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Full Length Research Paper

The Water Quality Phytoplankton and Zooplankton of the Lower Ogun River Lagos

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Abstract
The composition, abundance and temporal variation of phytoplankton and zooplankton at the lower part of Ogun river in Lagos in relation to water quality characteristics were investigated for six months (October, 2008 – March, 2009). The water quality showed monthly variations adjudged linked to tidal brackish water incursion from the Lagos lagoon, evaporative concentration and rainfall which initiate flood waters. The water quality in the area showed an initial stability (Oct. – Jan.) and a gradual increase in salinity and other related factors as the dry season progressed. Whereas Conductivity, Salinity, Total dissolved solids, Calcium, Magnesium and Chloride generally increased throughout the study period, Transparency, Acidity, Dissolved oxygen and Biochemical oxygen demand recorded lower values. Phytoplankton biomass in terms of numbers was relatively higher in the wet months than in the dry months. Additionally, there was a corresponding increase in Chlorophyll a values during this period. A total of 43 species from 23 genera were recorded. The observed classes in terms of diversity and abundance were Bacillariophyceae (48.8%, 46.2%), Cyanophyceae (37.2%, 46.7%) and the Chlorophyceae (14%, 7.2%) respectively. The Species richness index (d) was higher in March with a value of 3.41 while the Evenness (j) was between 0.76 and 0.93. The Shannon-Wiener (Hs) was highest in March and lowest in December. Frequently occurring genera were Oscillatoria (11 taxa), Aulacoseira (4 taxa) and Synedra (4 taxa). The Oscillatoria spp. were strongly indicating pollution. For the zooplankton, a total of 14 adult species from 11 genera, with 6 juvenile stages were recorded. In terms of diversity and abundance, Rotifers (40%, 37.6%), Copepods (25%, 28.9%), Cladoceran (5%, 4.2%) and Juveniles (30%, 29.6%) were respectively encountered. The juvenile stages were more frequently occurring than adult zooplankton suggesting the area to be a breeding and nursery ground for species. Species richness (d) and Shannon-Wiener diversity index (Hs) were lower during the rains and higher with the coming of the dry season. Whereas 42.9% of zooplankton taxa belong to Phylum Crustacea in terms of diversity, 57.1% was for the Phylum Rotifera. The total zooplankton species recorded 70% of adult forms and 30% of juvenile forms with regards to diversity. Notable species recorded include Daphina (Cladocerans), Cyclops sp., Cyclops strenus (Cyclopiod copepods) Lecane and Keratella spp. (Rotifers).

Keywords: *Lagos,Phytoplankton, Water Quality, Zooplankton*

Introduction

The rivers, creeks and lagoons of South-Western Nigeria form part of the numerous ecological niches associated with the Nigerian coastal environment (Onyema, 2009a; Chukwu and Nwankwo, 2004). A key feature of the Lagos lagoon, and adjoining rivers and creeks is the environmental gradient which is regulated by largely tidal seawater incursion in the dry season and the influx of flood water during the wet season (Onyema, 2009b). The brackish nature of these environments therefore is as a result of the extent of the tidal seawater migration upstream and the incursion of river induced flood water downstream. As reported by Nwankwo (1996), the dynamic interplay between freshwater inflow and tidal seawater incursion in these aquatic ecosystems in our coastal waters determines the environment at any one time.

In south-western Nigeria as well as other areas, rivers gravitate to larger (and lower) bodies of water enroute to the sea. For instance, the Ogun River is known to flow into Lagos from Ogun state. In Lagos, the river bifurcates and the southern arm is referred to as the Agboyi creek. Both arms of the river flow in the Lagos lagoon from its northern axis. The Lagos lagoon also flows via the semi-diurnal tidal regime and gravitation into the sea (Atlantic Ocean) through the Lagos habour (Onyema and Ojo, 2008). These hydrological regime are known to determine the absence, presence, or even abundance and distribution of aquatic flora and fauna in these coastal ecosystems. The phytoplankton, zooplankton, benthos and fishes in these systems at any time are reflections of the prevailing water chemistry characteristic (Onyema, 2013a). Aquatic life in these waters is hence subjected to changes in water quality features.

The plankton are the pioneers of aquatic trophic relationships. Emmanuel and Onyema (2007) are of the view that phytoplankton are the foundation of the food chain providing nutritional base for zooplankton and other invertebrates alike. Some literature on creeks in the region include Nwankwo and Akinsoji (1988) and Nwankwo and Amuda (1993) for the Ogbe creek and Nwankwo (1995) for the Orile creek. Furthermore, Onyema and Nwankwo (2006) investigated the Ijora creek, Emmanuel and Onyema (2007) the plankton and fishes of the Abule-Agege creek and Onyema and Ojo (2008) investigated the zooplankton and chlorophyll *a* values of the Agboyi creek. Furthermore, Adesalu and Nwankwo (2008) worked on the phytoplankton of Abule-Eledu creek and Chukwu and Nwankwo (2004) reported on the Porto-Novo creek. Whereas Lawal-Are *et al.* (2009) considered the crustacean zooplankton in the Abule-agege creek, Onyema, (2009a) considered the zooplankton of Tomaro creek while Onyema, *et al*., (2009) considered Chlorophyll *a*, water chemistry and zooplankton of the Badagry creek. Dimowo (2013) also reported on the phytoplankton and zooplankton of river Ogun in Abeokuta, Ogun State.

The aim of this study was to investigate the water quality characteristics, phytoplankton, zooplankton diversity and distribution of the lower Ogun River (Southern arm) in Lagos.

Materials and Methods

Description of Study Site

The study site for this investigation is situated in the Omodunni area of Kosofe Local Government Area, Lagos State, Nigeria. At this point (Fig. 1, Latitude 3.4^{0}E and Longitude 6.6^{0}N) the Ogun river is a slow moving water course and meanders on, before becoming the Agboyi creek (its saltier extension) which then flows into the Lagos lagoon. At the point where the River Ogun opens into the Lagos lagoon, it experiences marked tidal influence which is more discernable in the dry than wet season. Mangrove vegetation and associated communities are well developed in this area. The water course is also quite deep at this confluence point (≥10m).

The river serves as a major drainage channel for the area, receiving domestic waste discharges from houses with non existing or poor sewerage, pollutants from small and medium scale industries, markets, abattoir, a wood waste / sawdust deposition site, leachate and exudates from refuse / solid wastes used as land fill materials in the area. Sand mining, deforestation for fuel-wood and construction of brush parks (Acadja), land reclamation, fishing activities, transportation are all common practices. The river also receives industrial waste discharged from industries at Oworonshoki and Ogudu areas. The area is further plagued by housing development, transportation, mat making, fishing activities and fuel wood harvesting.
The region experiences a well marked dry (December - April) and wet season (May - November). There are two peaks of rainfall as well as two peaks of solar radiation in the region (Onyema 2008). The solar radiation peaks almost corresponds to the equinoxes while the rainfall peaks causes two different flooding periods. In addition to this, the colour of the water appearing green and turbid is as a result of various environmental cum anthropogenic influences in the region and sometimes the growth increases in algae.

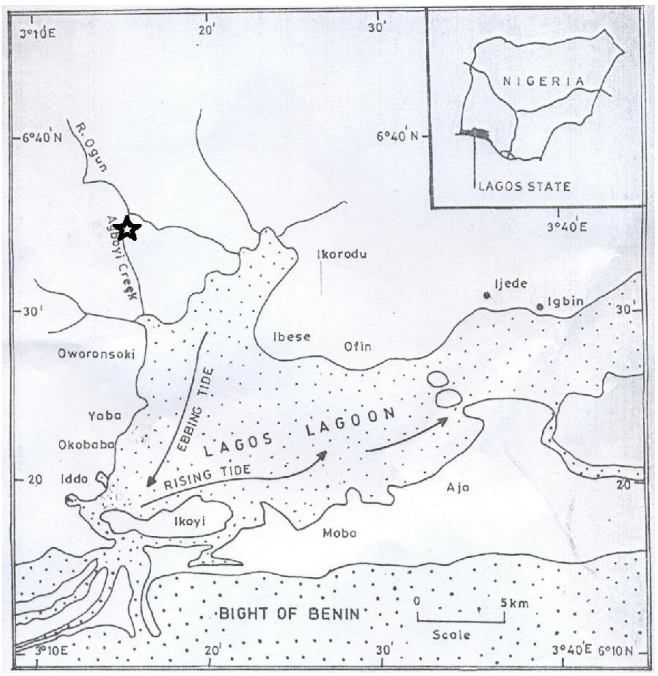

Fig. 1: The Lagos lagoon, showing River Ogun and indicating the study area.

The creek is open throughout the year and receives tidal influences which are experienced far inland especially during the dry season from the lagoon. These tidal influences and their effects are minimal during the wet season and at this time fresh water life predominates.

The river is characterized by floating plants such as *Pistia,* and an abundance of water hyacinths (*Eichhornia crassipes*) and *Vossia cuspidata*. Further downstream from the station *Acrostiscum aureum* (Halophytic fern), *Rhizophora racemosa* (Red mangrove), *Phoenix reclinata*, *Paspalum vaginatum, Cyperus articulatus* are common macro flora finds especially along the edges and shore zone of the water way. The Agboyi creek also serves as a nursery ground for fish, crabs and herons that also avail the area. The river bank is lined by human settlements especially at the south-western side of the river. Sparse or nonexistent settlements are found on the north-eastern divide. The area is basically a fishing community with the people, including the women and children involved in fish and shell fish fishery. Sedges in this region are used for mat making among others.

Collection of Samples

The area was sampled for six months (October 2008 – March 2009). Water samples were collected each month using 75cl plastic containers with each indicating the month of collection at the study site. Sampling was carried out between 11.00 and 14.00 hours on each sampling day. The plastic bottles were dipped into water to collect the water samples. All samples were taken to the laboratory for physical and chemical analysis of the water samples.

Plankton samples were also collected at the study site for six months (October 2008 – March 2009). They were collected by hauling standard plankton net of 55µm mesh size with a sample bottle attached at an interval of 5minutes, horizontally. This was done at low speed (4km/h) upstream. The filtrate in the attached sample bottle was transferred into a well labeled plastic container with screw caps. Samples were preserved in diluted 5% formalin and transported to the laboratory for microscopic analysis.

Plankton analysis (per 0.1ml)

Plankton sample was allowed to settle in the lab for at least 48hrs and concentrated to 20ml. For each settled sample, 5 drops of well mixed sample was investigated. On each occasion, one drop of sample (0.1ml) was thoroughly investigated using the Drop Count Method (Onyema, 2007b). The mount was thoroughly investigated and counts were made per species and recorded using a Carl Zeiss monocular microscope. An average of 5 outcomes of this procedure was carried out per sample and averaged.

Community Structure Analysis

For phytoplankton and zooplankton community's, eco-mathematical indices (biological indices) were used. Biological indices used were Total number of species (S), abundance of species (N), Log of Species Diversity (Log S), Log of Species Abundance (Log N), Shannon-Wiener Index (Hs), Menhinick Index (D), Margalef Index (d), Equitability (j) and Simpson's Dominance Index (C) (Ogbeibu, 2005).

Results

Monthly variation in the water chemistry parameters at the lower Ogun river from October (2008) to March (2009) are shown in Table 1. Air temperature estimates showed monthly variation. The highest value (33°C) was recorded in December and the lowest value (30°C) was recorded in November and February. The highest water temperature (30.8^{o}C) was recorded in March and the lowest (24.9^{o}C) was recorded in December with a mean temperature of 27.13^{o}C. Transparency ranged between 28cm in November and 77cm in February. Transparency was relatively higher in the dry season and lower in the wet season. Total suspended solid ranged between 349mg/L in October and 55mg/L in January with an average of 127.833mg/L. Total dissolved solids on the other hand ranged between 50mg/L recorded in October and 1,730mg/L in March. Mean Total dissolved solids was 549.83mg/L. The rainfall data showed monthly variation with the highest value (137.9 mm) in October and the lowest value (13.7 mm) in January.

With regard to chemical characteristics, the pH of the water fluctuated monthly (6.81 - 7.66) from October to March. The salinity values was 0.1‰ between October and January while there was an increase in February and March with the latter recording the highest value of 1.4‰. The mean value and standard deviation was: 0.518 and ±0.64 respectively. Conductivity increased progressively during the period ranging between 98.6 and 2890µS/cm. The lowest value (98.6µS/cm) was recorded in October and the highest (2890µS/cm) was recorded in March with a mean value of 993.88. The dry season recorded higher values. Alkalinity ranged between 9 and 140mg/L. The highest value was recorded in February (140.0mg/L) while the lowest (9.0mg/L) was recorded in October. The chloride values ranged from between 7.6mg/L in (October) and 360 mg/L in (March). Dissolved oxygen ranged between 4.7 and 5.8mg/L. The lowest (4.7mg/L) was recorded in March while the highest (5.8mg/L) was recorded in October with a mean value of 5.2mg/L. Recorded dissolved oxygen values were higher in the rainy season. Biological Oxygen Demand was constant during the period investigated with a value of 2.0mg/L except in March where the value was 3.0mg/L. Chemical oxygen demand ranged between 7.0 and 20.0mg/L. The Calcium concentration varied from a minimum of 4.2mg/L in January to a maximum of 302.0mg/L in February. Magnesium levels varied between 1.5 and 269.1mg/L. A minimum value of 1.5mg/L was recorded in January and a maximum of 269.1mg/L was recorded in February. With regards to the nutrient status,

Nitrate level was highest in December (7.7mg/L) and lowest (2.4mg/L) in November with a mean value of 4.67. Also the rainy season recorded higher values than the dry season. Phosphate level was highest in December with a value of 18.2mg/L and lowest in February with a value of 0.10mg/L. There was an increase in the rainy season than the dry season. The sulphate concentration ranged between 2.0 and 314.7mg/L with the minimum concentration (2.0mg/L) recorded in January while the maximum concentration (314.7mg/L) was recorded in March. It was higher in the dry season compared to the rainy season. Silica values ranged between 2.4mg/L in December and a maximum of 4.8mg/L in March with an average value of 3.31mg/L. Silica concentration was higher in the dry season than the rainy season.

Heavy metals levels also showed notable variations. Copper values were fairly constant ranging between 0.002 and 0.005mg/L. The lowest value (0.002mg/L) was recorded in November, December and January respectively while the highest value (0.005mg/L) was recorded in February and March respectively. Higher copper value was recorded in the rainy season than the dry season. Iron was highest (0.26mg/L) in November and February while it was lowest value (0.088mg/L) in October. Zinc on the other hand had its lowest value (0.005mg/L) in November while the highest value (0.017mg/L) was recorded in March.

Biological Characteristics

Chlorophyll a (µg/L)

There was a distinct variation in the values of chlorophyll *a* recorded during the sampling period. It increased steadily in the wet months and decreased in the dry months. The highest recorded value (24µg/L) was in December while the lowest value (6µg/L) was recorded in October. The mean and standard deviation values were 15.5 and ± 6.25 respectively.

Phytoplankton characteristics

A checklist of phytoplankton in the lower Ogun River between October, 2008 and March, 2009 is presented in Table 2. Phytoplankton population was more in the dry season than the wet season. The phytoplankton abundance was represented by three (3) Divisions namely; Bacillariophyta, Chlorophyta and Cyanophyta. The Bacillariophyta were represented by twenty-one (21) species from two orders (Centrales and Pennales), the Chlorophyta were represented by six (6) species from four orders (Ulothricales, Chlorococcales, Zygnemetales and Desmidiales) and the Cyanophyta were represented by sixteen (16) species from two orders (Chroococcales and Homogonales). Among the phytoplankton divisions, the Cyanophyta had the largest percentage (46.7%), followed by the Bacillariophyta (46.2%) and the Chlorophyta (7.18%) (Fig.2). The pennate diatoms were the majority in abundance in terms of numbers. The notable genera of the pennate diatoms were the *Synedra*, *Pinnularia*, and *Navicula.* The centrales were the *Aulacoseira*, *Coscinodiscus*, *Cyclotella* and *Terpsinoe*. Representing the Chlorophyta were *Ulothrix*, *Scenedesmus*, *Spirogyra*, *Closterium*, *Pediastrum* and *Staurastrum*, while the Cyanophyta was represented by *Oscillatoria, Microcystis, Merismopedia*, *Anabaena* and *Lyngbya.*

Table 1: Monthly Variation In Water Quality Parameters At The Lower Ogun River (October, 2008 - March, 2009)

PARAMETERS	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	MEAN	STD
Air temperature (^{0}C)	31.8	30.0	33.0	31.0	30.0	31.0	31.22	±1.14
Water temperature (^{0}C)	26.1	27.0	24.9	28.0	27.0	30.3	27.13	±1.83
Transparency (cm)	48.0	28.0	30.0	50.0	77.0	50.0	50.16	±17.71
Total Suspended solids (mg/L)	349	96	114	55	80	73	127.83	±110.20
Total Dissolved solids (mg/L)	50	54	112	94	1259	1730	549.83	±747.11
Rainfall (mm)	137.9	28.0	137.2	13.7	84.6	52.0	75.60	±53.69
pH at 25^{0}C	7.19	7.17	6.81	7.05	7.58	7.66	7.24	±0.32
Conductivity (µS/cm)	98.6	106.6	223.1	185.0	2460	2890	993.88	±1310.1
Salinity (‰)	0.10	0.10	0.11	0.10	1.3	1.4	0.518	±0.65
Acidity (mg/L)	6.0	5.2	6.6	5.6	6.3	3.9	5.60	±0.97
Alkalinity (mg/L)	9.0	84	74.0	11.0	140	19.6	56.27	±52.39
Total Hardness (mg/L)	62.6	66.7	125.1	16.3	1875	652.1	466.30	±729.46
Calcium (mg/L)	13.0	16.4	27.1	4.2	302.0	60.6	70.55	±115.07
Magnesium (mg/L)	6.2	5.9	13.1	1.5	269.1	118.9	69.12	±107.83
Zinc (mg/L)	0.008	0.005	0.007	0.006	0.006	0.017	0.01	±0.01
Iron (mg/L)	0.088	0.26	0.24	0.22	0.26	0.24	0.22	±0.07
Copper (mg/L)	0.003	0.002	0.002	0.002	0.005	0.005	0.003	±0.0015
Chloride (mg/L)	7.6	12.3	16.5	17.6	466.7	405.2	154.32	±219.05
Nitrate (mg/L)	2.4	3.8	7.7	6.3	3.0	4.8	4.67	±2.03
Sulphate (mg/L)	2.0	6.1	6.1	3.4	210.0	314.7	90.38	±137.27
Phosphate (mg/L)	17.4	14.3	18.2	8.8	0.10	8.8	11.27	±6.81
Silica (mg/L)	2.8	2.6	2.4	3.1	4.2	4.8	3.33	±0.96
Biological Oxygen Demand (mg/L)	2	2	2	2	2	3	2.17	±0.41
Chemical Oxygen Demand (mg/L)	20	16	13	7	8	12	12.67	±4.89
Dissolved Oxygen (mg/L)	5.8	5.4	5.1	4.9	5.0	4.7	5.15	±0.39
Chlorophyll *a* (µg/L)	6	16	24	18	11	18	15.50	±6.25

Table 2: A checklist of Phytoplankton at the lower Ogun River (October, 2008- March, 2009).

PHYTOPLANKTON TAXA
DIVISION : BACILLARIOPHYTA
CLASS: BACILLARIOPHYCEAE
ORDER 1: CENTRALES
Aulacoseira granulata Ehrenberg (Ralfs)
Aulacoseira granulata var. *angustissima* Muller
Aulacoseira granulata var. *curvata* Simon
Aulacoseira granulata var. *muzzaenisi* (Meist)
Coscinodiscus sp.
Cyclotella sp.
Terpsinoe musica (Ehrenberg) Hustedt
ORDER 2: PENNALES
Achnanthes sp.
Diatoma elongatum (Lyngb.) Agardh
Gyrosigma hippocampus Ehrenberg
Navicula mutica Kutzing
Navicula rhynchocephala Kutzing
Navicula sp.
Pinnularia brannii Grunow
Pinnularia sp.
Pleurosigma elongatum Wm Smith
Stauroneis anceps Ehrenberg
Synedra crystallina Kutzing
Synedra ulna (Nitzsch) Ehrenberg
Synedra ulna biceps Ehrenberg
Synedra sp.
DIVISION CHLOROPHYTA
CLASS: CHLOROPHYCEAE
ORDER 1: ULOTHRICALES
Ulothrix sp.
ORDER 2: CHLOROCOCCALES
Scenedesmus quadricuada (Turp.) de Brebisson
ORDER 3: ZYGNEMATALES
Spirogyra africana (Fritsch) Czurda
ORDER 4: DESMIDIALES
Closterium moniliferum (Bory) Ehrenberg
Pediastrum simplex (Meyen) Lemmermann
Staurastrum sp.
DIVISION: CYANOPHYTA
CLASS: CYANOPHYCEAE

ORDER 1: CHROOCOCCALES	***Oscillatoria geminata* Meneghini**
***Merismopedia glauca* (Ehr.) Nageli**	***Oscillatoria limosa* Roth**
***Microcystis aeruginosa* Kutzing**	***Oscillatoria margatifera* (Kutz) Gomont**
***Microcystis flos-aquae* (Kirchner)**	***Oscillatoria platensis* Geitler**
	***Oscillatoria subtilissima* Kutzing**
ORDER 2: HOMOGONALES	***Oscillatoria tenius* Agardh**
***Anabaena spiroides* Klebahn**	***Oscillatoria trichodes* Szafer**
***Lynbgya martensiana* Meneghini**	***Oscillatoria* sp. I**
***Oscillatoria curviceps* Agardh**	***Oscillatoris* sp. II**
***Oscillatoria formosa* Bory**	

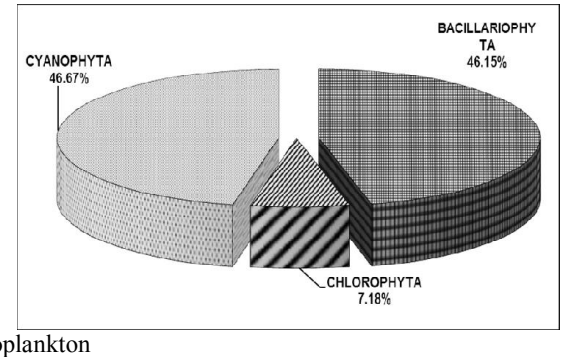

Fig. 2: Relative Abundance of Phytoplankton

Community Structure Indices for phytoplankton assemblage (Table 3)

Species richness (d) value ranged between 1.20 and 3.41. The highest value (3.41) was recorded in March and the lowest (1.20) was recorded in February. The Shannon-Wiener diversity index (Hs) ranged between 0.73 and 1.13. The highest (1.13) was recorded in March and the lowest (0.73) was recorded in February. Menhinicks index (D) value ranged between 0.73 and 1.01. The highest value 1.01 was recorded in March and the lowest value of 0.73 was recorded in December. The Evenness (j) value ranged between 0.76 and 0.93. The highest value (0.93) was recorded in October and February while the lowest value (0.76) was recorded in December. The Simpsons' Dominance Index (C) value ranged between 0.01 and 0.25. The highest value (0.25) was recorded in December while the lowest value (0.01) was recorded in March.

Table 3: Phytoplankton biological indices at the lower Ogun river per 0.1 ml (October, 2008- March, 2009).

Bio-indices	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.
Total species diversity (S)	8	8	10	10	6	22
Total abundance (N)	65	75	190	105	65	475
Log of Species diversity (Log S)	0.90	0.90	1.00	1.00	0.78	1.34
Log of abundance (Log N)	1.81	1.88	2.28	2.02	1.81	2.68
Shannon-Wiener Index (Hs)	0.84	0.77	0.76	0.89	0.73	1.13
Menhinick Index (D)	0.99	0.92	0.73	0.98	0.74	1.01
Margalef Index (d)	1.68	1.62	1.72	1.93	1.20	3.41
Equitability Index (j)	0.93	0.85	0.76	0.89	0.93	0.84
Simpson's Dominance Index (C)	0.17	0.23	0.25	0.15	0.21	0.10

Zooplankton characteristics

A checklist of zooplankton species between October 2008 to March 2009 is shown in Table 4. A total of 14 adults species from 11 genera were recorded for the study with 6 juvenile stages. More taxa were recorded in March compared to January and February more less others. Two major phyla of zooplankton were identified period namely Crustacea and Rotifera. The major orders represented were Order: Cladocera, Order: Calanoida and Order: Cyclopoida Phylum Rotifera was more important in terms of diversity, accounting for 57.1% followed by the Crustacea accounting for 42.9%. Among the Crustacea, *Microcyclops* species (Cyclopoida) had the highest number of species (110 individual per 0.1ml) while *Paracalanus parvus* (Calanoida) ranked next with (40 individuals per 0.1ml) while among the Rotifera, *Brachinous falcatus* (Monogonotha) had the highest number of species (180 individual per 0.1ml). *Epiphanes senta, Keratella cochleraris* and *Lecane* species ranked lowest with a total number of 10 individuals per 0.1ml. Nauplii larvae of copepod (juvenile) had the highest number of individual ranking 150 individuals per 0.1ml while the copepod egg ranked next accounting for 40 individuals per 0.1ml and the fish egg was 15 individuals per 0.1ml.

The Phyla Crustacean and Rotifera occurred throughout the sampling period except in October and November. The highest number of individual species was recorded was in March 2009 (650 individual per 0.1ml) while the least number occurred in October, 2008 (20 individual per 0.1ml). In terms of diversity, Copepods recorded 25%, Cladoceran 5%, Rotifers 40% and Juveniles 30%. Additionally, in terms of total recorded occurrence, Copepods was 28.9%, Cladoceran 4.2%, Rotifers 37.6% and Juveniles 29.6% (Fig. 3).

Table 4: A checklist of Zooplankton at the lower Ogun River (Oct., 2008 - Mar., 2009).

TAXA	ORDER:PLOIMIDA
PHYLUM CRUSTACEA	***Ascomorpha saltans* Bratsch**
CLASS I:BRANCHIOPODA	***Brachionus falcatus* Zacharias**
ORDER I:CLADOCERA	***Epiphanes senta* O.F.Muller**
***Daphnia* sp.**	***Keratella cochlearis* Cosse**
	***Keratella quadrata* Muller**
CLASS II:COPEPODA	***Lecane luna* O.F.Muller**
ORDER II:CALANOIDA	***Lecane* sp.**
***Arcatia clausii* Giesbrecht**	***Scaridium longicaudum* O.F.Muller**
***Paracalanus parvus* Claus**	
	JUVENILE STAGES
ORDER III:CYCLOPOIDA	**Copepod egg**
***Cyclops strenus* Fritch**	**Decapod nauplii larvae**
***Cyclops* sp.**	**Fish egg**
***Microcyclops* sp.**	**Nauplii larvae of copepod**
	Molluscan larvae
PHYLUM ROTIFERA	**Rotiferan egg**
CLASS:MONOGONOTHA	

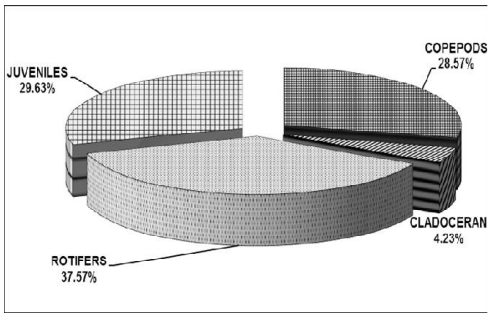

Fig. 3: Relative Abundance of Zooplankton

Community Structure Indices For Zooplankton (Table 5)

Species richness (d) value ranged between 0.33 and 1.85. The highest value (1.85) was recorded in March and the lowest value (0.33) was recorded in October. The Shannon-Weiner diversity index (Hs) value range between 0.24 and (0.93). The highest value (0.93) was recorded in March and the lowest value 0.24 was recorded in October. The Evenness (j) value ranged between 0.81 and 0.92. The highest value (0.92) was recorded in December and the lowest (0.81) was recorded in October. The Simpsons' Dominance Index (C) value range between 0.15 and 0.63. The highest value 0.63 was recorded in October and the lowest value (0.15) was recorded in March. (Table 5). The juveniles were Copepod egg, Decapod nauplii larvae,fish egg, Molluscan larvae, Nauplii larve of copepod and Rotifer egg. Whereas, Nauplii larvae of copepod recorded 53.57%, Copepod egg 14.29%, Rotifer egg 12.50%, Decapod nauplii and Molluscan larvae recorded 7.14% and fish egg 5.36% (Fig. 4).

Table 5: Zooplankton community composition parameter at the Lower Ogun River per 0.1ml (Oct., 2008 - Mar., 2009).

Bio-indices	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.
Total species diversity (S)	2	5	3	8	3	13
Total abundance (N)	20	55	30	120	70	650
Log of Species diversity (Log S)	0.30	0.70	0.48	0.90	0.48	1.11
Log of abundance (Log N)	1.30	1.74	1.48	2.08	1.85	2.81

Shannon-Wiener Index (Hs)	0.24	0.64	0.44	0.84	0.43	0.93
Menhinick Index (D)	0.45	0.67	0.55	0.73	0.36	0.51
Margalef Index (d)	0.33	1.00	0.59	1.46	0.47	1.85
Equitability Index (j)	0.81	0.91	0.92	0.93	0.90	0.84
Simpson's Dominance Index (C)	0.63	0.26	0.39	0.16	0.40	0.15

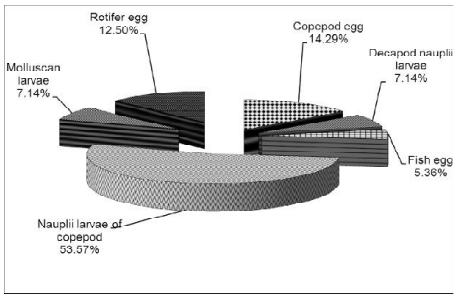

Fig. 4: Relative Abundance of Juvenile stages

Discussion

Environmental characteristics recorded for the study at the Omodunni area of the Agobyi creek showed monthly variation in all the parameters investigated. The fluctuation in water quality conditions and chlorophyll *a* during the study could be attributed to fresh water input from upstream Ogun River and from brackish water inflow from the adjoining Lagos lagoon, downstream. Concentration of dissolved substances resulting from increased evaporation in the dry season could also have influenced the variation in environmental characteristics recorded.

Transparency was lower in the wet season and higher in the dry season. A similar trend in values has been recorded by a number of authors in the region (Olaniyan, 1969; Nwankwo, 1996; 1998; Onyema *et al.* 2003). Transparency was observed to increase progressively with the dry season. The lowest transparency value was recorded in February 2009. There was a decrease in the turbidity value in March linked to the occurrence of rainfall just a few days before sampling. Transparency and rainfall are inversely related (Onyema, 2013b). Furthermore Nwankwo (1990) highlighted that seasonal variation in transparency in the coastal water of south-western Nigeria is linked to the rainfall pattern and associated floods.

pH was Alkaline except in December which recorded 6.81. According to Olaniyan (1969), pH is an indicator of environmental condition and the result of chemical condition in an aquatic environment. Conductivity increase with decrease in the total suspended solids and an increase in the total dissolved solids especially during the dry months. Salinity increased during the study. Similarly Total Dissolved Solids, Calcium, Magnesium, Conductivity and Chloride showed similar increases. These factors are possibly chemically related especially with regards to their trends. According to Nwankwo (1996, 1998), salinity which created horizontal environmental barriers to the

The continued increase in salinity values observed during the investigation could be due to reduced freshwater, coupled with increase in evaporation. Barnes (1980) highlighted the facts that in the wet seasons, lagoons are usually diluted considerably by freshwater from rain and river systems, while in the dry season, evaporation becomes more prominent, leading to increased values. The nutrients level recorded during the period of investigation was high for sulphate. Most tropical waters have low nutrients values, a feature considered common for natural and polluted waters, but the level of sulphates and nitrates recorded during the study could be as a result of both chemical, organic pollution and nutrient enrichment. The high levels of nitrate-nitrogen and sulphate could be due to the effect of direct discharges of pollutants such as municipal sewage and other biodegradable wastes into these coastal waters coupled with the enrichment from the environs of adjoining wetlands, creek and subsequent run-offs. The phosphate concentration was very low. The silica concentration was observed to increase especially during the dry months. Biochemical Oxygen Demand (BOD) was constant throughout the study period While Chemical Oxygen Demand (COD) and Dissolved Oxygen (DO) was relatively high in the wet months.

The values of Chlorophyll *a* which is a measure of photosynthetic productivity increased with an increase in phytoplankton biomass. The abundance and diversity of phytoplankton and zooplankton species varied with rainfall pattern. According to Kadiri (1993), seasonal fluctuation in abundance of phytoplankton is influenced by changes in the physical and chemical properties of the water which themselves can be dependent on rainfall. Lagos lagoon biota is also directly linked to the rainfall pattern (Onyema, 2009b).

The phytoplankton biomass was dominated by blue-greens and diatoms (majorly the pennate forms). Similar observations in the Lagos lagoon have been reported by many workers (Nwankwo, 1988 and 1996; Nwankwo and Akinsoji, 1989; Onyema *et al*., 2003, 2007). Dorminant species include *Oscillatoria* sp., *Navicula* sp., and *Synedra* sp. The abundance of pennate diatoms may be an indication that the water is probably shallow.
More zooplankton taxa were observed in January and March. This may be as a result of increased rainfall volume during these months which consequently led to an increase in flood effects and a dilution of the water body and an increase in the population of freshwater species. These observations showed that the number of individuals of the zooplankton species decreased with an increase in the amount of rainfall. Floods associated with rainfall dilute the ionic concentration of the coastal waters and breaks down any horizontal, environmental gradient within the lagoon system (Onyema 2009).
However, there was an increase in the abundance and species diversity of zooplankton and some juvenile stages in January and March, despite the sharp increase in the salinity of the water. This would probably signal high tolerance in these zooplankton components or delimit them as brackish water species.

Results from the biological indices for the phytoplankton and zooplankton communities (Shannon-Wiener Index (Hs), Menhinick Index (D), Margalef Index (d), Equitability Index (j) and Simpson's Dominance Index (C) followed a similar regime with the phytoplankton and zooplankton species composition and distributive pattern and were reflections of the species diversity (S) and species abundance (N) at the different stations. Hence, the bio-indices values were a good likeness of the species diversity and abundance. Biological indices values were generally higher in the dry than wet season. This is a reflection of the overall increase in diversity and occurrence.

Conclusion

The composition, abundance and temporal variation of phytoplankton and zooplankton at the lower part of Ogun river in Lagos were linked to tidal brackish water incursion from the Lagos lagoon, evaporative concentration and rainfall which initiate flood waters. These conditions controlled the regime of water quality. Phytoplankton and zooplankton biomass in terms of numbers and Chlorophyll *a* recorded variations. The recorded juvenile stages suggests a breeding and nursery ground for some aquatic species.

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