Primary Productivity in Tidal Creeks of South-West Nigeria II. Comparative Study of Nutrient Status and Chlorophyll-a variations in two Lagos Harbour creeks.

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

[1]Department of Marine Sciences. University of Lagos, Nigeria
[2]Department of Botany University of Lagos, Akoka, Nigeria
boseadesalu@yahoo.com

Abstract: A comparative study of the nutrient status and chlorophyll-*a* variations at the Five Cowrie and Light House creeks were undertaken for eight months (October 2009-May 2010). There was temporal variation in the water chemistry, nutrients and phytoplankton productivity. Water temperature (≥26.5^{0}C), transparency (≥30.4; 47.8), pH (≥7.6), and salinity (≥9.0; 5.0$^0/_{00}$) were high in the dry months while in the wet months, total suspended solids (≥5.8; 8.8mg/L) and total dissolved solids (≥56.2-64.7mg/L) values were higher. Dissolved oxygen values (4.40-5.76mg/L) were moderate in the two creeks while biochemical oxygen demand varied between 12.0mg/L and 28.0mg/L. Reactive phosphorus and nitrogen values were higher in the Five Cowrie creek than Light House creek. In the Light House creek, reactive nitrogen was high in the dry months while in Five Cowrie creek, reactive phosphorus was high in the wet months. Reactive silicate values rose in the dry months (≥3.41; 4.09mg/L) while sulphate values increased in the wet months. Phytoplankton biomass (in terms of cell numbers) was high in the dry months and more in Five Cowrie creek than in Light House creek. Chlorophyll-*a* values were higher in the Five Cowrie creek (≤0.44mg/L) during the dry months than in Light House creek and followed phytoplankton biomass trend very closely. Five Cowrie creek is more productive than Light House creek base on existing results.

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1. Introduction

The coastline of south-west Nigeria is endowed with creeks. The environmental dynamics in these creeks are regulated by rainfall and salinity. Thus an environmental gradients exists all through the year in the Five Cowrie and Light House creeks that drain directly into the Lagos harbour and seasonally in Abule Eledu and Abule Agege creeks which are much further away from the harbour. The Lagos harbour provides the only channel that drains runoffs from creeks, rivers and lagoons into the sea (Hill & Webb, 1958), Oyenekan (1983), Nwankwo (1996).

Plankton studies in the Lagos Harbour include those of Olaniyan (1957) who investigated the zooplankton, Fox (1957) and Hendey (1964) who studied the phytoplankton. Sandison and Hill (1966) described the distribution and effect of salinity on the life cycle of *Balanus* in Lagos harbour and adjoining creeks while Olaniyan (1961, 1969) reported the salinity dynamics in the Lagos harbour.

Two creeks, the Five Cowrie and Light House, empty directly into the harbour; and of these, only the Five Cowrie creek has received any attention. For instance, Nwankwo (1991) included species of armoured dinoflagellates from Five Cowrie creek in his study of armoured dinoflagellates of the Lagos lagoon and associated tidal creeks. Nwankwo *et al.,* (In Press) reported that creeks are transitory zones draining water from fresh to more saline environments. Whereas Five cowrie creek provides one of the two routes channeling lagoon water into the harbour, the Light House creek serves as a conduit for some backwaters that enter the Harbour. The aim of the study was to compare nutrient status and chlorophyll-*a* variations at the Five Cowrie and Light House creeks for biological monitoring of the creeks.

2. Materials and Methods

Study site.

Between Cotonou harbour in Benin republic and the river, estuary in the Niger delta, the Lagos harbour provides the only opening draining all the water of the Lagos lagoon system to the sea. It experiences two seasonal trends, the dry season (Nov-April) and the wet season (May-October). It enjoys semi-diurnal tidal fluctuation spread inland and tied to the rainfall pattern. Two creeks are associated with the Lagos harbour; the Five cowrie creek to the east and the Light House creek to the west (Fig.1). Both creeks are deep, tidal and subjected to the same physical conditions as the harbour.

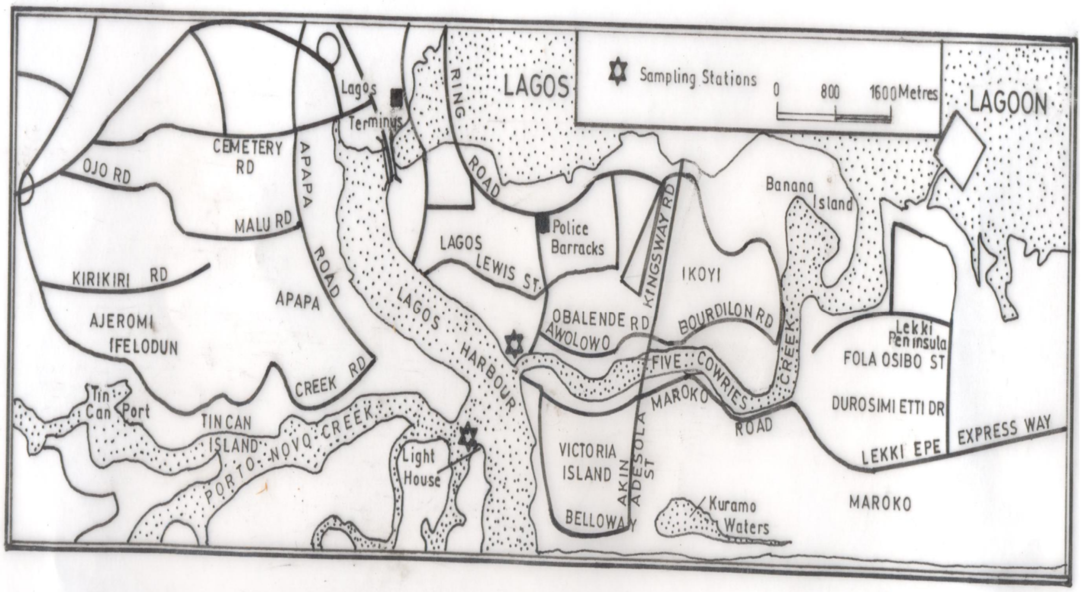

Fig. 1: Lagos Harbour and associated creeks

Collection of Samples

Duplicate samples, one for water chemistry and the other for biological analysis were collected monthly for eight months. For water chemistry and chlorophyll-a determination, samples were collected in a 1L non-plastic water sampler 50cm from the surface and stored in well labeled 1L plastic containers with screw caps. All samples were transported in an ice chest into the laboratory for further analysis. On each occasion, plankton samples for phytoplankton biomass were collected in a 55µm mesh size standard plankton net attached onto a motorized boat and towed at low speed (<4 knots). Each haul was stored in a well labeled 500ml plastic container and preserved in 4% unbuffered formalin.

Determination of physico-chemical characteristics

On each occasion, air and water temperature were determined using an ordinary mercury in–glass thermometer to the nearest 1^0C. Transparency was measured with a 20cm diameter black and white painted Secchi disc while the pH and Dissolved Oxygen (DO) were measured in-situ using the Graffin digital pH metre (model 80) and Graffin digital Dissolve Oxygen metre (model 40) respectively.

The 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 500ml of the sample through pre-weighted filter papers that was subsequently dried in an oven at 105^0C for 24hrs, cooled and re-weighted while Total Dissolved Solids (TDS) were estimated by evaporating 100ml of filtrate in a pre-weighted evaporated dish at 100^0C. Reactive phosphorus content was estimated after treatment with Denige's reagent while reactive nitrogen was estimated using the phenol disulphonic acid (APHA, 1998).

The sulphate and reactive silicates were determined using the standard method as described by Strickland and Persons (1972). Biochemical oxygen demand (BOD) value was estimated after 5-days incubation period using the method described in APHA (1998). Rainfall data were kindly supplied by Department of Meterological Services, Oshodi.

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 is scanned in five fields with the movement of the stage to various sides. In this study, the microtransect drop count method was used as described by Lackey (1938). All organisms, unicells, filaments, and coenobia were counted as one and recorded as organisms per ml after appropriate conversions. The phytoplankton were identified using relevant texts (Deskachary, 1959; Barber and Harworth, 1981; Hendey, 1964 and Patrick and Reimer, 1966, 1975).

Chlorophyll-a determination in water sample

Chlorophyll-"*a"* was determined using the method described by Holm-Harsen (1978). This method involves filtering 250ml water sample, extracting the chlorophyll-"*a"* with methanol, centrifuging at 3200rpm for 10min and measuring the extract at 665nm and 750nm. Calculation was done using the formula:

Chlorophyll-"*a"* =

(Abs 665nm-Abs 750nm) × A × Vm Vf × L
where :
A= Absorbance coefficient of chlorophyll-a in methanol (12.63)
Vm = Volume of methanol used for extinction
Vf = Volume filtered
L = Path length of cuvette

3. Results

Data on the physical and chemical characteristics are presented in Table 1 while nutrients values, phytoplankton biomass and chlorophyll-a are represented graphically in Figures 2-4. Values of water temperature (≥26.5^0C), transparency (≥30.4; 47.8cm), salinity (9.0; $5.0^0/_{00}$) and pH (≥7.69; 8.00) were higher in the dry months than wet months in both creeks. In the wet months, total suspended solids values (≥5.8; 8.8mg/L) and total dissolved solids (≥56.2; 64.7mg/L) were higher.

In the Five Cowrie creek, dissolved oxygen values varied between 4.49- 5.59 mg/L while in Light House creek, DO values varied between 4.82 and 5.70. In Five Cowrie creek, BOD values ranged between 12.0 and 28.0 mg/L while in the Light House creek, BOD values ranges from 12.0 to 25.0 mg/L. Reactive phosphorus was higher (≥1.91mg/L) in the dry months at the Five Cowrie creek while at the Light House creek; it was higher (≥ 0.37mg/L) in the wet months.

At the Five Cowrie creek, reactive nitrogen was high (≥11; 2.1mg/L) all through the sampling months while at the Light House creek, reactive nitrogen values were higher (≥3.80 mg/L) in the dry months. Reactive silicates were higher (≥2.02; 3.80 mg/L) in the dry months at Five Cowrie and Light House creeks respectively (Fig.2). On the other hand, sulphates were higher (≥4562; 1820 mg/L) at the Five Cowrie and Light House creeks respectively. Phytoplankton biomass (in terms of cell numbers) was higher in the dry months than wet months in Five Cowrie creek, while in Light House creek, phytoplankton biomass was higher (≥55) in the wet months at the Light House creek (Fig.3).

Phytoplankton biomass was low at both creeks in December and May (Fig.3). Similarly, chlorophyll-a values at the Five Cowrie creek were higher (≥0.21 mg/L) in the dry months while at the Light House creek, it was higher (≥0.08 mg/L) in the wet month. Chlorophyll-a values in both creeks were low (0.03; 0.04 mg/L) in December and May (0.03; 0.05 mg/L) respectively (Fig.4).

Table 1. Test results

Water temperature (^{0}C)								
Five Cowrie creek	27	26.5	27	28	26.6	27	27.5	26
Light House creek	27	26.5	27	28.5	26.6	27	28	26.5
Rainfall (mm)	140	55	15	-	-	17.5	35	95.5
Total Suspended Solids (mg/L)								
Five Cowrie creek	8	6	ND	ND	ND	ND	0.17	5.8
Light House creek	18.8	9.8	8.8	8	4	3.2	3.2	9.8
Total Dissolved Solids (mg/L)								
Five Cowrie creek	7.9	74.6	23.1	28.4	34.2	35.2	47.3	56.2
Light House creek	81.5	86.9	48.6	53.7	94.4	53.6	53.4	64.7
Parameters	Oct. 2009	Nov. 2009	Dec. 2009	Jan. 2010	Feb. 2010	Mar. 2010	Apr. 2010	May. 2010
Salinity ($^0/_{00}$)								
Five Cowrie creek	5	7	9	12	18	23	26	30
Light House creek	12	18	15	20	23	27	30	32
pH								
Five Cowrie creek	7.6	7.66	7.69	7.78	8	8	7.8	7.5
Light House creek	7.89	8	8.06	8.09	8.1	8.2	8	7.8
Dissolved Oxygen (mg/L)								
Five Cowrie creek	5.2	4.4	5.2	5.4	5.6	5.8	5.4	4.5
Light House creek	5.7	5.5	5.3	4.91	5.1	5.5	5.2	4.8
Biochemical Oxygen Demand (mg/L)								
Five Cowrie creek	28	28	3	3	3	24	25	68
Light House creek	13	13	12	12	13	14	14	14
Transparency (cm)								
Five Cowrie creek	23.5	28.1	30.4	36.8	38	40	32	25
Light House creek	48.2	23.6	47.5	49.8	57	61	51	32
Sulphates								
Five Cowrie creek	7500	7200	2920	2990	3050	1220	1290	4562
Light House creek	8220	8007	3150	3200	3500	1320	1340	1820

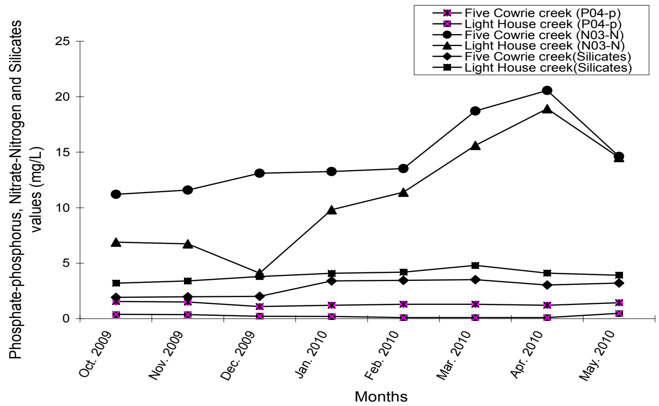

Figure 2: Comparison of micronutrients at Five Cowrie and Light House creeks.

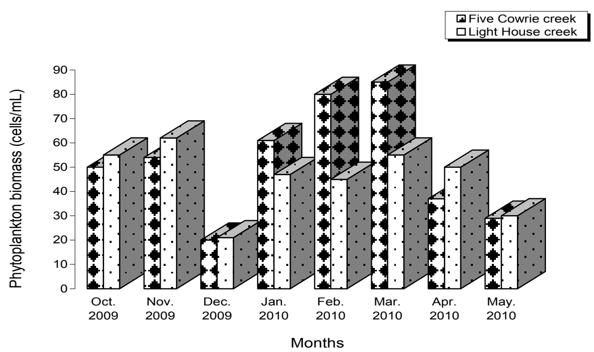

Figure 3: Variations in phytoplankton biomass (cells/ml) at Lagos Harbour tidal creeks

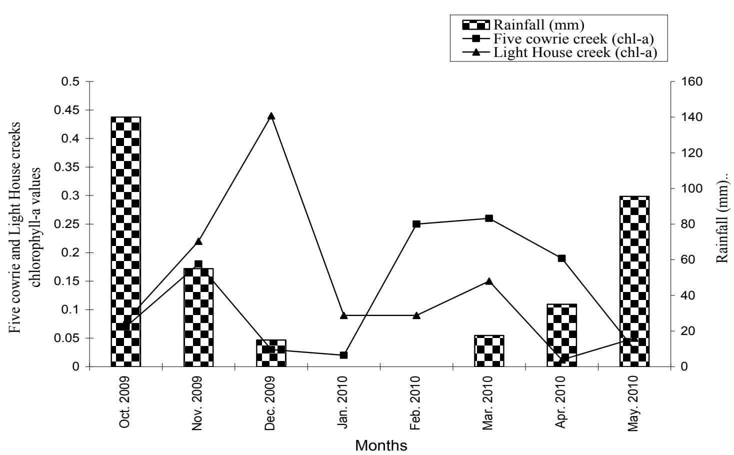

Figure 4:Variations in chlorophyll-a values at Lagos Harbour tidal creeks

4. Discussion

The proximity of the Five Cowrie and Light House creeks to the Lagos Harbour places them in the same physical environments regulated by rainfall and salinity variations. According to Nwankwo (1996), Nwankwo *et al.,* (In Press) whereas rainfall is the dominating climatic variable in coastal waters of South-west Nigeria, the interplay between rainfall and salinity determine the biotal spectrum. The reduced water temperature, transparency and salinity in the wet months may be due to the effect of low insolation, increase in suspended particles and the dilution effect of flood waters. According to Nwankwo (1991) increased cloud cover and its attendant lowered insolation, lead to a drop in temperature. The effect of flood water caused by rainfall on the coastal water of South west Nigeria has been documented by Hill and Webb (1958), Olaniyan (1961, 1969) and Nwankwo (1996). Total dissolved solids and the total suspended solids values were high in both creeks possibly due to the introduction of derived materials from adjoining wetlands, recruitment from flood waters and dissolution of some particles in the creek water.

These observations support earlier ones reported in Nwankwo *et al.,*(In Press). The pH values in both creeks remained above 7.60 all through the sampling months possibly because of the effect of buffered tidal sea water while tidal mixing boat traffic and photosynthetic process of phytoplankton in the creeks accounted for the moderate DO levels reported similar reports appeared in Nwankwo (1991), Nwankwo *et al.,*(In Press). Biochemical oxygen demand in both creeks ranged between (12.0-28.0 mg/L) at the Five Cowrie creek and (12.0 – 25.0 mg/L) at the Light House creek.

The BOD values recorded for the two marine creeks lie below the acceptable limit set by the WHO for international water quality standard (15.9 – 37.5mg/L) with warming limit from 18.9-34.5 mg/L. The creeks could be said to be slightly organically polluted. Reactive phosphorus (PO_4-P) and reactive nitrogen (NO_3-N) were higher in Five Cowrie creek than Light House creek and this may be due to the input of several point sources of pollution located along the lagoon. The elevated values recorded in the wet months may be due to the influx of leachates of dissolved organic matter as well as soluble nitrates from land based sources. Similar observation was reported in Nwankwo (1993) and Adesalu (2007).

The increase of reactive silicates in the dry months may be due to the effect of greater tidal seawater incursion while the higher sulphate values in the wet months may be due to flood water intrusion from the freshwater zones of the lagoon. The disparity in micronutrient of the two creeks may be linked to the hydrology of the lagoons and creeks of South west Nigeria. Moreover, whereas, the Five Cowrie creek is one of the conduits that drain creek and lagoon water into the Harbour the creek of the Light House received its water partly from the harbour and partly form runoffs from adjacent wetlands.

Phytoplankton biomass in terms of cell numbers was higher in Five Cowrie creek in the dry months than wet months as compared to Light house creek. Similarly, chlorophyll-a values were higher in Five Cowrie creek than in the Light House creek. The increase in insolation in the dry season may have increased the photosynthetic depth as shown in transparency values recorded. This with micronutrients available may have resulted in higher productivity. Although, the two creeks are tidal and directly linked to the harbour, the Five Cowrie creek is wider, longer and receives both lagoon water and seawater.

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