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A Comparative Study of the Epiphyton and Phytoplankton Biomass in Yewa Lagoon at Iragbo in Relation to Environmental Characteristics

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ABSTRACT

A comparative study of the phytoplankton and epiphyton biomass in relation to environmental characteristics at the Iragbo part of Yewa Lagoon were undertaken for six months (December, 2012- May, 2013). Water temperature (≤32.20C), air temperature (≤ 48.50C), transparency (≤ 48.5cm), pH (≤ 8.16), were higher in dry months while in the wet months total suspended solids (≤ 1.3mg/L) and total dissolved solids (≤ 49.0mg/L) values were higher. Dissolved oxygen values (≥ 2.8mg/L ≤ 7.6mg/L) were moderate in the Lagoon while biochemical oxygen demand varied between 7.0mg/L and 16.0mg/L, chemical oxygen demand also varied between 21.0mg/L and 40.0mg/L. Reactive silicates ranged between 0.002mg/L and 0.004mg/L throughout the sampling months. The heavy metal values; Copper (≤0.03mg/L), Lead (≤ 0.017mg/L), Zinc (≤ 0.62mg/L) and Iron (≤ 0.34mg/L) remained low throughout the sampling period. Both the phytoplankton and epiphyton biomass were higher in the dry months. Phytoplankton chlorophyll-a values were highest in January while epiphyton chlorophyll-a value was highest in February. The pinnate diatoms dominated the epiphyton community while the centrales diatoms dominated the phytpplankton community. A total of 4885 individuals of 76 phytoplankton species belonging to 6 divisions were identified while a total of 2505 individuals of 39 epiphyton species belonging to 4 divisions were identified. For the phytoplankton community, a total of 1565 individuals (31.80%) represent bacillariophyta division while 635 (12.90%), 2535 (51.52%), 115 (2.33%), 15 (0.5%), and 20 (0.85%) represent chlorophyta, euglenophyta, chrysophyta and pyrophyta respectively. For the epiphyton community, a total of 2525 individuals (87.37%) represents bacillariophyta division while 105 (3.69%), 195(6.74%), and 65(2.24%) individuals represent chlorophyta, cyanophyta and euglenophyta respectively. Species used elsewhere for biomonitoring were observed in the lagoon, they include (Euglenoid) Euglena and Phacus species, *Trachelomonas hispida*, (Diatoms) *Gomphonema parvulum*, *Synedra ovata*, *Pinnularia major* and (Green algae) *Chlorella sp*.

1. INTRODUCTION

Planktonic algae are free-floating microscopic plants, which obtain chlorophyll and grow by photosynthesis in the presence of sunlight and lacks roots, stems and leaves (Lee, 1999; Nwankwo, 2004a). Phytoplankton are the plant components of plankton that photosynthesize, release oxygen to the environment and serve as food producers in aquatic ecosystems (Mader, 2001). Freely suspended microscopic plant forms are termed phytoplankton; they are photosynthetic organisms that float near the surface water. Whereas forms attached to aquatic macrophytes are termed epiphyton (Nwankwo 2004b). They absorb nutrients from the water or sediments, add oxygen to the water as a by-product and are usually the major source of organic matter at the base of food web in the aquatic environment (Lawson and John, 1987; Lee, 1999).

Algae are almost ubiquitous throughout the world, being most common in aquatic habitats. They can be categorized ecologically by their habitats. Planktonic microscopic algae grow suspended in the water, whereas neustonic algae grow on the water surface. Cryophilic algae occur in snow and ice; thermophilic algae live in hot springs; edaphic algae live on or in soil; epizoic algae grow on animals, such as turtles and sloths; epiphytic algae grow on fungi, land plants, aquatic plants or other algae; corticolous algae grow on the bark of trees; epilithic algae live on rocks; endolithic algae live in porous rocks; and chasmolithic algae grow in rock fissures. Some algae live inside other organisms, and in a general sense these are called endosymbionts. Specifically, endozoic endosymbionts live in protozoa or other, larger animals, whereas endophytic endosymbionts live in fungi, plants, or other algae (Encyclopaedia, 2012). The coastal area of south western Nigeria, more specifically is a meandering network of lagoons that angle approximately 450 to the prevailing south westerlies (Hill and Webb, 1958; Ibe,1988). Of these Lagos Lagoon complex stretches for 4257km from Benin Republic to the west in the Niger Delta to the east and consist of nine lagoons. According to Nwankwo, 1993, the lagoons and creeks of south western Nigeria are linked to the sea through Lagos harbour which remains open all through the year. A well-defined salinity gradient, linked with the rainfall pattern, extends far inland westwards and eastwards. This area therefore shows major floristic changes along salinity gradient (Nwankwo, 1988). Furthermore, the texture of the

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bottom sediment maybe described as muddy sand, sandy mud, muddy or coarse with shell material.

Since the incursion of water hyacinth (Eichhonia crassipes) into Nigerian coastal waters in September 1984 from the Porto Novo creek (Benin Republic), it has continued to flourish especially in Yewa lagoon that has a direct influence from the Yewa River being fresh water. Some of the immediate problems created by this infestation include blockage of drainages, increase in breeding sites of mosquitoes and snails, interference with fishing and even impairment of navigation (Nwankwo, 1993). Epiphyton is a complex mixture of algae, heterotrophic microbes, and detritus that are attached to submerged surfaces in most aquatic ecosystems. It serves as an important food source for invertebrates (Kadiri, 1992) tadpole and some fishes. It can also absorb contaminants removing them from the water column and limiting their movement through the environment. Epiphyton is also an indicator of water quality; response to this community to pollutants can be measured at a variety of scales representing physiological to community-level changes. For this reason, epiphyton has often been used as an experimental system in, example pollution induced community tolerant studies (Sladeckova, 1962; Patrick, 1965, 1967 1975; Wilkinson et al, 1976). The importance of aquatics in providing suitable foci for epiphyton algae is well known (Odum, 1957; Saszka, 1975; Cattaneo and Kalff, 1978). Similarly reports by Zoebell and Allen (1933), Wilson (Barbour et al, 1999), Erth (1971) have shown relevance of artificial surfaces in the trapping and study of attached algae. Epiphyton algal communities are important components of aquatic ecosystem. Their contribution to primary production varies from 0.2% to 41% in lakes (Laugaste and Reumanen, 2005). Furthermore, the epiphyton algae with macrophyte are employed as the buffering zone of lakes lagoons (Lakatos et al, 1999). They are important components of food webs (Michael et al, 2006). Epiphyton algae are good indicator of water quality and environmental changes due to their sensitivity to external sources of fertilization (Lowe, 1996). The aim of the study is to carry out the comparative study of epiphyton and phytoplankton biomass of Yewa Lagoon at the Iragbo in relation to environmental characteristics.

2. MATERIALS AND METHODS

2.1 Study Area

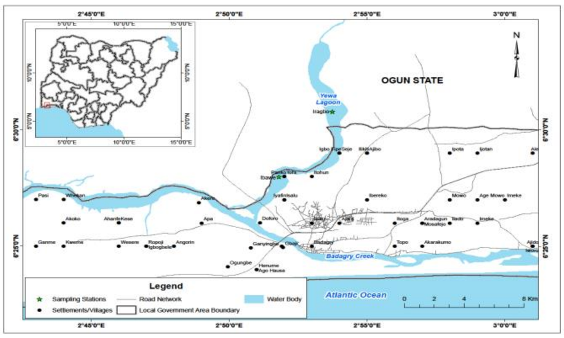

Fig 1. Map of Yewa Lagoon showing Sampling Site.

Yewa lagoon is about 17km from the Nigeria-Benin Republic boarder (Egborge, 1988). It lies along the boundary between Ogun and Lagos states, and is perpendicular to Badagry Lagoon (Fig. 1). It lies approximately 6.21km upstream of River Yewa (Egborge, 1988). It experiences the characteristics seasonal rainfall that determines environmental gradients in South-Western Nigeria.

River Yewa which is the major river emptying into the lagoos has Ere and Iragbo as tributaries, (Effiong and Inyang, 2015). Mangrove vegetations such as the red mangrove (Rhyzophora sp) and black mangrove (Avicenia sp) are abundant. Some other species of other aquatic floral species also found in abundance include; Paspalum orbiculare, Acrostichum aureum, Phoenix rachinata and Nypa fructicans. Manatees, migratory birds, periwinkle aquatic crab, fishes of various species and snakes make the fauna of Yewa lagoon. Artisanal fishing and sand mining is the major economic activities of the indigenes.

2.2. Collection of Samples.

Collection of water and phytoplankton samples for analyses were carried out between 9:00hrs and 12:30hrs monthly for six months (December, 2012- May, 2013). Water samples were collected 20cm below the surface water with 250ml screw capped plastic bottles for physical and chemical analysis. Chlorophyll-a sample, DO and BOD samples were collected in three 250ml amber bottles. Phytoplankton samples were collected using plankton net of 55µm mesh size towed for 7mins at low speed (< 4 knots) and was preserved in 4% unbuffered formalin. The attached algae of interest were collected along Iragbo area of Yewa lagoon. Water hyacinth was harvested monthly from the central part of the lagoon away from the water edges including the fringes of "acadja" (artificial vegetation for fishing). Healthy plants were carefully selected to ensure uniformity in size before putting each into plastic containers with 500ml of fresh water. The attached algae were removed mechanically by shaking vigorously in water as suggested by Forester and Schlichting (1965), and was preserved in a well labelled plastic container and 4% formalin added as a preservative. Another 500ml container was filled with an unfixed sample for chlorophyll-a determination

2.3. *Chlorophyll-a Determination*

Chlorophyll-a was determined using method described by Holm-Harsen (1978). 250ml of water sample was filtered and the chlorophyll-a was extracted by methanol. The extraction was centrifuged at 320rpm for 10mins and absorbance was measured at different wave length, the chlorophyll-a concentration was measured using the formula below.

$$\text{Chlorophyll-a } (\mu g/L) = \frac{(Abs[66snm] - Abs[750nm])\ x\ A\ x\ Vm}{vf\ x\ L} \quad (1)$$

Where; A = Absorbance coefficient of chlorophyll-a in methanol Vm= Volume of methanol used for extraction

Vf = Volume of sample filtered L = Path length of cuvette.

Where; A = Absorbance coefficient of chlorophyll-a in methanol Vm= Volume of methanol used for extraction

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2.4. *Community Structure Analysis*

Community structure analysis were determined by four indices

2.4.1. Margelef index (d): This is a diversity of species richness, which does not take into account dominant diversity, but is largely dependent on the species richness, that is, the more the species present in a sample the greater the diversity [Margelef, 1957].

$$d = \frac{s-1}{logeN} \quad (2)$$

Where: d = Diversity Index S = Number of Species

N = Number of Individuals log = Natural logarithm

$$H = \frac{NlogN - \sum filogfi}{N} \quad (3)$$

Where: H = Shannon-Wiener Information Index

∑= Summation fi = Observed proportion of individuals that belong to the ith species loge = Natural logarithm.

2.4.2. *Species Equitability or Evenness (j) Jaccard*.

This is a measure of how evenly the individuals are distributed among the species present in a sample. It ranges between 0 and 1, the maximum value. One represents a situation where individuals are spread evenly among the species present [Jaccard, 1912]. It was calculated as follows:

$$j = \frac{H}{Hmax} \text{ or } \frac{H}{logs} \quad (4)$$

Where: j = Equitability measure H = Shannon-Wiener Information Index S = Number of species in the sample.

2.4.3. *Similarity /Dissimilarity Index (Bray Curtis 1957)*

In a similarity index, a value of 1 means that the two communities you are comparing share all their species, while a value of 0 means they share none. Whereas, in a dissimilarity index the interpretation is the opposite.

The Similarity Index (BC) between two samples is given by the equation:

$$S = \frac{2C}{A+B} \quad (5)$$

Where: S= Similarity index

C= Number of species common to both samples

A= Number of species in sample A

B= Number of species in sample B,

Dissimilarity = 1- Similarity.

3. RESULTS

3.1. Hydro Climate Properties

Data on some hydroclimatic features of the sample site at Yewa Lagoon is presented in table 1. The highest surface water temperature (32.2°C) was recorded in February while the lowest (30.2°C) was recorded in December. Similarly, higher pH, conductivity, DO and transparency values were recorded in the dry months than in the wet months (Table 1). On the other hand, Total Dissolved Solids (TSS), nutrients and Biochemical Oxygen Demand (BOD) values were higher in the wet months than during the dry months.

Higher sicche disc readings in the dry months coincided with periods of drop in TSS values. Phosphates-phosphorus recorded a progressive increase into the wet months (≥0.5; ≤ 10.1) and nitrate level increases steadily and were very high during the wet months. Silicate values rose steadily in December and January, but fluctuated slightly in other months.

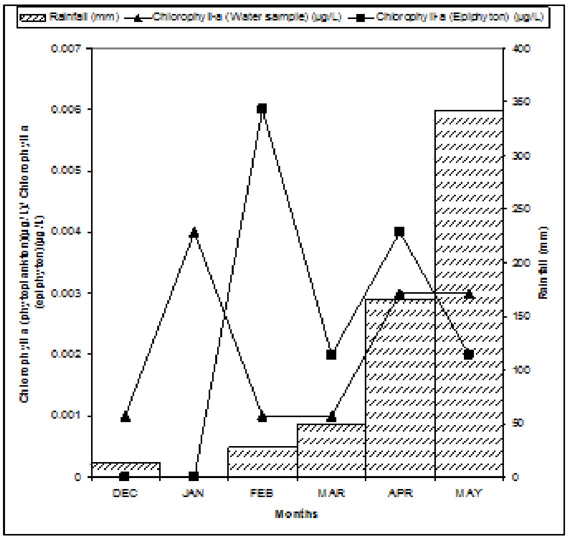

Fig. 2. Monthly variation in chlorophyll a (phytoplankton), chlorophyll a (epiphyton) and Rainfall at the Iragbo part of Yewa Lagoon (Deccember, 2012-May, 2013).

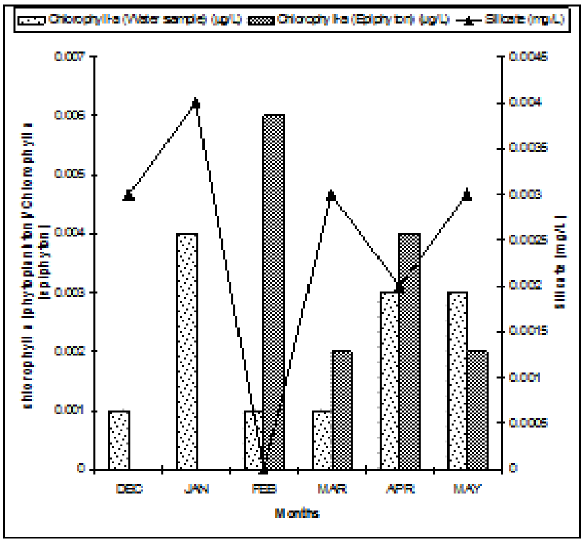

Fig. 3. Monthly variation in chlorophyll a (phytoplankton), chlorophyll a (epiphyton) and Silicate at the Iragbo part of Yewa Lagoon (Deccember, 2012- May, 2013).

Table 1. Variations in some physical and chemical parameters in Iragbo part of Yewa Lagoon (December, 2012-May 2013.

PARAMETERS	MONTHS					
	DEC.	JAN.	FEB.	MAR.	APR.	MAY.
Surface Water temperature (ºC)	30.2	30.8	32.2	31.8	31.3	30.5
Transparency (cm)	37.5	48.5	35	34	30.3	28
Ph	8.0	7.6	8.2	7.5	7.3	7.0
Conductivity (µS/cm)	94.0	97.0	99.0	83.0	80.0	78.0
Rainfall (mm)	13.2	0.0	28.0	50.1	165.3	340.8
Total Suspended Solids (mg/L)	49.0	46.0	37.0	45.0	56.0	68.0
Reactive Phosphate (mg/L)	0.53	0.67	0.53	6.8	10.1	6.9
Reactive Nitrate (mg/L)	0.1	0.2	3.1	16.8	18.1	33.0
Reactive Nitrate (mg/L)	0.1	0.2	3.1	16.8	18.1	33.0
Sulphate (mg/L)	0.01	0.02	ND	7.0	8.0	7.82
Iron (mg/L)	0.072	0.07	0.07	0.34	0.208	0.068
Silicate (mg/L)	0.003	0.004	ND	0.003	0.002	0.003
Dissolved Oxygen (mg/L)	2.8	7.6	5.1	4.1	5.5	4.5
Biochemical Oxygen Demand (mg/L)	7	10	10	16	13	13
Chemical Oxygen Demand (mg/L)	32	38	21	37	38	40
Chlorophyll a (phytoplankton)	0.001	0.004	0.001	0.001	0.003	0.003
Chlorophyll a (Epiphyton)	0.002	0.005	0.014	0.012	0.003	0.002

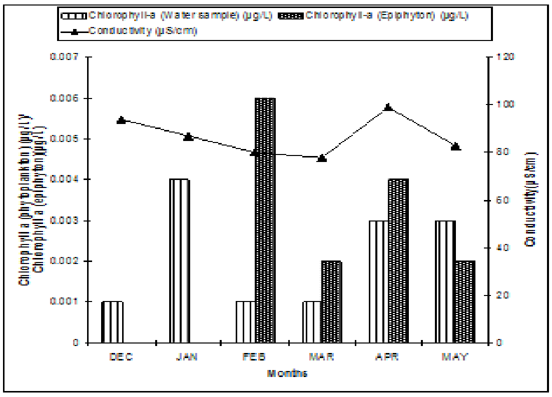

Fig. 4. Monthly variation in chlorophyll a (phytoplankton), chlorophyll a (epiphyton) and Conductivity at the Iragbo part of Yewa Lagoon (Deccember, 2012- May, 2013).

3.2 Diatom Community

The phytoplankton of the Iragbo part of Yewa Lagoon belonged to seven main divisions: Bacillariophyta (32%), Chlorophyta (13%), Cyanophyta (51%), Euglenophyta (2%), Crysophyta (0.2%), and Pyrophyta (1%). A total of 55 species belonging to 35 genera were observed. Throughout the sampling period, the highest (2450 individuals per ml) (53%) phytoplankton occurrence was recorded in January, the least (414 individuals per ml) (9%)) was recorded in May. Thirteen phytoplankton orders were also recorded throughout the sampling months, namely;Centrales, Pennales, Chlorococcales, Volvocales, Zygnematales (Conjugales), Ulotricales, Chroococcales, Hormogonales, Euglenales, Mischoccocales, Dinokontae, Gonyaulacales and Nocticulales .The highest individual species (biomass) was Oscillatoria sp. which indicated a bloom in January. It is represented in the table 2 below.

3.3 Community Structure Indices

The indices of species richness (d), Shannon-Wiener diversity (Hs), Evenness or Equitibility (J), Bray Curtis similarity/dissimilarity index (BC) were calculated to estimate the monthly variation in phytoplankton and epiphyton diversity.

All through the sampling period, both species richness (d) and Shannon-Wiener index (H) decreased as wet months approached in both phytoplankton and epiphyton communities. Generally, diversity was low between April and May in both communities, a pattern possibly related to low light penetration caused by high turbidity.

4. DISCUSSION

The physical and chemical changes observed in the Lagoon may have been as a result of hydroclimatic changes linked to the seasons. For instance, the dry months concentrated between December and April was accompanied by higher conductivity, higher temperature and higher transparency. On the other hand, changes may be linked to impact of leacheates into the Lagoon from Yewa River, associated creeks and wetlands in the wet months. Similar observations have been reported by Nwankwo (1993,1996) in the Lagos Lagoon. The higher surface water temperature observed in the dry months maybe due to less cloud cover and high insulation. Nwankwo et al. (2008) made similar observations. The decrease in total dissolved solids, totalsuspended solids and turbidity during the dry months may be attributed to decrease in the influx of flood waters from the rivers, creeks and wetlands. This observation supports the view of Egborge (1988) in Yewa Lagoon.

Conductivity was relatively stable all through the sampling months possibly due to lack of any intrusion of sea water. Lagoons of South West Nigeria are known to be of two types, some like the Lagos and Iyagbe Lagoons directly influenced by tidal sea water are said to be physical while others like Epe, Kuramo, Lekki, Yewa, Badagry are said to be biologically controlled Onyenekan (1987). Though the concentration of oil pollution here is very minimal there are still some traces of effects that it has especially on phytoplankton biomass. The effect of this oil pollution of the coastal waters is more noticeable during rainy season when spilled products are washed from drains and drainage channels into the water bodies (Odiete, 1999). The pH range of between 6.95-8.16 maybe due to the influence of high carbonate leacheates draining part of Ewekoro cement factory in Ogun state into the Yewa river that empties into the Yewa Lagoon. The buffering effect of carbonate in coastal waters of south western Nigeria is well known (Nwankwo et al (2008). The higher COD values throughout the sampling months and low BOD could be an indication of some levels of pollution. The BOD values recorded for the Lagoon during the sampling period lie below the acceptable limits set by WHO for international water quality standard in coastal waters (15.9-37.5mg/L) with warning levels from (18.934.5mg/L). The Lagoon could be said to be slightly organically polluted. According to Hynes (1960) working in a river, biochmical oxygen demand values less than 2.0 mg/L indicate clean water, 2.0 to 4.0mg/L indicates moderate pollution while above 8.0 mg/L indicates severe stress. However, Yewa Lagoon is not a river and Hynes criterium may not be relevant. Since Yewa Lagoon is fresh and lotic and since there is no direct connection to the sea, it is still possible that standards higher than 8.0mg/L but lower than 16.5mg/L may point towards pollution stress.

The rising values of micro nutrients between February and April maybe due to reduction of water inflow from the creeks and rivers, it may also be as a result of an increase in water temperature and possible increase in bacterial oxidation. Similar observations were made by Thomas (1966) in a small man-made Lake in Ghana. Reactive silicate all through the sampling months remained comparatively stable possibly due to non-influence from sea water, although reactive silicate values was less in months where there is high diatom biomass, this may be due to the fact that diatoms use reactive silicate to build its (frustules). The higher values of nitratenitrogen recorded in the study may account for the relatively higher phytoplankton abundance. Similar report was found in Nwankwo et al (2013) working in temporal variations in water chemistry and chlorophyll-a at Tomaro creek. The impacts of Copper, Lead and Zinc on the growth of both phytoplankton and epiphyton algae were not specifically felt, the reason maybe that their presence did not exceed 0.62mg/L in all the sampling months. Bilgrami and Kumar (1997), studying the effect of Copper, Lead and Zinc on phytoplankton growth found out that at concentrations0.1mg/L, these metals were not toxic. However, at concentrations 10.0mg/L, the growth of phytoplankton was inhibited, Cu was the most toxic, followed by Pb and Zn. The rising values of Iron between March and April showed an increase in plankton biomas, this may confirm the fact that algae especially diatoms require Iron for growth. Similar observations were also made by Bilgrami and Kumar (1997).

Table 2. Species Abundance of Phytoplankton Species that occurred from December 2012 to May, 2013 at the Iragbo part of Yewa Lagoon.

	DEC.	JAN.	FEB.	MAR.	APR.	MAY
Division: BACILLARIOPHYTA (DIATOMACEAE)						
Class: BACILLARIOPHYCEAE						
Order I: CENTRALES						
Family: COSCINODISCACEAE						
Aulacoseira granulata Ehrenberg	5	50	95	80	75	90
Aulacoseira granulata var. *angustissima*(Ehr.) Ralfs	5	20	60	55	95	65
Aulacoseira granulata var. angustissima f. *spiralis* Muller	-	5	70	55	85	65
*Aulacoseira italica*var.*subarctica*O. Muller	-	5	-	-	-	
Bacteriosira fragilis	-	-	30	-	25	10
Coscinodiscus concinnus	-	-	-	5	5	-
Coscinodiscus lineatus Ehrenberg	5	-	-	-	-	-
Coscinodiscus marginatus Ehrenberg	5	5	-	-	-	-
Coscinodiscus nitidus	-	-	15	10	-	-
Cyclotella comta	-	5	10	15	10	-
Cyclotella stelligera	-	-	5	-	5	10
Melosira islandica	-	-	-	10	5	-
Stephanodiscus astraea Grunow	-	5	-	-	-	-
Family:LEPTOCYLINDRACEAE						
Leptocylindrus daniscus	5	10	70	35	-	20
Family: RHIZOSOLENIACEAE						
Rhizoselenia stolterfothii	5	-	-	-	-	-
Order II: PENNALES						
Family: FRAGILARIACEAE						
Diatoma vulgaris	5	-	-	-	-	-
Synedraacus	-	15	-	-	-	-
Synedra ulna (Nitzsch) Ehrenberg	5	-	-	-	-	-
Tabellaria flocculosa (Roth) Kutzing	5	-	-	-	-	-
*Thalassiothrix nitzschioides*Grun.	-	5	25	20	-	10
Thalassiothrix spattulata	-	-	15	5	-	10
Family: GOMPHONEMACEAE						
*Gomphonema parvulum*var. lagenula	-	5	-	-	-	-
Family: ACHNANTHACEAE						
Cocconeis placentula	5	5	-	-	-	-
Family: NAVICULACEAE						
Navicula elliptica	5	-	-	-	-	-
Pinnularia major	5	-	-	-	-	-
*Stauroneis phoenicentron*f.*gracilis*	5	-	-	-	-	-
Family: NITZSCHIACEAE						
Nitzschia longissima	5	-	-	40	30	15
*Nitzschia tryblionella*var.*victoriae*	-	5	-	-	-	-
Division: CHLOROPHYTA						
Class: CHLOROPHYCEAE						
Order I: CHLOROCOCCALES						
Family: CHLOROCOCCACEAE						
Chlorella sp. Butcher	-	-	45	10	15	30
Chlorella vulgaris	150	5	-	-	-	-
Oocystis lacustris	-	5	-	-	-	-
*Palmellococcus minutus*Kutz.	25	-	-	-	-	-
*Tetraëdron regulare*var.incus	-	-	5	-	5	-
Family: HYDRODICTYACEAE						
Hydrodictyon reticulatum	-	5	25	-	10	15
*Pediastrum biradiatum*Meyen	-	5	-	-	-	-
Pediastrum clathratum (A. Brawn) Lengerth	-	5	-	10	15	5
Pediastrum duplex	-	-	15	-	5	-
Family: SCENEDESMACEAE						
Actinastrum hantzchii	-	-	-	10	15	5
*Actinastrum hantzchii*var.*fluviatile*	-	-	10	15	10	-
Crucigena minima	-	5	-	-	-	-
Tetrastrum sp.	-	-	-	5	5	-
Order II: VOLVOCALES						
Family: VOLVOCACEAE						
Pandorina morum	5	-	-	-	-	-
Volvox globator	-	-	-	-	5	-
Order III: ZYGNEMATALES (CONJUGALES)						
Family: DESMIDIACEAE						

Closterium arcuarium	**5**	-	-	-	-	-
Closterium arcutum	**5**	-	-	-	-	-
*Closterium cornu*var. *javanicum*	**5**	-	**10**	**5**	-	**10**
Hyalotheca dissiliens	**5**	-	-	-	-	-
Order IV: Ulotrichales						
Family: Ulotrichaceae						
Stichococcus bacillaris	-	**10**	**35**	**15**	-	**10**
Family: MESOTAENIACEAE						
*Golenkinia radiata*Chodat	-	-	**10**	**5**	-	**5**
Gonatozygon kinahanii	**5**	-	-	-	-	-
Family: ZYGNEMATACEAE						
Family: ZYGNEMATACEAE						
Spirogyra africana Fritsch Cruda	**5**	-	-	-	-	-
Division: CYANOPHYTA						
Order I: CHROOCOCCALES						
Family: CHROOCOCCACEAE						
Chroococcus disperses	-	**10**	-	-	-	-
*Chroococcus pallidus*Nageli	**5**	-	-	-	-	-
*Microcystis aeruginosa*f. *flos-aquae*	-	**5**	-	-	-	-
Microcystis aeruginosa Kutzing	**175**	**375**	-	-	-	-
Order II: NOSTOCALES						
Family: NOSTOCACEAE						
*Anabaena spiroides*Klebahn var. minima Nygaard	-	-	**15**	-	**10**	**20**
Anabaena spiroides Klebahn var. tumida Nygaard	-	-	**25**	**15**	**5**	**10**
Order III: OSCILLATORIALES						
Family: OSCILLATORIACEAE						
Oscillatoria sp.	-	**1850**	-	-	-	-
Oscillatoria tenius Agardh	**5**	-	-	-	-	-
Division: EUGLENOPHYTA						
Order: EUGLENALES						
Family: EUGLENACEAE						
Euglena ehrenbergii	-	-	**15**	**10**	**5**	-
Phacus caudatus	**5**	-	-	-	-	-
Phacus longicauda	**5**	-	-	-	-	-
*Phacus longicauda*var. *rotundus*	-	-	**15**	**10**	**5**	-
*Phacus oblonga*var.*planctonica*	**5**	-	-	-	-	-
Phacus sp.	**5**	-	-	-	-	-
Trachelomonas conica	**5**	**5**	-	-	-	-
Trachelomonas nigerica	-	**5**	-	-	-	-
Trachelomonas robusta	-	**5**	-	-	-	-
Trachelomonas volvocina	**5**	-	-	-	-	-
Trachelomonas volvocinopsis	**5**	**5**	-	-	-	-
Division: CHRYSOPHYTA						
Order: MISCHOCCOCALES						
Family: SCIADACEAE						
Centritractus belonophorus	-	**5**	-	-	-	-
Ophiocytium capitatum Wolle	**5**	-	-	-	-	-
Tetrasporopsis perforate	**5**	-	-	-	-	-
Division: PYRRHOPHYTA						
Class: DINOPHYCEAE						
Order: DINOKONTAE						
Family: PERIDINIACEAE						
Peridinium cinctum	**5**	-	-	-	-	-
Family: GYMNODINIACEAE						
Gymnodinium excavatum	-	**5**	-	-	-	-
Order: GONYAULACALES						
Family: GONIODOMATACEAE						
Alexandrium catenella	**5**	-	-	-	-	-
ORDER: NOCTILUCALES						
Family:NOCTILUCACEAE						
Noctiluca scintillans	**5**	-	-	-	-	-
Total species diversity (S)	**38**	**30**	**23**	**22**	**23**	**19**
Total abundance (N)	**525**	**2450**	**630**	**440**	**460**	**415**

Table 3. Species Abundance of Epiphyton Species that occurred from February to May, 2013 at the Iragbo part of Yewa Lagoon.

EPIPHYTON TAXA	DEC.	JAN.	FEB.	MAR.	APR.	MAY
Division: BACILLARIOPHYTA						
Class: BACILLARIOPHYCEAE						
Order: CENTRALES						
Family: COSCINODISCACAEA						
Aulacoseira granulata var. augustissima	185	180	200	175	80	95
Aulacoseira granulata var. muzzanensis	190	160	185	145	110	75
Aulacoseira italica var. supsp. Subarctica	50	75	85	70	45	55
Aulacoseira granulata Ehrenberg	55	50	40	25	20	30
Coscinodiscus granii	10	-	5	-	-	5
Coscinodiscus nitidus	15	20	15	10	-	5
Cyclotella comta Kutzing	10	15	15	10	5	-
Order: PENNALES						
Family: FRAGILARIACAEA						
Diatoma elongatum	5	-	-	-	10	15
Fragilaria virescens	-	-	10	15	-	-
Gyrosigma scalproides	10	-	5	5	-	-
Pediastrum chlathratum	-	10	10	-	10	5
Pediastrum duplex var. subgranulatum	10	15	20	10	-	5
Surirella ovate	15	20	15	-	5	-
Surirella robusta	15	10	15	5	-	10
Surirella robusta var. armata	-	15	-	15	-	10
Surirella robusta var. splendid	15	10	25	40	15	5
Synedra acus	15	10	30	25	5	20
Leptocylindrus daniscus	25	-	45	20	-	10
Leptocylindrus sp.	10	20	30	15	20	-
Dentonula schroderi	20	30	20	10	15	5
Stephanodiscus astraea Grunow	20	15	25	10	15	5
Stephanodiscus minutulus	20	15	20	25	-	15
Tabellaria fenestrata var.intermediata	10	10	30	20	15	20
Melosira islandica	55	70	45	75	50	35
Pinnularia divergens	10	-	10	25	-	15
Gomphonema dubravicense	-	15	10	-	10	5
Division: CHLOROPHYTA						
Class: CHLOROPHYCEAE						
Order: TETRASPORALES						
Family: TETRASPORACAEA						
Asterococcus superbus	10	20	25	-	-	10
Order: DESMIDIALES						
Family: DESMIDIACAEA						
Desmidium sp.	5	-	5	5	-	-
Desmidium swartzii	20	10	-	5	10	5
Hyalotheca dissiliens	-	5	5	-	15	5
Order: VOLVOCALES						
Family: VOLVOCACAEA						
Pandorina morum	-	10	-	-	5	-
Volvox globator	5	-	5	-	-	5
Division: CYANOPHYTA						
Class: CYANOPHYCEAE						
Order: NOSTOCALES						
Family: NOSTOCACAEA						
Anabaena affinis	20	20	30	20	5	10
Anabaena spiroides var.tumida	10	20	25	35	15	5
Calothrix pariatina	5	-	-	5	-	-
Tetraëdron regulare var.incus	-	5	-	5	-	-
Division: EUPHYTA						
Class: EUPHYCEAE						
Order: EUGLENALES						
Family: EUGLENACAEA						
Euglena ehrenberghii	10	-	15	-	10	5
Phacus longicauda	10	5	-	10	-	15
Trachelomonas hispida	-	10	-	-	5	5
Total species diversity (S)	31	29	26	23	20	25
Total abundance (N)	895	885	880	705	465	455

Table 4. Variations in species richness (d), Shannon-Wiener index(H), Bray Curtis index(BC) and Equitibility index(J) in phytoplankton community across months Iragbo part Yewa Lagoon.

	MONTHS					
INDICES	**DEC.**	**JAN.**	**FEB.**	**MAR.**	**APR.**	**MAY**
Shannon-Wiener Index (Hs)	1.05	0.43	1.22	1.18	1.10	1.09
Margalef Index (d)	5.91	3.72	3.41	3.45	3.59	2.99
Bray Cutis Index	0.45	0.58	0.49	0.55	0.60	0.54
Equitability Index (j)	0.67	0.29	0.90	0.88	0.81	0.85

Table 5. Variations in species richness (d), Shannon-Wiener index(H), Bray Curtis index(BC) and Equitibility index(J) in epiphyton community across months Iragbo part Yewa Lagoon.

	MONTHS					
INDICES	**DEC.**	**JAN.**	**FEB.**	**MAR.**	**APR.**	**MAY**
Shannon-Wiener Index (Hs)	1.40	1.36	1.34	1.25	1.21	1.30
Margalef's Index (d)	4.02	4.00	3.98	3.62	3.41	4.27
Bray Cutis Index	0.49	0.50	0.52	0.48	0.51	0.47
Equitability Index (j)	0.91	0.94	0.95	0.92	0.93	0.93

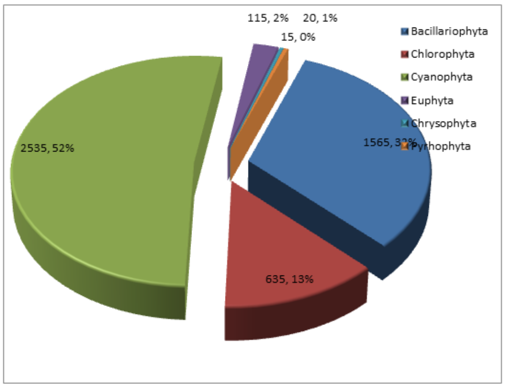

Fig. 5. Relative abundance of phytoplankton divisions that occurred at the Iragbo part of Yewa Lagoon from December, 2012 to May, 2013.

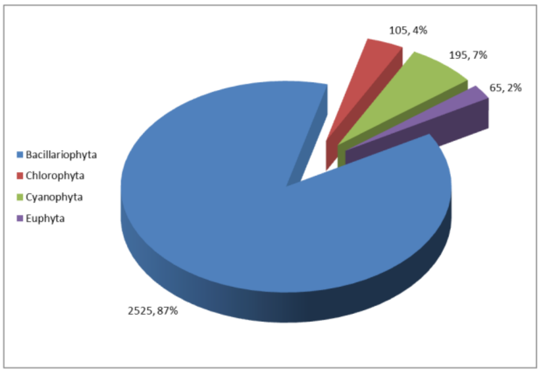

Fig. 6. Relative abundance of Epiphyton divisions that occurred at the Iragbo part of Yewa Lagoon from December, 2012 to May, 2013.

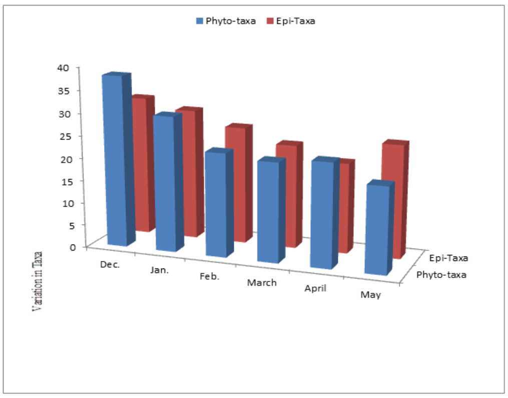

Fig.7. Variations in taxa for Phytoplankton and Epiphyton communities from Dec. 2012- May 2013 at Irabgo part of Yewa Lagoon.

The abundance of aquatic machrophytes like Ipomoea aquatic Forsk, Eichhornia crassipis and Pistia stratiotes by the Yewa Lagoon side as well as the water surface is an indication of the eutrophic level of the Lagoon. Nwankwo and Akinsoji (1988) made similar observations while working on benthic algal community on water hyacinth in south western Nigeria. With the nutrient loads mainly from domestic and industrial which drains into the Lagoon through creeks, rivers and wetlands, it would be expected that the algae present would be pollution-tolerant and hence indicator species.

Diatoms dominated the water hyacinth epiphyton community possibly because of their ability to develop rapidly on newly submerged surfaces or due to their ability to successfully adapt to fresh water habitat. According to Shevchenco (2000), it has been found that the most favorable condition for epiphyton development are formed on submerged plants, where the number of algal species and their intraspecific taxa is higher than that on plants of other ecological groups. Nwankwo and Onitiri (1992), while working on periphyton community on submerged aquatic macrophytes (Horn-wort and Bladder-wort) in Epe Lagoon reported the dominance of diatoms. Chlorophyll-a (phytoplankton) abundance showed positive correlation with COD and DO although not significant while chlorophyll-a (epiphyton) showed significant positive relationship with P,N and S. The phytoplankton community has a higher species richness than the epiphyton but the epiphyton has a better spread across the months. A higher population of central diatoms are found in the phytoplankton community whereas the epiphyton community has a higher population of pinnate diatoms, this maybe as a result of the ability of the pinnate diatoms to attach easily to aquatic machrophytes. The similarity between phytoplankton and epiphyton is 0.49. this may mean that about half of the species found in the phytoplankton community may also be found in the epiphyton community. The dissimilarity index also indicates that half of the species in the two communities may not be found in both.

Since many of the species observed were found in almost all the months regardless of the water status, their presence may not make them satisfactory indicators of any particular pollution. However, it may be possible to relate the abundance of some species with changes in water quality. For instance the presence of species like Gomphonema parvulum (diatom), Synedra acus (diatom), trachelomonas hispida (Euglenoid), Phacus longicauda (Euglenoid), surivella ovata (Diatom), Pinnularia major(Diatom),Chlorella vulgaris(green algae), Actinastrum hintzschii(green algae), Pandorina morum(green algae) are known to be indicators of organic pollution (Butcher 1947, Palmer, 1969), this may be a pointer that the Iragbo part of Yewa` Lagoon is gradually being enriched probably due to several tributaries connected to it. Nwankwo and Amuda (1993), while working on periphytic diatom on three floating aquatic macrophytes in a polluted south-west Nigerian creek also made similar observations. Some algal species like Actinastrum hantzzchii(Green algae), Pediastrum clathratum(Green algae), Pinnularia divergens(Diatom), Euglena ehrenbergii(Euglena) and Golenkinia radiata(are threatened by the pollution status of the Lagoon.

5.0 CONCLUSION

Both phytoplankton and epiphyton biomass were higher in the dry months due to relative stability of the lagoon water and higher light penetration, this may imply that during wet months the lagoon receives substantial amount of inland waters through its many tributaries, resulting to light penetration, high turbidity and high TSS thereby resulting to paucity of diatoms in the lagoon. Naturally the pH of fresh water like the Yewa Lagoon is well known to be more acidic but in this work it is seen to be more alkaline due to lechaets from Ewekoro cement factory. Almost half of the species identified during the investigation belong to both plankton communities. Phytoplankton algal species that could be used as indicator of organic pollution identified include: Diatoms- Gomphonema parvulum, Synedra acus, Pinnularia major. Green algae- Chlorella vulgaris, Actinastrum hantzschii. Euglenoids- Phacus longicauda while Epiphyton species that could be used as indicator of organic pollution identified include: Diatoms- Synedra acus, surivella ovata, Green algae- Pandorina morum, Euglenoids- Trachelomonas hispida, Phacus longicauda.

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