankton growth. In this creek, chlorophyll-a value may also indicate the status of the water.

REFERENCES

Adesalu TA, Nwankwo DI (2005). Studies on the phytoplankton of Olero creek and parts of Benin river, Nigeria. The Ekologia.3:21-30.

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

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

American Public and Health Association (1993). Standard methods for the examination of water and waste water 20th Edition. American Public and Health Association.

Barber HG, Horworth EY (1981). A guide to the morphology of the Diatom frustules. Freshwater Biol. Assoc. Sci. Publ. 44: 112.

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

Desikachay TV (1959). Cyanophyta. India council of Agriculture and Research. New Delhi. p. 696

Egborge ABM (1988). Water hyacinth a biological museum. International proceeding on water hyacinth held in Lagos. pp. 51-66.

Emmanuel BE, Onyema IC (2007). The plankton and fishes of tropical creek in south western Nigeria. Trop. J. Fisheries and Aquatic Sci. *7:* 105-114.

Hendey NI (1964). An introductory account of the small algae of the British coastal water. Part V. Bacillariophycea (Diatoms). Ministry of Agriculture, Fisheries and Food London. Fisheries investigations. 4: 317.

Holm–Hansen O (1978). Chlorophyll *a* determination improvements in methodology Oikos. 30: 438-447.

Kadiri MO (1993). Phytoplankton distribution in some coastal waters of Nigeria. Nig. J. Bot. 12: 51-62.

Karlman SG (1982). The annual floods regime as a regulation for phytoplankton production in Kainji lake Nigeria.

Lackey JB (1938). The manipulation and counting of river plankton and changes in some organisms due to formalin preservation. United States Public Health Reports. 63: 2086-2093.

Nwankwo DI (1991). A survey of armoured dinoflagellates of Lagos Lagoon and associated tidal Creeks. Nig. J. Bot. 4:39-66

Nwankwo DI (1995). Euglenoids of some polluted storm water channels in Lagos, Nig. Trop. Freshwater Biol. 4:29-39.

Nwankwo DI (1996). Phytoplankton diversity and succession in Lagos Lagoon, Nigeria. Arch. Hydrobiol. 135: 529-542.

Nwankwo DI (1997). A first list of dinoflagellates (Pyrrophyta) from Nigerian coastal waters (creeks, estuaries, lagoons) Pol. Arch. Hydrobiol. 44: 317-321.

Nwankwo DI, Adesalu TA (2010). Notes on indicators of Environmental status in inshore and offshore waters of south- western Nigeria. Nature and Science 8: 62-65.

Nwankwo DI, Amuda A (1993). Periphyton diatom on the floating aquatic macrophytes in polluted South-western Nigeria Creek. Int. J. Ecol. Environ. Sci. 19: 1-10.

Nwankwo DI, Gaya EA (1996). The Algae of an Estuarine Mari-culture site in South-western Nigeria. Trop. Freshwater Biol. 5: 1-11.

Nwankwo DI, Ogunwemimo CA, Chukwu LO, Adesalu TA, Kupoluyi GA, Adefuye OA, Odunsi CA, Alabi LO (2010). Studies on thewater quality and hydrobiological of a tropical tidal eutrophic creek (inpress). (Reference was not provided in the work. Please provide.)

Onuoha PC, Nwankwo DI, Vyverman W (2010). chlorophyll-a dynamics in relation to environmental parameters in a tropical lagoon. J. Am. Sci. 6: 327-337.

Onyema IC, Nwankwo DI (2006). The epipelic assemblage of a polluted estuarine creek in Lagos, Nig. Pol. Res. 25: 459-468.

Onyema IC (2007).The phytoplankton composition, abundance and temperature variation of a polluted estuarine creek. Turk. J. Fish. Aqua. Sci. 7:89-96.

Onyema IC, Ojo AA (2009).The zooplankton dynamics and chlorophyll-a concentration of a typical tidal creek in relation to water quality indices. Life Sci. Jour. 5:7-14.

Onyema IC, Nwankwo DI (2009). Chlorophyll-*a* dynamics and environmental factors in tropical estuarine Lagoon. Researcher. 1:46-60.

Patrick R, Reimer CW (1966-1975). The diatoms of the United States Vol 1-2. Monogr. Acad. Natl. Sci. Philad. 13: 1-213.

Strickland JDH, Parsons TR (1972). A practical Handbook of seawater analysis. Fisheries Research Board of Canada, Ottawa p. 311.